



# **The 8<sup>th</sup> World Congress of the International Association for Landscape Ecology**

*landscape ecology for sustainable environment and culture*

# **PROCEEDINGS**

Aug. 18-23, 2011, Beijing, China



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## Foreword

On behalf of the IALE Executive Committee and the Congress Organizer of the IALE-China Chapter, we would like to welcome you all and invite you to participate in the 8th IALE World Congress in Beijing, China.

China is an ancient country with a rich cultural legacy. The beauty of China's natural areas and the diversity of its cultural landscapes have gained much attention from all over the world. The harmonious multi-national development in this region of the world provides an ideal background for studying the relationships between humanity and nature, and natural and cultural landscapes. Over the past three decades, China has experienced a dramatic change in economic development which has resulted in accelerating rates of landscape change and inevitable conflicts between man and the environment. China now faces the challenge of developing landscape ecology practices that will provide a basis for economic growth as well as environmental security.

By organizing the IALE Congress, we wish to bring these issues to the attention of international scientists and to establish a platform to start cooperative research projects in China. We welcome all IALE members and interested individuals to participate in this congress in Beijing with our full hospitality. We expect to provide a rich academic and social experience that participants in past IALE World Congresses have always enjoyed.

As a contribution to a "Low Carbon Society", and to lower the weight of the luggage you take back home, we have saved the proceedings with all abstracts and symposium proposals as PDFs on a USB stick, which is also intended as a souvenir.

Enjoy the presentations and may you have a rewarding stay in Beijing!

Bruce Jones and Bojie Fu  
Chairs of the 8<sup>th</sup> IALE World Congress  
Aug. 17<sup>th</sup>, 2011

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Foreword to the 8<sup>th</sup> IALE World Congress in Beijing, 18-21 August 2011 on  
**Landscape Ecology for Sustainable Environment and Culture**

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Dear Congress participants!

I accepted with pleasure the kind offer by my dear friend and collaborator, Professor Xiuhzen Li, to address the participants of this IALE World Congress by a short foreword. As I will not be able to attend personally this important event, it affords me the opportunity to share with you my thoughts about the challenges of realizing the theme of this conference and thereby transforming landscape ecology into the leading science for sustainable environment and culture.

### **Introduction**

Landscape ecology has emerged and developed in the industrialized countries of the West, expanding after the foundation of IALE from Central Europe across the Atlantic Ocean to North America and then also across the Pacific Ocean to Australia. However, since the beginning of the last century and landscape ecology has further expanded into a truly global science with strong roots in the rapidly developing countries of Asia and especially in China. It is therefore very appropriate that the present 8<sup>th</sup> International Congress will take place in Beijing. This is a good opportunity to address the need for facing the great challenges facing the rapidly developing countries in the global information society and to fuse the experience, knowledge and insights gained by Western landscape ecologists with the changing outlooks and needs of Asian landscape ecologists

I feel myself very privileged having been able to participate in this fusion of West and East with the publication of the Chinese version of my 2007- Springer anthology (Naveh, 2007). This was possible, thanks to the close cooperation with Professor Xiuzhen Li and the support and encouragement by Professor Larry Bai-Lian Li, to whom we are both grateful (Naveh and Li, 2010).

In our joint discussion of the severe problems facing China to create such a sustainable environment and at the same time safeguarding the great cultural values of Chinese landscapes, we stated that no other developing country in the world can serve a better example of a society that has moved successfully with such a fast space from a pre-industrial agrarian phase with two thirds of a poor and hungry population, to the accelerating global information phase, becoming one of the leading economic nations in the world with a dramatic rise in its life standard. This has been achieved in spite of its poor natural resources, but with heavy costs for the quality of environment, and with great threats to human health and the biological and cultural assets of its landscapes. Therefore China is now approaching the critical "window decision" phase, at the crossroads between sustainable and unsustainable development.

We pointed out that China has still the chance to prevent these threats by avoiding the fatal mistakes made in highly developed industrial countries of the Western world. Chinese, as well

as other Asian people should not accept uncritically the strife of most Western people to pursue only one-sided economic goals of quantitative and materialistic values, by which development is regarded merely as economic growth, and not as overall qualitative improvement and progress of human welfare. Instead, they have still the opportunity to develop their own version of sustainable development. This version should be based on authentic and indigenous natural and cultural values and traditions, which have been shaped by the naturalism of Lao-tzu, the social discipline of Confucius, and the concern with personal enlightenment of Buddha.

If these basic principles would be adopted, then sustainable development could lead to the qualitative improvement of human life, dignity and equity and the concern for nature and both its life supporting instrumental and life enriching intrinsic values. This could be realized if these eastern cultural values would **be modernized but not westernized by their careful, step- by-step transformation into well-adapted, comprehensive, planning and land use strategies ensuring lasting synergistic (mutually reinforcing) benefits for the people, their economy, culture and their rural and urban landscapes.**

### **The need for a breakthrough towards a sustainability revolution of our global Total Human Ecosystem**

In this conference we have to realize that we are dealing not only with the need for a sustainable environment, but with a sustainable world of our **Total Human Ecosystem**, by which we humans, together with all other organisms are integrated with our total environment into an irreducible whole. Our global Total Human Ecosystem is undergoing presently, what the world renowned systems scientist, philosopher and planner Ervin Laszlo (2006; 2008) has called: A **World Macroshift transformation**. This is a chaotic process, driven by economic, sociological, and ecological unsustainability, and therefore leading sooner or later to a global breakdown. Human society has left little time for the choice of navigating this transition from the threatening breakdown to a **breakthrough towards a sustainable world**. Such a breakthrough is a "chaos point", during which any input or influence on the system, however small, can replace existing trends by new trends and processes. This can be achieved only by **a complete change in ways of thinking and doing things, in effect, an all embracing sustainability revolution**. It demands a shift from the age of fossil energy emphasis to a solar age, and a shift from the depletion of natural resources to their more efficient and wiser sustainable use. This requires recycling through-flows of material and energy and reduction of their adverse impacts on human and landscape health. It must be coupled with more sustainable lifestyles and consumption patterns, caring for nature and even investing in nature. As one of the central challenge facing humanity, this can be achieved only by **a true synthesis between nature, human society and its culture**, in which full use will be made both of natural and human scientific and technological potentials for their mutual benefit. But such a synthesis cannot be ensured and enhanced merely by piecemeal, ecological, technological, political, and economical means. It requires **a far-reaching shift in our worldview**, including the spheres of scientific, cultural, spiritual and ethical values.

### **The role of transdisciplinary landscape science in advancing the sustainability revolution**

As outlined in more detail, both in the Springer anthology (Naveh, 2007) and its Chinese version (Naveh and Li, 2010), there is no other science, like a holistic and transdisciplinary landscape science, dealing with land use planning, management, conservation and restoration,

that is better equipped with theoretical and practical tools to contribute to these aims.

In such a transdisciplinary landscape science we have to respond, together with all those academicians, professionals, and practitioners, concerned with sustainable land use planning and development, to the demands of the emergent global information society. This means, **taking an active role in steering this transition towards an all embracing, radical change, a revolution for sustainable healthy and attractive global landscapes.** It demands a mind shift from narrow disciplinary approaches to transdisciplinary systems thinking and acting, transcending and crossing disciplines and professions, and aiming together towards a common systems goal.

In such a holistic landscape science, landscapes are not considered merely as large-scale repeated ecosystems of different geometric shapes, but they are studied and managed simultaneously with a biperspectivable view as **both tangible-physical and mental-cognitive ecological Gestalt systems of closely interwoven, coherent natural and cultural entities, ranging from the smallest discernable landscape cell or ecotope to the global ecosphere landscape.**

Landscapes are **more** than puzzles of mosaics in repeated patterns of ecosystems. Their multidimensional organized landscape complexity is much greater than that of the monodimensional ecosystems complexity, characterized solely by material processes of flow of energy/matter and biophysical information. Our mixed natural-cultural, **multidimensional and multifunctional landscapes serve as tangible bridges between nature and mind.** They deal both with the functional dimensions of natural bio-ecological processes which are transmitted by biophysical information, and with the cognitive mental and perceptual dimensions, transmitted by cultural information. This information cannot be described fully by the formal scientific language, but only by our natural language and its visual means. Therefore both languages have to be used for translating this multidimensional functional complexity into actual landscape appraisal, planning and management practices. Only in this way can we attain an optimization of the "hard" instrumental and monetary landscape values and the "soft", eco-cultural and psycho-hygienic, and intrinsic existence value of nature.

For a full comprehension of these values, we have to overcome our deeply ingrained dualistic view of the positivistic natural sciences, by which mental phenomena "do not count" because they cannot be counted, measured and quantified by conventional statistical methods and mathematical models. We should realize that even the important term "natural capital", introduced by ecological economists, cannot account for the intangible, but not less vital life enhancing services provided by the therapeutic functions of aesthetic, cultural, spiritual and re-creative values of healthy and attractive biosphere landscapes. Their value in the information society is becoming now even of greater importance than in the industrial society, hence they will become critical issues in the land use decision-making process. Of greatest relevance in this context are the findings by Kaplan (1995) on "the restorative experience of nature" against the multitude stresses of modern life and especially after "direct attention fatigue", caused by continued and intensive mental work. These are presently performed by High-Tech workers, and all those, spending many hours behind the computer.

Therefore, in such a transdisciplinary landscape science we will be able to cope comprehensively with the complexity of landscapes as an integrative part of the complex network of interactions between nature and modern life, if we will apply this biperspectivable

landscape view to deal with all relevant human-ecological aspects, concerning the people living using, perceiving and shaping these landscapes. We will have to consider not only the material and economic needs, but also their spiritual needs, wants, and aspirations of all stake holders involved and seek their active participation. And most importantly, we will have to convince land-users and decision makers that our semi-natural and cultural biosphere landscapes should not merely be viewed as a source for our materialistic satisfaction, but also as a source of enlightenment and enjoyment, a source of mental health. If managed well, they can fulfill not only the free tangible carrier, protection, purification, detoxification, stabilization and mitigation "ecosystem services" and their dollar-priced "hard" values, but also those "soft" intangible psychotherapeutic, spiritual, aesthetic and cultural functions, serving as unique and invaluable sources of physical and mental health. These open, green and attractive landscapes are the most efficient antidote for uplifting our lives from the severe urban density stresses.

### **Some practical tools: "Total Landscape Diversity" and "Redbooks" for threatened keystone landscapes**

One of our major transdisciplinary challenges is therefore to provide meaningful parameters and indices for the evaluation of these 'soft', non-marketable landscape values to be included in any land use decision, and their application by land managers and users. These integrative parameters could be expressed as **"Total Landscape Ecodiversity", taking into account not only the biological and geophysical diversity, but also the cultural diversity, as evaluated by the richness and distribution of cultural, historical and other artifacts within the specific landscape unit.**

As explained in more detail by Naveh (1998b) and by Li (2001), we can achieve the goal of having precisely manipulative linguistic expressions for these qualitative, aesthetic, spiritual, historic values and other "soft" cultural parameters with the help of innovative statistical and modeling methods, based on fuzzy logic mathematics.

Such highest attainable landscape ecodiversity and its vital biological, ecological, cultural and socio-economic functions and values, **require the well-controlled continuation, simulation and restoration of all natural and cultural landscape patterns and processes and their homeorhetic flow equilibrium.** These have shaped the permutation dependent, seminatural biosphere landscapes throughout their human land use history (Naveh 1998 a, b).

For such a comprehensive evaluation of this multifunctional landscape complexity as well as for the preparation of strategies for integrated ecological, socio-economic and cultural sustainable development, a common effort of landscape ecologists is required with scientists from relevant natural, social and humanistic fields, such as artists, planners, architects, eco-economists and eco-psychologists, historians and philosophers, as well as land use managers and decision makers. As shown by Grossman and Naveh (2000) and by Naveh (2007), it can be achieved by jointly developed systems dynamic models in combination with cross-catalytic networks, assessing the interrelations between anthropogenic process and landscape dynamics for regional sustainable development.

As outlined in more detail elsewhere (Naveh, 1993; Naveh, 2009; Naveh and Lieberman, 1994), practical and valuable tool for the conservation of threatened biosphere landscapes, are **"Redbooks" or "Greenbooks", which serve as "keystone" landscape systems** and their life supporting and enlightening values. These should demonstrate how demands for



safeguarding intrinsic biological and cultural "soft" landscape values can be reconciled with the sustainable utilization of "hard" values, vital for socio-economic advancement. In contrast to the "top-down" syndrome of conservation plans exposed by administrators, maximum involvement of all the stakeholders and the local population should be ensured. Although based on strict scientific methods, such as dynamic simulation models and scenarios, the information gained thereby should be presented in clear, well-illustrated non-technical language. Instead of being filed away - like so many valuable research projects - this semantic information should be translated into "pragmatic" information, utilized for changing the reality through its feedback on the decision maker and land managers.

### **New challenges, demanding not only ecological, but also ethical and socio-economic solutions**

A new challenge is facing now landscape ecologist: New ecological problems are arising, demanding not only strictly ecological, but also ethical, social and economic sound solutions. Already now it has become apparent that even desirable and urgently needed "green technologies", such as wind power farms, can despoil landscape scenery and cause severe damage to birds, especially if these are established in or near the flyways of migrating birds along routes of bird migration.

This is the case, China is leading the way by building wind power farms with more than 10,000 megawatts in the single year of 2009. This is the first time any country has with 25,000 megawatts overall, doubled its total installed wind capacity in each of the last five years, bringing it into third place behind the United States and Germany. And considering the ambitious projects already in its development pipeline, it is not likely to stay in third place for long. Thus, for instance, besides the inland windmills, Shanghai is developing the first offshore windmill park at the Yangtze Estuary, with a capacity of 100,000KW. It is supposed to start working in 2010. Other coastal provinces are also aiming to develop coastal / offshore windmill parks in the coming couple of years. Although Shanghai has made great effort to avoid "bird collision" to the wind turbines at the designing stage, she is still worried about the whole migration route, if more windmill parks are to be established along the coast ( Xiuzhen Li 2010, personal information).

Further progress in the right direction towards sustainability in the post-industrial information age will be accompanied by other serious ecological problems, requiring practical solution for the reconciliation between clashing "Clean" - and "Green Technologies" and landscape demands. Their importance for successful sustainable development lies not only in the ecological but also in the socio-cultural, ethical and economic reality, determined among others, by the "free market principle".

Lester R. Brown, in chapter 10 "Can We Mobilize Fast Enough?" of his important recent book: Plan B 4.0: Mobilizing to Save Civilization (Brown 2009) has, rightly, pointed out to this severe obstacle for of sustainable development, that is also the most serious threat for the future of our open landscapes:

"A market that is allowed to ignore the indirect costs in pricing goods and services is irrational, wasteful, and self-destructive. The key to building a global economy that can sustain economic progress is the creation of an honest market, one that tells the ecological truth. To create an honest market, we need to restructure the tax system by reducing taxes on work and raising those on carbon emissions and other environmentally destructive activities, thus

incorporating indirect costs into the market price. If we can get the market to tell the truth, then we can avoid being blindsided by a faulty accounting system that leads to bankruptcy."

These principles should also apply for the conversion of green, open land into concrete of buildings and asphalt of highways or for any other technosphere construction leading to the loss of these vital, free landscape services.

### **New insights into nature-humans-culture–landscape relations**

Of far-reaching implications for the comprehension of the connectivity between nature - human - culture – landscape, are the new insights gained thanks to some of the most important recent breakthroughs in such diverse sciences as quantum physics, physical cosmology, evolutionary-, neuro, - and quantum biology, as well as in the new field of consciousness studies. Fortunately they have been brilliantly summarized and integrated by Laszlo (2002; 2004), into a unified view of the world as the "informed universe", by which all organisms and their environment are coherently connected. It opens new vistas for our understanding of the place of humans in nature – and therefore also in landscapes - as an integral part of an all-embracing conception of synthetic, geological, biological, cultural and even cosmic evolution. These issues are of the greatest significance for the theoretical foundations of a new transdisciplinary science of landscape planning and management, conservation and restoration (Naveh, 2007; Naveh and Li, 2010).

I look forward to a scientific breakthrough, enabling us to expand our landscape studies deep down to the "nano-scales" of a new science of "quantum ecology". It may help to provide conceptual, educational and practical tools for all those concerned with the sustainable future of human life on Earth. It should also help to attain the urgently needed post-industrial symbiosis between human society and nature on which the sustainable future of both nature and mankind depends.

### **Conclusions**

I would like to conclude my foreword, with the hope that on this important event, Chinese and other Asian landscape ecologists will have the opportunity to interact with landscape ecologists from all over the world, not only in formal lectures and seminars, but in close, personal contact, which we are in the danger of losing altogether in this age of virtual, computerized information.

I also hope that there will be sufficient time for an open discussion on the future directions of landscape ecology, as a problem-solving and mission-driven transdisciplinary science. It should be based on integrative, dynamic and flexible systems thinking and systems acting, by which scientific and professional knowledge and ecological and evolutionary literacy is combined with ecological wisdom and indigenous knowledge and culture. It should be implemented with ecological ethics and norms for the sake of nature, society and future generations.

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Abstracts of plenaries

## **Landscape Ecology Principles Incorporated into Other Fields for Solutions on the Land**

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History is likely to record two remarkable accomplishments in the rapid 25-year emergence of modern landscape ecology. First, a robust body of principles, theories and models has developed to readily understand the land of nature and people. Second, the principles are useful and therefore have been quickly absorbed, enhanced and used by many disciplines for solutions on the land. Familiar principles include edge types/widths, functions of natural corridors, metapopulations in a mosaic, spatial scale dimensions, and changing spatial-pattern trajectories. Diverse impressive uses of principles are highlighted, e.g.: (1) in forestry, a sequence of cut stands selected relative to surrounding mosaic pattern to mesh wood products, biodiversity and soil conservation; (2) in transportation, wildlife overpasses/underpasses across highways to reduce roadkills and the barrier effect, and increase habitat connectivity; (3) in landscape architecture, park designs combining visual quality with soft/hard edges plus small patches for wildlife viewing; (4) in biological conservation, using the patch-corridor-matrix model for a patch on land surrounded by diverse habitats, each a source of effects on the patch, a species source, and differentially suitable for movement between patches; (5) in water resources, the width and habitat heterogeneity of natural corridors to protect a stream or reservoir system; and (6) in urban planning, using greenways, which combine recreation with ecological conservation, in the “emerald network” of large connected natural patches. Landscape ecology has been readily incorporated into geography. Many principles are also valuable for, e.g., agriculture, archaeology, range science, hydrology, recreation studies, and climate change. Thus published landscape ecology research provides double value, catalyzing both the field itself and other fields for society. The highlighting of principles with wide applicability and predictive ability is likely to accelerate their absorption, enhancement and use by other disciplines, for molding the land so nature and people both thrive long-term.

### **Planning for Landscape Services: Linking Human Benefits to Landscape Systems**

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Since prehistoric times, humans have been changing landscapes to their benefits. By adapting the physical pattern, landscape processes were changed to create added value to the owners and users of land. Thus, landscapes were amended to produce more food and fibre, to prevent floods and erosion, or to create beautiful scenery to enjoy. However, this basic notion learns that the classic paradigm of landscape ecology (understanding the interaction between

landscape pattern and process) is not adequate for providing a scientific basis for landscape planning. Landscape change is primarily about values. Therefore, to bridge the gap to application to planning and design, landscape ecology needs to extend its basic paradigm with a link to valuation, as considered in economic and social sciences.

Termorshuizen and Opdam (2009) introduced the concept of landscape services, as a specification of ecosystem services, to link the physical landscape system to valuation by humans. In this plenary I discuss recent findings in The Netherlands how landscape infrastructure can be used as the physical basis for collaborative planning by local multi-stakeholder groups. These achievements suggest that the ecological services provided by Green (or blue) infrastructure networks structure complex planning processes, enhance coalition building and stimulate actors in a planning process to recognize the physical pattern as conditional to the values they want to create. In this plenary, I will draw conclusions on how this concept could be built into socio-ecological models. These emerging models may provide a tool to understand how local communities respond to change by adapting their landscape, and how such responses can be influenced by governmental instruments.

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## **The State-of-the-Art of Urban Landscape Ecology: Key Issues and Future Directions**

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Cities are home to more than half of the world population. Cities have been the centers of economic and social developments, as well as sources of many major environmental problems. Cities are created and maintained by the most intense form of human-nature interactions. Cities are spatially extended complex systems – which we call landscapes. The future of humanity will increasingly rely on cities, and the future of landscape ecology will inevitably be more urban. To meet the grand challenge of our time – sustainability – cities must be made sustainable and, to this end, landscape ecology has much to offer. In this presentation, I compare and contrast different perspectives in urban ecological studies, and examine their relevance to urban sustainability. Recent advances in urban ecological studies will be reviewed and synthesized. Key issues and future directions in urban landscape ecology will then be discussed. I argue that, in order to achieve urban sustainability, we need to go beyond the “ecology of cities” perspective and develop a landscape-based approach to the “sustainability of cities”. This integrative approach combines landscape ecology of cities with sustainability science and resilience thinking of cities.

## **Ecological Design: Marking Landscapes to Protect Ecosystem Services**

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Ecological design is intentional landscape change that rigorously applies scientific knowledge and promotes environmentally beneficial behavior. A challenge for ecological design is to functionally link science and behavior. Strategies that seek to understand and employ public experience of landscapes can help to forge this link. One key strategy is to create public attachment to landscapes that embody ecosystem services by marking them with forms, patterns, and textures that have recognizable cultural value.

This strategy is possible because of a powerful intrinsic characteristic of landscapes, their visibility. The visibility of landscapes can be exploited to achieve both more relevant science and more environmentally beneficial behavior. More relevant science will enable and learn from real world applications. Synthesis of data and knowledge from across environmental and social, theoretical and applied disciplines is needed. Because the landscape is tangible and can be seen simultaneously through different conceptual frames at different scales, it can be a platform for socio-environmental synthesis. Understanding the cultural values that people ascribe to landscapes contributes to socio-environmental synthesis. In addition, ecological design can use this understanding to directly exploit the visibility of landscapes by intentionally marking them to communicate their value. Such markings are cannot be mysterious or obscure. Rather they should take forms that are immediately recognizable in the vernacular, achieving a cultural resonance that can affect behavior and protect ecosystem services. Environmentally beneficial behavior is more sustainable when it is authentic to cultural values, which are likely to be more durable than market or policy effects alone. Reviewing metropolitan and agricultural landscape examples, this paper will examine how design and science can employ the visibility of landscapes to protect ecosystem services.

## **Solutions for a Sustainable and Desirable Future**

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A high and sustainable quality of life is a central goal for humanity. Our current socio-ecological regime and its set of interconnected worldviews, institutions, and technologies all support the vision of unlimited growth of material production and consumption as a proxy for quality of life. However, abundant evidence shows that, beyond a certain threshold, further material growth no longer significantly contributes to improvement in quality of life. Not only does further material growth not meet humanity's central goal, there is mounting evidence that it creates significant roadblocks to sustainability through increasing resource constraints (i.e., peak oil, water limitations) and sink constraints (i.e., climate disruption, pollution). Overcoming these roadblocks and creating a sustainable and desirable future will require an integrated, systems level redesign of our socio-ecological regime focused explicitly and directly on the goal of sustainable quality of life rather than the

proxy of unlimited material growth. This transition, like all cultural transitions, will occur through an evolutionary process, but one that we, to a certain extent, can control and direct through the process of shared envisioning. Visions and models of integrated sets of worldviews, institutions, and technologies are needed to stimulate and seed this enlightened evolutionary process.

## **Biocultural Diversity for Sustainable Cultural, Sacred and Ecological Landscapes**

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The understanding of the connection between the cultural, spiritual and natural values of landscape and the people that shaped it is essential for the healthy and sustainable management of our planet. We cannot manage our cultural and natural landscapes if we do not understand their cultures and vice versa. Studies of biocultural diversity can help in such understanding.

International organisations are increasingly drawing attention to intangible values, cultural heritage and traditional knowledge in their programmes related to nature conservation. These fundamental cultural principles are taken into account to build a society which is just, sustainable and peaceful. The spiritual dimension of the environment, moreover, has been emphasised by numerous religious organisations, indigenous people and local communities, with the aim of preventing destructions of sacred places, healing social wounds and aiding environmental struggles (Egos et al, 2011; Pungetti et al., 2011).

Indeed maintaining the integrity of life through cultural landscapes, traditional land use and sustainable development is essential for the conservation of biodiversity. We need, however, also to respect and preserve cultural diversity, including languages and knowledge, in order to maintain biodiversity (Maffi and Woodley, 2010; Posey, 1999). This talk addresses recent studies related to biocultural diversity and biocultural landscape, which offer a way forward for nature conservation.

Sacred species and sacred sites have been acknowledged to be of special significance for landscape ecological studies in biocultural diversity (Pungetti et al, 2011). Yet it is necessary to understand their essence, context and relation to people for their appropriate development, conservation and management. Whether our landscapes are ecological, cultural or sacred, it is imperative to look at the future with a holistic approach in order to sustain the current paradigm shift in our understanding of future developments.

The cultural, spiritual and ecological dimensions of landscape are here investigated in the context of biocultural landscapes, per se and in relation to biocultural diversity, with the aim of advancing synergies and knowledge of sustainable landscape conservation and of providing an integrated perspective for a truly holistic approach in landscape ecology.

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## Landscape Ecology for Sustainable Environment

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Landscape ecology play a great role in ensuring the humans and ecosystems coexist for sustainable Environment. To address the issues, the landscape ecology has evolved into a new and critically important phase: 1) Research subjects shifted fundamentally from undisturbed natural ecosystems to managed ecosystems; 2) Research ranges expanded substantially from site and local scales to encompass regional, continental and global scales; 3) Research objectives moved from understanding to managing ecosystems, from ecosystem restoration to design and construction. Socioeconomic factors are increasingly considered in contemporary landscape ecology that emphasizes the driving mechanisms and environmental impacts of landscape change. Interfacing with other scientific fields has created new growing points of landscape ecology, including multifunctional landscape research, and sustainable landscape design and planning. These new growing points are leading landscape ecology to a more advanced stage.

The transition in landscape ecology is of particularly importance in China with the most population, intensive land use and rapid economic growth. Large strides in landscape ecological studies have been made with: From Ecosystem function, landscape ecological processes, to large scale ecological studies; Promotion of application studies to provide ecological knowledge and solution needed for ecosystem management. The major progress of landscape ecology in China was from the fields of land use structure and ecological processes, landscape pattern and dynamics analysis, theoretical and methodological development, and landscape ecological applications.



Abstracts of all presentations

## **Land Use Change and The Ecological Structure of Urban Areas**

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Urban development has resulted in changes in land use and urban forms. Patterns of land use change reflect the environmental, economic and social responses to population needs. In this way land use change is associated with different factors. One of the challenges of land use change is the prediction of consequences of ecological change. These changes usually result in challenges for urban and regional planning. While in many countries sustainable development is the dominant approach in planning systems, managing land use change in Iran has always been a critical issue because of the fact that land is a limited and expensive resource. It should be considered that planning decisions made today may have long term effects on the ecological balance of a city. In most cases, land use change is irreversible and may result in an imbalance between urban networks and environmental patterns. This paper considers how to determine land use patterns in the future, investigates the process of land use change, evaluates the ecological effects of land use change and provides an illustration of physical development strategies.

The southern valleys of Alborz is the case study location for this paper. This region has experienced severe land use change that has affected the ecological characteristics of Tehran. In order to investigate land use change in this region, a combination of land use modelling and ecological assessment was undertaken.

One of the planning goals for the region is to use a modeling approach to obtain a vision of future land use patterns. Many models are currently used to simulate land use change. In this paper, the logic of the model Cellular Automata is combined with statistical indicators that form the basis of landscape ecology principals.

Such an approach has been taken to study both physical and environmental factors as well as the possibility of simulating land use change using data and indices in a land use model. Simulations have been run in order to analyse land use changes and their consequences. This analysis is focused on environmental considerations. The extensive environmental aspects of the study has led the ecological analysis to be limited to the ecological structure of the case study region.

This study used both analogical presumptive and posterior reasoning research methods. Therefore, two different approaches were considered; the down-top approach and top-down approach. The analysis process was divided into two principle scenarios: the "what if?" scenario and the "so what?" scenario. The "what if" scenario was simulated in the land use change model through the inclusion of selected indices. Different future scenarios for land use change were then introduced. The next step was to assess each scenario using a landscape ecology assessment. This methodology has been considered as a planning support tool.

# **Climate Change, Aridity Trends and Agricultural Sustainability in the Sudano-Sahelian Belt of Nigeria**

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Climate change has aggravated the degradation of sub-humid and dry land ecosystems. This has led to the intensification of aridity, resulting in plant moisture stress which has subsequently decreased the bio-productivity of the physical environment. Investigating rainfall variability in the Sudano-Sahelian belt of Nigeria is crucial to gain understanding of the indicators of climate change in the region. A lack of information on changes that have taken place in this region is evident. In particular, research has not yet been carried out investigating and mapping changes in the belt which would allow the identification of sustainability issues for adaptation. This paper therefore, investigates the intra-annual as well as inter-annual rainfall trends in order to identify sustainability issues in the belt. This study used rainfall and temperature data (1950-2006) to derive indicators of eco-climate characteristics; rainfall related-onset dates, cessation dates, Moisture Quality Index, hydrologic growing season (HGS) and Aridity Index (AI). These data sets were summarised by calculating decadal-determined means and ranked using numerical indicators for the interpretation of the various moisture zones across the belt. A geo-spatial database was developed for the indicators and classes were defined using quantitative definitions for decadal time series. Point data was transformed into spatial data and added to the geo-spatial database. Surfaces were interpolated and mapped and areas of moisture effectiveness were used to determine a spatio-temporal aridity trend for the belt. The results signalled a rapid advancement of a desert condition such that areas of deficient moisture zones grew significantly; AI appreciated from approximately 0.3 to 4.5%, MQI from 2.3 to 6.1%, HGS from 0.4 to 7%, onset from 1.4 to 7.5% and cessation from 1.8 to 6%. Adequate and abundant moisture zones apparently declined; AI decreased from approximately -1.4 to -4.2%, MQI from -0.7 to -6.2%, HGS from -1.6 to -4.3%, onset from -0.1 to -1.5% and cessation from -0.7 to -6.3%. Consequently, agro-climatic zones thought to have been affected by climate change were confirmed. The trends determined from this investigation may be responsible for the recurrent crop failures which are thought to have induced a southward migration of communities and their associated livestock since the late nineteenth and early twentieth century to the present day. The trend of decreasing spatio-temporal moisture effectiveness confirms drastic degradation of sub-humid and dry land ecosystems and a southward shift of eco-climatic zones in the last four decades. These results reflect the belt's vulnerability to desertification. Geo-spatial information has the capability to provide indicators of best possible solutions to address critical environmental issues. Thus, the sustainability of agricultural productivity and other socio-economic activities in the belt is mainly a function of accurate and up-to-date eco-climatic information on the state of the environment. This information will provide insight as to specific management actions that will minimise progressive ecological degradation and enhance food security in the belt and the country in general.

## **Conservation Status of Wildlife Protected Areas in Peninsular Malaysia**

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The establishment of wildlife protected areas in peninsular Malaysia was initiated during the British colonial period. A combination of political history and socio-economic development has influenced the planning and management of wildlife protected areas in peninsular Malaysia. As a result, some of these protected areas have not received much attention and have been exposed to various land use activities, particularly agriculture. This has been an issue of concern particularly since the rapid development of land for large-scale agriculture in the 1950s and the 1960s. However, since the 1980s until most recently, urbanisation and other similar types of development have emerged to affect the sustainability and conservation status of wildlife protected areas. Therefore, this study assessed landscape change within and outside of wildlife protected areas in relation to land use development in peninsular Malaysia over three years; 1988, 1996 and 2005. The objective of this study was to understand the linkages between land use development and conservation status of wildlife protected areas in peninsular Malaysia. Wildlife protected areas within peninsular Malaysia were exposed to various land uses over the three selected years. The intensity of human land use within the wildlife protected areas was apparently concomitant to land use outside of these areas. Hemeroby analysis revealed that several wildlife protected areas are vulnerable to any further land use development, whereas others are considered highly threatened and/or not effective anymore as protected areas. This study concluded that land use development in peninsular Malaysia has affected the conservation status of wildlife protected areas. In the context of conservation planning, understanding the linkages is considered vital for the review of the current wildlife protected area network system.

## **Historical Plant Use and Its Influence on Recent Rejuvenation Trends in a Tropical City – Case Study Bandung, Indonesia**

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Cities are regarded as centres for introduction and cultivation of non-native plant species, whereas ornamental species escaped from cultivation play a specific role at biological invasions worldwide. Within the context of cities in tropical regions the issue of undeliberate

spread of non-native plants into natural forests is of great importance. In this study we investigate effects of historical plant use in the tropical city of Bandung, Indonesia, especially on rejuvenation trends of non-native species in and around the urban area. Research questions are whether non-native plants, recommended in historical plant schemes show recently spontaneous reproduction and which underlying determinants explain their spread? Our study compares datasets for woody seedling species occurrence in 10 urban parks and 109 streets with 66 natural and semi-natural forest patches in differing distances to the city centre.

Out of 317 woody species 37% show rejuvenation trends, thereof, 30% are non-native ornamental species. Six non-native ornamental species escaped from cultivation could be detected already outside the city area, whereas *Lantana camara* and *Piper aduncum* are regarded as invasive species in Indonesia.

The further results will provide valuable data for future plant use in tropical cities, considering the limitation of exotic plants and higher promotion of native species.

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## **Biodiversity Urban Planning and Design Strategies and Best Practices**

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Biodiversity is a fundamental issue and resource that is fundamental in urban policy and planning for sustainability. While some consider cities to be biodiversity deserts, and value urban biodiversity as non-essential, many cities have protected and built new forms and types of biodiversity, from accidental/spontaneous, to carefully planned and designed urban environments. This urban biodiversity gains support when it is linked with specific ecosystem services and green infrastructure. Urban designers conceive and practice strategies that link policies with funding and actions – such as promoting biodiversity. This paper will present a typology of urban planning and design strategies for promoting urban biodiversity including: opportunistic bundling of ecosystem services, ecological infrastructure for resilience, and safe-to-fail design experiments. The typology will be referenced to in, and illustrated with international case studies in the context of urban biodiversity's contribution to fundamental urban sustainability challenges: adaptation to population-related pressure(s) and climate change.

## **Development of a Landscape Ecology Approach for the Restoration of a Cultural Landscape to Achieve Sustainability Aspects**

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In this research descriptive and analytical methods were used to present cultural landscape restoration principles with an emphasis on a landscape ecology approach. To achieve the main research goal, basic concepts (landscape ecology, landscape restoration, cultural landscape and sustainability) were initially studied and analysed. Sustainability aspects were then assessed to define sustainable landscape design principles. Landscape restoration principles were finally presented with an emphasis on a landscape ecology approach and sustainable landscape design principles were obtained.

The results of this research show that a sustainable cultural landscape may be obtained by restoring both of its natural bed and cultural- historical monuments and signs. It should be mentioned that while conservation methods and visual and applied limits of these beds need to be determined and ecological evaluation of structural elements (e.g. corridors, lows and patches) undertaken, it is also essential to restore a relationship between human and nature to achieve a sustainable cultural landscape.

**Keywords:** Cultural landscape, Landscape restoration, Landscape ecology and sustainability

## **On the Influence of Scenario-based Landscape Design – The Roles of Substantive Outputs and Social Learning**

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Transdisciplinary landscape design, understood as any intentional change of landscape pattern in collaboration of scientists and practitioners, has been proposed as a promising approach to enhance the exchange of science and practice and to increase the knowledge to action transfer in landscape ecology (Nassauer and Opdam, 2008).

This paper investigates more specifically how landscape design processes can be constructed and implemented in order to be most likely to fulfill these functions and to actually enhance the impact of scientific knowledge on policy and decision making. The research questions are: What mechanisms and characteristics of influential landscape design outputs can be identified? How can landscape design processes facilitate social learning that enhances the understanding and skills of relevant actors for informed and cooperative decision making?

The paper is based the results of several studies on the influence of landscape design on social

learning and decision making, carried out by the author in collaboration with different international research teams. A certain emphasis is placed on scenario-based design processes. Key research approaches were literature analyses, case studies, planning experiments, and action research. Case studies were five landscape design projects in Germany, Great Britain, and Italy, ranging from the local planning to regional policy making scales.

Taken together, the case studies lead to four main conclusions and propositions:

First, both strategies – either through improving perceived output quality or through facilitating social learning in landscape design – are of importance and may be complementary for enhancing the influence of science on practice.

Second, previously suggested properties of influential outputs of scenario planning, namely credibility, salience, legitimacy and creativity, are confirmed and further substantiated for application in the field of scenario-based landscape design.

Third, the cases illustrate that scenario-based landscape design can facilitate social learning among participants with benefits for subsequent decision-making. Significant increases in participants' perceived levels of relevant understanding and skills are detected, and impacts of learning outcomes on awareness, agendas, and actual land use decisions are found.

Finally, a framework is proposed for enhancing the likelihood of SLP to influence decision making. It builds upon Carl Steinitz' Alternative Futures concept, but stronger emphasizes the systematic integration of interested and affected actors, fosters joint framing of the project design, and supports a collaborative development of implementation strategies.

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## **The Effects of Good Agricultural Practices on the Environment and its Sustainability**

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The aim of this study was to assess the level of understanding and implementation of various training programs that mango farmers have received on good agricultural practices.

The objective of the study was to determine the strengths and weaknesses of the current agricultural practices of mango farmers. Questionnaires, recording observations of farming practices and interviews with farmers were used as methods to collect information on agricultural practices.

212 farmers were interviewed covering a total farm acreage of 1860.63. The evaluation of

mango farmer agricultural practices revealed that pruning, mulching, fertiliser application and farm hygiene were well implemented by farmers. Record keeping, maintaining good health standards, plant protection, intercropping and integrated pest management were found to be major farming practice weaknesses. Farmers have now been introduced to record keeping and have been provided training on safe handling and storage of pesticides, worker's health, safety and welfare.

**Keywords:** Good Agricultural Practices, Integrated Pest Management

## **Quantification of Landscape Multifunctionality Based on Farm Functionality Indices**

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The term multifunctionality is used to indicate that agricultural landscapes simultaneously provide goods and services (functions) e.g., food security, livelihood opportunities, life support system maintenance, and space for cultural and recreational activities (O'Farrell & Anderson 2010). Different landscapes differ in the capacity to provide such goods and services (Willemen et al. 2008).

The quantification of different functions in comparable units is challenging. Willemen et al. (2010) presented a top-down method in which interactions of functions are quantified based on national survey data. We present a bottom-up method in which landscape multifunctionality is quantified by using functional indices developed from farm questionnaire data. The interview survey comprised 382 farms in a rural area of Denmark.

The functional classes included in the method are: (1) production, (2) residence, (3) wildlife habitats, and (4) recreation. At farm level each of these functions is defined by data on a number of farmers' activities as well as farm characteristics which can be harvested by a selection of the interview questions. The selected interview questions are attached as indicators to the relevant function. A score spectrum is assigned to each indicator to enable a representation of its relative contribution to the function on each farm depending on the question responses from the interviewees. The values for each indicator are weighted in relation to each of the others and all the values are summed to create an index for each function. The combination of indices for the four functions represents the farm's functional profile.

The scores of the four functions from each farms are mapped to show the results of the functional distribution at landscape level. From the maps functional hotspot and according coldspots are identified. The distribution of functions is compared with the landscapes biophysical factors to identify structural-functional correlations.

**Keywords:** Multifunctionality, Quantification, Landscape, Functional distribution

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## Practical Tool for Landscape Planning? An Empirical Investigation of Network Based Models of Habitat Fragmentation

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This study presents a graph-theoretical modelling approach using daily movements and habitat demands of different target bird species in an urban context to assess: 1) habitable land cover types, 2) threshold distances between patches of habitat, 3) the required minimum accessible habitat areas and 4) the effects of barriers and stepping stones. The modeling approach is tested using empirical data from field surveys in the urban area of Stockholm, Sweden.

The results show that groups of small habitat patches can house the same species as larger contiguous patches as long as they are perceived as functionally connected by the inhabitant organisms. Furthermore, we found that binary habitat/non-habitat representations of the landscape could roughly explain the variation in species occurrence, as long as habitat was properly defined. However, the explanatory power of the landscape models increased when features of matrix heterogeneity such as stepping stones and barriers were accounted for.

Synthesis and application: in a world where forest ecosystems are becoming increasingly fragmented there is an urgent need to find comprehensive and scientifically relevant methods for managing and planning ecosystems. This study shows that: 1) groups of well placed small habitat patches can, together, be sufficient to attract birds in intensively developed areas, 2) the presented modeling approach can help identify such groups of patches, 3) matrix heterogeneity should preferably be accounted for, and 4) proper assessments of habitable land cover types are important. Finally, we argue that the modeling approach applied here may substantially improve landscape management and planning at scales ranging from whole landscapes down to neighborhoods.



## Protected Nature in the Urban Region of Bogotá: A Multi-Scale Landscape Planning and Management Approach

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Bogotá, the capital city of Colombia, is expected to become one of the world's new megacities by 2025. This is a result of an urban coalescent process currently under way in Bogotá within and beyond the multi-clustered human settlements that constitute the Urban Region. The expanding urban area will have an enormous direct impact on biodiversity and ecosystem processes over a huge territory, and indirect influences upon large watersheds and remaining natural areas. At the turn of the 20th century, city authorities in the context of the Territorial Management Plan POT (for its Spanish acronym of *Plan de Ordenamiento Territorial*) proposed the Main Ecological Structure EEP (Spanish acronym for *Estructura Ecológica Principal*), an Ecological Network that has served as a natural backbone around which other land uses were organised. Although from its beginning the EEP consisted of Protected Areas and other green spaces, many actors perceived them as no-go areas equivalent to strict nature reserves. This view was enhanced through court decisions regarding socio-environmental conflicts over disputed uses within the EEP, such as human connectivity and active recreational uses, which were forbidden. In theory the EEP represented a major achievement in bringing “nature into the city” to some extent (at least at the planning stage). In practice conservationists' views and perceptions have remained in a conflict prone stage. During 2008, the city administration began to review its POT and considered this an opportunity to overcome perceptual conflicts, better integrate EEP with infrastructural development and active expansion of urbanised lands, as well as to galvanize full implementation of conservation within the EEP. It was also an opportunity to expand positive conservation impacts across the region through the conceived Regional Ecological Structure (EER, Spanish for *Estructura Ecológica Regional*). The principal aim of the EER is to de-compose the EEP into its functional conservation components. In this paper (conference) we present the adopted conceptual landscape ecological framework and the methodological steps proposed to re-visit the renewed integrated EEP-EER. An attempt to overcome technical and perceptual misfits of the EEP-EER and potentiate its contribution to human well-being and ecosystem resilience is also presented. Three nested spatial scales were adopted for this study for which management prescriptions were defined and management implications identified. The regional level was defined as the predicted space that the mega city will consolidate, complemented with the regional scale of manifestation of its natural supporting ecosystems. A regional ecosystem gap and vulnerability analysis was carried out across political and administrative municipal boundaries, depicting a way to direct “bring city to nature” through regional planning. The second nested scale was that of the current city's protected area system, for which management categories were proposed and landscape level management actions were included in planning exercises. This included filling representative gaps and connectivity. The third scale was that of “built nature” within the urban tissue, including greenbelts, green infrastructure, parks, avenues and gardens. The latter was developed particularly with the help of urbanism principles, landscape architectural and horticultural outlook and was called the Environmental Complementary Structure (EAC, *Estructura Ambiental Complementaria*). Overall, the new EEP is a multi-scale, value driven, and disciplined oriented planning tool in which conservation biology and landscape architecture complement each other. It represents a multi-actor and multi-interest opportunity for achieving a land use planning equilibrium in Bogotá and to enhance social and ecological resilience of the emerging regional highland tropical city.

# **Incorporating Recreational Suitability into Multifunctional Landscape Management**

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The Ecosystem Services concept is commonly applied, in several variations, to try and model the various benefits humans obtain from the environment, and to assess possible future changes to them (Fisher et al., 2009). Under the Millennium Ecosystem Assessment (MEA, 2005), 'cultural services' include recreational use of ecosystems; access to the natural environment can have positive effects on physical and mental health (de Vries et al., 2003) and is widely supported by planners and decision-makers.

The requirement for rural recreation can be catered for in many ways, via the provision of facilities at levels varying from visitor centres and similar facilities to simple footpaths. The wider landscape also has an important bearing on recreation by contributing to the attractiveness of a destination or route, not only through simple aesthetic preference – which in truth is by no means simple (Ode et al., 2008) – but also for example by the opportunity to see certain wildlife or experience tranquillity.

This ongoing research examines landscape and other factors relating to the suitability of a rural area for recreational activity, using the example of a lowland river catchment in eastern England within which recreation and tourism are economically important. Assessment is carried out using Geographical Information Systems (GIS) techniques. Beginning with the current situation, it then considers possible landscape changes under published future scenarios, assesses their effects on recreational suitability and consequent effects of recreation on the landscape, and discusses how these effects could be managed to maintain recreation alongside other functions in this area.

This research is funded by the ESRC under an Interdisciplinary Early Career Fellowship, reference RES-229-27-0006.

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## **Application of a Spatial Optimization Concept for Modelling the Desirable Land Use Patterns in the Peri-urban North Beijing Mountain Area**

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Peri-urban metropolitan landscapes present particular challenges for applied landscape ecology and land use planning to support sustainability goals. In this research, an original pattern-optimization/regulation model using the *Aggregate-with-Outliers* spatial concept (Forman 1995) is applied to the remnant historic agricultural landscape in the foothills north of Beijing. The model characterizes the spatial composition, and configuration of the area and gives a quantified perspective on the possible, or desirable outcome regarding land use change. The model is not a completely prescriptive planning tool, rather it provides a macro-diagnostic that can inform, and serves as a base for evaluation of alternative plans.

The peri-urban area of Beijing is a study case appropriate for land use optimization planning purposes. The application of the quantified differentials against a desirable scenario - regarding land use distribution/ regulation-, allows joint land use composition and configuration analysis for macro-diagnoses of the heterogeneous landscape mosaic. The model provides this way a narrative of the existing spatial complexity, land use dynamics and the most desirable future land use scenarios at N.Beijing peri-urban fringe. The results from the Beijing study case are compared with previous applications of the model, both in Barcelona urban region and the N.E. megalopolis in the United States.

## **Low Carbon Society through *Pekarangan* Traditional Agroforestry Practices in Java, Indonesia**

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*Pekarangan* are traditional homestead gardens found in the tropical region of Indonesia and are considered an optimal and sustainable land use type. Research into this system of agro-forestry has been undertaken since 1995. A *pekarangan* consists of a green open space located in the surroundings of a house or residential building. The establishment of *pekarangan* has spread from rural to urban areas and from upstream to downstream in watersheds. The area of a *pekarangan* varies with ownership and depends on the socio-economic level and profession of the owner, as well as the distance from their residence to the nearest city. Sustainable and abundant bio-resources produced from *pekarangan* are expected to be available regardless of size. Through local community wisdom and knowledge, *pekarangan* have been implemented as agro-forestry, agro-silvo-pastura, and

agro-silvo-fishery systems. Agricultural biodiversity and sustainable material circulation are maintained in *pekarangan*. *Pekarangan* are also areas with potential for providing ecosystem services such as carbon sequestration, water resource management, agro-biodiversity conservation and landscape beautification. The Presidential Decree of the Republic of Indonesia No. 22/2009 regarding a policy of the acceleration and movement of local resource based food diversification was published in 2009. A *pekarangan* movement by the Ministry of Agriculture was conducted from 2010 to 2014 in order to revitalise *pekarangan* production of starchy crops, fruit plants, vegetable crops, medicinal plants, spice crops, industrial plants, ornamental plants and other miscellaneous plants. Multi-storey levels of vegetation structures and the species richness of *pekarangan* are not only proposed to mitigate global warming and global climate change impacts, but also to support agricultural land for food security at the household level. In addition, as an agro-forestry system *pekarangan* can also contribute significantly to a region's carbon budget while simultaneously enhancing the livelihoods of rural communities (Arifin and Nakagoshi, 2011; Kehlenbeck et al., 2007).

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## Spatial Network of Green Structure and Ecological Services in Planned Areas of Bahawalpur City, Pakistan

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Human communities depend upon their environment and utilise different services provided by ecosystems that are vital for health, as well as economic and social functions. Ecosystem services provide a range of benefits at a local, regional and global level. These services may be classified as provisional, regulating, cultural and supporting functions for an urban community (Hancock 2010). Green Structure is an important component of the natural and built environment in terms of services provided to an urban community. Green Structure in an urban environment refers to green infrastructure that is planned and supports urban development. From a planning perspective the spatial structure of green space provides a basis for sustainable urban development. From a spatial perspective, Green Structure is more than the sum of green spaces. It is considered a spatial network of open spaces, public and private gardens and parks, sports fields, allotment gardens, woodlands and recreational grounds (Tjallingi S. 2005). Therefore, it is considered a significant part of the built

environment and a major source of ecological services. The concept of Green Structure may be described in various ways including objective and subjective points of view. From an objective point of view, a Green Structure that is non-vegetated can be considered an open space and provide opportunities for the environmental improvement for wild life and recreational services in an urban setting. From a subjective point of view, Green Structure is considered a key issue in urban land use planning and design. An ecological approach to Green Structure planning should be considered by Authorities. To structure urban areas for sustainable development it is necessary to appropriately apportion areas for both grey and green cities. In consideration of the above discussion, this study will investigate spatial networks of Green Structure in planned areas of Bahawalpur City, Pakistan. The spatial network of Green Structure will be analysed through Green Structure patterns, Green Structure elements and identification of major challenges that are barriers to the use of Green Structure in residential areas. The research will analyse ecological services in terms of the functions generated from investigated Green Structure. The quality of Green Structure will be addressed in view of inhabitant demands by comparing the sizes of green spaces. This research will develop an ecological approach for studying Green Structure in planned city areas. Strategies will be proposed for better land use planning from a green perspective that involves Green Structure design, according to specific situations and neighborhood populations.

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## **Mechanism and Evaluation of Urban River Ecological Processes**

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Rivers are highly open systems with uni-directional flows and are subject to high disturbances. These characteristics have made their ecosystems very unique. Rivers with frequent flooding and inundation are characterised by gentle slopes and gravel areas along their channels. These provide habitats for many endangered plants, nesting areas for birds and act as purification systems for polluted water. However, urban rivers in densely populated areas are often modified by constructing compound or steeply sloped channels in order to provide recreational play-grounds for residents and for the enforcement of levees. These channels are rarely submerged during low or middle-class floods and subsequently, annual plants therein are gradually replaced by perennial species, followed by bush and tall trees in succession. This process can be accelerated by the occurrence of heavy nutrient loads in river water (Asaeda et al, 2010). Ecological systems in urban rivers are thus highly dependent on their artificial geomorphology, modified flooding regime and trophic conditions.

Correlations between ecological parameters such as vegetation coverage of the sediment bar in riparian areas and other environmental and hydrological parameters were investigated for a number of major rivers in Japan. Correlations were determined between parameters including frequency and magnitudes of floods, number of dams, eutrophication level of river water and channel shape. It was found that most of the flood plains of compound channels were seriously encroached upon by dense vegetation. The most influencing parameter in single channel sections was found to be the nutrient concentration of river water. Frequency of submergence and the number of constructed weirs also had a significant effect on vegetation coverage. It was found that less inundated channels suffered from the presence of dense vegetation, dominated by exotic, highly productive species. Other ecological factors were also highly influenced by vegetation coverage.

Although these high levels of correlation appeared to be linked to the modification of urban rivers, ecological systems in urban riparian areas were also apparently affected by the alteration of hydrological conditions and the eutrophication of rivers.

## **A Trait-based Analysis of the Functional Connectivity Provided by Mobile Grazers in an Island Grazing System**

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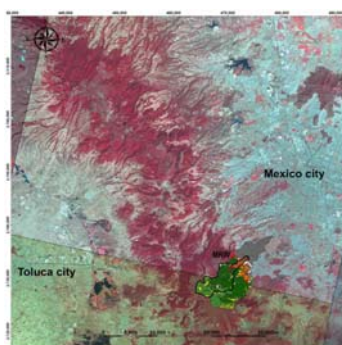
The area of species-rich semi-natural grassland in Europe has declined dramatically during the past two centuries. The Stockholm archipelago was once a vibrant agricultural landscape, with the movement of livestock between islands forming an extensive grazing network. Like in much of Europe, agricultural industrialisation led to most grasslands either being abandoned to become scrub or woodland, or converted to arable fields and subsequently reverted to relatively species-poor pasture. The restoration of these habitats to species-rich grassland communities has been a major goal, but restoration success has often been found to be seed or dispersal limited. In island systems, the hostility of the matrix exacerbates this problem, but also provides an ideal study system for investigating the dispersal of plant species between fragmented habitats. One management strategy has been to restart small grazing networks to improve connectivity in the landscape, and in the summer of 2009, we collected fresh manure samples from grazing cattle and sheep after movement by boat between islands. These were then grown in a greenhouse, and 5915 seedlings of 74 species emerged from the 18 samples, corresponding to 18 movements within the grazing network. Comparing the species dispersed with the vegetation communities in the donor and receiver islands, we assess the subset of species and species traits which were transported. We can thus examine the extent of the functional connectivity provided by these mobile grazers, and the effect that timing of movement has on the range of species and traits dispersed.

# Quality Assessment of Forest Landscapes for Ecosystem Services Provision, Case Studies West of Mexico City

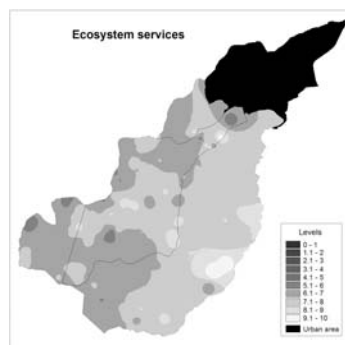
Víctor ÁVILA-AKERBERG<sup>1</sup>, Lucía ALMEIDA-LEÑERO<sup>2</sup>, Mariana NAVA-LÓPEZ<sup>2</sup>, Alya RAMOS-ELORDUY<sup>2</sup>, Julieta JUJNOVSKY-ORLANDINI<sup>2</sup>

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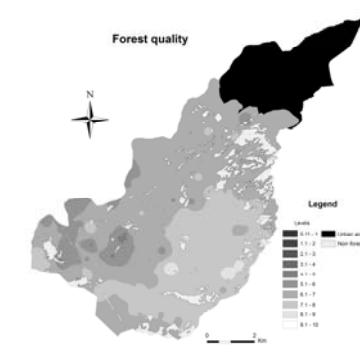
Mexico hosts a great cultural and biological diversity. In spite of the importance of Mexican forests in terms of biodiversity, these landscapes have an average annual cover loss of 350,000 ha. Attempts have been made to define criteria and indicators (C&I) for the assessment of sustainable forest management (SFM). The WWF and the IUCN developed the forest quality C&I initiative to assess SFM at the landscape level, relying on criteria from two main categories: (1) forest authenticity and (2) ecosystem services (Dudley et al., 2006, Ávila-Akerberg, 2009). The aim of this study was to assess high elevation temperate forests west of Mexico City with respect to adherence to the concept of forest quality. This assessment was undertaken to generate and integrate the information needed for SFM. The forests in the study area are mainly semi-rural and community owned and provide goods and services to ca. 22 million people. We integrated and mapped field and laboratory verifiers of forest composition, pattern, function, process, tree health, area and fragmentation and management, as well as ecosystem service indicators (carbon content, biodiversity conservation, water infiltration and recreational value). Together with their verifiers, C&I were weighted by a group of experts and stakeholders through a pair-wise multicriteria analysis (Saaty, 1977). A forest quality index and map were produced by means of integrating information for all indicators through spatial interpolation, in combination with an object based land cover classification of Spot images from 2010. These tools are expected to provide a solid yet flexible framework for decision making and monitoring of SFM in the study area and other places around the world.



Study area.- West of MC



Ecosystem services map



Forest quality map

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# Impact of Seasonal Heterogeneity of the Cultivated Mosaic on Carabid Population Distribution and Dynamics

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Spatio-temporal heterogeneity is recognised as a key factor for biodiversity. In agricultural landscapes, landscape heterogeneity is mostly described by the amount of semi-natural elements. In addition, the heterogeneity of cover types in the cultivated matrix might also influence biodiversity (Fahrig *et al.* 2011). Within a year, this matrix is highly heterogeneous in space and time, due to the diversity of crop covers, crop phenology and cultural practices. Thus, for species that use crops during their life cycle, the cultivated matrix can be viewed as a mosaic of asynchronous habitats with fast-changing suitability, which is likely to affect species distribution and survival (Vasseur *et al.* 2008).

In this study we tested whether intra-annual heterogeneity of the cultivated mosaic affects population distribution and dynamics of a beneficial carabid species (*Pterostichus melanarius*). We hypothesized that distribution of carabid populations is driven in space and time by seasonal changes in habitat suitability in crops and by insect movements from unsuitable to suitable crops during the season. The study was conducted in a 30 ha mosaic of five to six adjacent crop fields (winter cereals, maize) and their boundaries in western France. Winter cereals and maize exhibit dense vegetation cover at different periods (May-July and July-September, respectively) and were expected to have asynchronous suitability for carabid beetles. From May to September 2009 and 2010, trapping was used to describe: 1) densities of post-emergent adults in crop fields (enclosed emergence arenas), 2) carabid activity-density in crop fields and field boundaries (open pitfall traps) and 3) carabid movements between adjacent crop fields and between crop fields and their boundaries (directional barrier traps).

In the early season (May-July), carabid activity-density was higher in cereals than in maize fields. This was partly explained by lower densities of emergent adults in maize fields due to destructive effects of spring soil tillage on larvae and pupae in maize. On the other hand, suitable vegetation cover and microclimatic conditions in cereals might also have resulted in higher carabid activity-density. During this period carabid beetles moved preferentially from maize fields with bare soil toward cereal fields with dense vegetation cover. Later in the season, cereal harvest and vegetation growth in maize were followed by a drastic increase in carabid activity-density in maize fields due to massive colonisation of these crops by insects. The results suggest that the distribution and dynamics of carabid populations is driven by asynchronous suitability of cereals and maize fields, which act as complementary habitats during the season. The spatio-temporal heterogeneity of the cultivated mosaic might therefore play a crucial role for the persistence of beneficial carabid beetles.

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## **The Effects of Climatic Changes on Drying of Bornmullerian Fir that occur in Kastamonu Area Forests**

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Climatic changes can be defined as long-term and slow-developing changes which have global and important local effects on climatic conditions (Türkeş, 1997). In terms of the effects of global climatic changes, Turkey is listed as one of the risk group countries. Due to the ecological degradation caused by drought and desertification in Turkey it is expected that diseases and infestations will become more widespread. Drought and heat can have direct negative and positive impacts on tree resistance and insect populations and can also alter the function of ecosystems and the structure of stands (Şimşek et al, 2010).

In previous studies conducted in Turkey, a general decreasing (cooling) tendency in annual and seasonal average surface aerial temperatures, particularly during summer months, has been established in most parts of the country. However, a prevailing warming tendency has been detected since the 1990s, particularly after a cold year in 1992. The most prominent finding in the First National Declaration of Climatic Change of Turkey and in evaluations over the period between 1951 and 2004 is the widespread increase in summer temperatures. Average temperatures in Turkey have tended to increase in a similar manner to global average surface temperatures. The increase in temperatures, however, is only observable in Turkey after the 1990s, in comparison to the global phenomenon which has been observed since the 1980s (Demir et al., 2008).

Due to global warming, intense drying incidents are being observed in Bornmullerian fir (*Abies nordmanniana* subsp. *bornmülleriana* Mattf.) forests in the western Black Sea region of Turkey in recent years. The general expansion of Bornmullerian fir, which is an endemic species unique to Turkey, is occurring in the western Black Sea basin and Kocaeli basin, located between the estuary of Kızılırmak and Uludağ. The best forests in the area may be seen in Ayancık, the Kastamonu-Ilgaz mountains, the Bolu-Seben mountains, the Boyabat-Göktepe forests and in the Abant and Uludağ areas. Bornmullerian fir trees develop strong stake roots which can reach considerable depth from a young age. These trees demand highly humid weather. Their temperature requirement is medium (Anşın et al, 1997).

In this study reasons for the drying of Bornmullerian fir forests located within the area of the Kastamonu Regional Forestry Directorate were examined. Climatic data such as average maximum temperature, minimum temperature, average temperature, minimum humidity and average humidity were obtained from State Directorate General of Meteorology for this study. Changes in these data sets were examined statistically. Meteorological data sets from over 35 years were divided into three periods (1975-1985, 1986-1997, 1998-2009) for better evaluation. Trends for some of the essential meteorological parameters measured at the Kastamonu meteorological station (such as maximum temperature, minimum temperature, average temperature, minimum humidity and average humidity) were determined using a linear regression model on a yearly time scale. Variance analysis and trend analysis were also undertaken for these parameters.

Results from the study show that statistical differences ( $p<0.05$ ) in average temperatures,

minimum net values and maximum temperatures in particular were present. Further analysis found that the increase in temperatures, particularly in the summer months (June, July and August), created a decreasing tendency in humidity. It is thought that the significant increase in temperatures during summer months and the significant decrease in humidity will cause drying in Bornmullerian fir-type forest trees, which demand high humidity and are sensitive to excessive temperatures.

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## **Biodiversity and Ecological Tree Community Thresholds in the Gallery Forest and Savannah Boundary at the Landscape Scale, in the Biosphere Reserve of Pendjari, Benin**

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Much of the seasonal tropics are composed of a mosaic of savannah and gallery forests at landscape and regional scales. Detecting changes in tree species distribution along an environmental spatial gradient at the boundary of these vegetation types is a critical step for understanding species realised niches and for predicting their dynamics. To detect and interpret biodiversity and ecological tree community thresholds, data was collected along 30 transects of 3 km spatial gradients located at right angles to a gallery forest from a riverbed into surrounding savannah. Because it was anticipated that vegetation change would be more rapid in the zone immediately adjacent to the river than at a greater distance from it, the plots were located at 20, 70, 120, 170, 220, 300, 400, 500, 750, 1,000, 1,500, 2,000 and 3,000 m from the riverbed. Trees species densities (number/ha, 67 species) were measured from 335 sampling stations. Thresholds Indicator Taxa Analysis (TITAN) was performed on the data set in R 2.11.1 to distinguish negative (z-) and positive (z+) tree species responses and track cumulative responses of declining [sum(z-)] and increasing [sum(z+)] tree species in the community. Indicator reliability and purity, as well as uncertainty around the location of individual tree species and community change points, were estimated from 500 bootstrap replicates. 40 species simulated a threshold decline or increase and had median change-point distributions that overlapped their true threshold value of distance from the river. However,

the distribution for 16 species included both thresholds. TITAN identified several tree species with synchronous declines in response to distance at between 20 and 120 m from the river, resulting in a distinct peak in sum(z-) at 70 m. The cumulative distribution of sum(z-) change points among bootstrap replicates was quite narrow. The strong synchrony of change in many species at short distances from the river was consistent with an ecological community threshold. Relatively few species exhibited positive associations with increasing distance from the river. Those that did were widely distributed along the spatial gradient, spanning most of the range of values and approximating a linear distribution of observed taxon change points with increasing distance from the river. By deconstructing tree communities at the savannah-gallery forest boundary, TITAN showed that the savannah is a harsh environment for the establishment of forest species. Further investigations are required to understand the driving factors of nurse plant establishment and forest nuclei development in the savannah and thus the different facets of niche colonization at the landscape scale.

## **Forest Fragmentation in Central Cebu and Its Potential Causes: A Landscape Ecological Approach**

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Forest fragmentation has been a pressing issue in the environment, particularly with respect to its contribution to climate change. This study analyses forest fragmentation in Central Cebu by using GIS and thematic maps developed for the Central Cebu Protected Landscape. The analysis utilised three landscape indices: patch number (PN), mean patch size (MPS) and mean shape index (MSI).

Data analysis showed that the remaining forests in the study site are highly fragmented. This is indicated by the greater number of smaller forest fragments with areas less than 20 ha (PN = 37) compared to larger fragments (MPS > 81 has) as well as higher MSI values of larger fragments. All forest patches in the study site have convoluted or elongated shapes which are more prominent in larger fragments than in smaller fragments. Among the identified causes for this pattern are agricultural activities such as the production of annual and perennial crops. It is probable that forests are converted into agricultural lands for this purpose.

Patch shape elongation and production of annual crops necessitate the implementation of a management strategy that can address edge effect and manage regular disturbance resulting from agricultural areas.

**Keywords:** Forest, Fragmentation, GIS, Cebu, Landscape, Ecology

## Investigation of Indicator Plant Species for Degradation of Rangelands

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*Euphorbia hatradena* and *Cirsium arvensis* species are dominant species in a degraded mountain landscape - Chahar Bagh, Golestan Province. The hypothesis was that certain species caused a decrease in species richness and in the proportion of particular functional groups. The objective of this study was to investigate index species to clarify mechanisms of rangeland degradation. Species richness was found to be higher in the grazed protected area than in the grazed, unprotected area. Grazing was found to decrease the total number of species and grasses (*Stipa barbata*, *Festuca ovina*) while substantially increasing forbs and shrubs (*Cirsium arvensis*, *Euphorbia hatradena*, *Acantophylumi* spp.). Topography also appeared to impact the dominance of forbs and shrubs. Based on regression analysis, a decrease in species richness with change in cover of grasses was evident. *Cirsium arvensis*, *Euphorbia hatradena*, and *Acantophyllum* are suggested as indicator plant species assessments of degraded semi-steppe rangelands.

## The Confounded Effects of Habitat Disturbance at the Local, Patch and Landscape Scale on Understorey Bird Communities of the Atlantic Forest

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Numerous studies attempt to determine a single spatial scale or a dominant factor that best describes changes in the structure of communities in fragmented landscapes. Yet the heavily intercorrelated nature of these factors complicates analyses (Koper et al. 2007), and the wide variation in species responses prevents the identification of a general trend (Gardner et al., 2009). In this study, we used a two-tiered hierarchical variation partitioning (Cushman & McGarigal 2002) to identify: 1- the relative importance of changes in vegetation structure at the plot scale, patch structure (size and shape), and forest cover at the landscape scale; and 2- the relative importance of variables within these scales; as predictors of the variation in bird community structure in a fragmented landscape of Atlantic Forest. Birds were sampled with mist-nets with a constant effort of 680 net-hours at each of 23 sites, which resulted in almost 2,600 captures from 15,000 net-hours. Regression models showed that changes in plot, patch and landscape scale variables explained a large proportion of the variation in the bird community, but results from variation partitioning showed that the intercorrelation among predictors was so high that the unique contribution of each was non-significant. Our results point to a relatively large importance of local and landscape scale variables at structuring the bird community, but we also show that results vary greatly depending on the trophic guild being analysed. We show that there is no single ‘best’ scale that is associated with changes in

bird communities, and suggest that conservation efforts should be focused on finding a strategy that best encompasses all scales and the needs of different taxa. Research support was provided by Petrobras, CNPq, CAPES and NERC.

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## Physiological Characteristics and Heavy Metal Concentrations of Urban Street Tree Leaves in Beijing, China

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*Sophora japonica* L., as a representative of urban street trees in Beijing, China, was investigated for pollution characteristics in August 2010. *Sophora japonica* L. leaves were collected at 103 traffic sites, including the roadsides of expressways, trunk roads, secondary trunk roads and branches. 12 non-traffic sites were also investigated for contrast. Chlorophyll content, chlorophyll a/b, malonaldehyde content, pH, membrane permeability, sulfur, nitrogen and heavy metals (Pb, Cu, Cd, Zn, Cr, Ni, Mn) of leaves were measured. Relationships between these characteristics were discussed and differences among different grades of highways were compared. General trends in space distribution of pollutants in Beijing were also investigated.

## Landscapes and Legends in Northern Nigeria: What Implications for Sustainable Land Uses?

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Relations between people and natural landscapes in northern Nigeria are becoming increasingly strained. Landscape disturbances arising from cultivation and grazing are the

major human impacts on rural landscapes. In urban areas, unprecedented levels of land conversion into other urban land uses constitutes a threat to natural landscape systems. Most of the scientific, institutional and technical tools of land resource management have failed to abate these negative trends. As a result, removal of vegetation cover, desertification, soil erosion and other forms of land degradation are rife in both rural and urban landscapes in the region. However, a number of natural landmark landscapes have been conserved courtesy of existing ancient legends and folklore. This paper aims to investigate the potential of local folklore to aid in the conservation of elements of natural landscapes in northern Nigeria. The paper is based on field observations and interviews. The findings reveal that most folklore assumes the existence of sacredness and power in some of the attributes of natural phenomena such as water bodies, trees and hills. This sense of sacredness provides security for some natural landmarks against rampant human misuse. In Kano, a city with one of the highest population densities in Africa, centuries-old biodiversity sinks still exist. Legends have led to the creation of a ‘forest’ within this savanna city. The small biodiversity sinks of this city offer unique ecosystem services and biodiversity multiplication and protection. In some rural areas folklore helps to shield some vulnerable landscapes. Legends have induced the protection of land cover on some slopes, leading to slow run-off and extraordinarily rich grazing and arable areas. The conclusion of this paper is that the major challenge is determining how to sustain folklore in an increasingly globalising world which relegates indigenous belief systems. Surprisingly, the legends of the region have continued to exist even after Islamic faith has swept across the region for centuries. Though seemingly contradictory to conventional science, the potential of this heritage system is high and may be valuable for ecological landscape sustainability. Landscapes under the influence of legends are very few, yet they could be used to educate urban and rural populations on the needs and benefits of ecosystem conservation.

**Keywords:** Legends, Natural landscapes, Land use, Sustainability, Northern Nigeria

## **Impacts of Gentrification and Densification on the Ecological Quality of Traditional African City Landscapes**

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Kano city in northern Nigeria was the largest city in sub-Saharan Africa in the 16<sup>th</sup> century. Although located in an ecologically precarious dryland area, the city’s indigenous land management practices aided the entrenchment of habitat sustainability for a couple of centuries. Past spatial patterns of the city allowed for the existence of numerous small and large size ponds, open spaces, scrublands and wetlands within and separate to the city’s compact built-up areas. In the last thirty years, however, the city has witnessed massive urban growth that has replaced most of the scrublands, wetlands and open spaces with houses of the elite. Mass, illegal steady encroachments on these urban ecological resources has also occurred. This paper seeks to measure the role of rapid urban surface permutations in Kano City on local ecosystem services. The specific objectives are: to measure the extent of spatial changes in the landscape in the last thirty years; identify the effects of land use and land cover change on the environmental components and quality of the city; and to discover the reasons

for the loss of the entrenched indigenous pro-environmental values. To achieve these objectives the study has utilised sets of meteorological data; field observations, analysis of two air-photos and satellite images. It is anticipated that the findings of this research will reveal that the main drivers of urban landscape change in traditional African cities like Kano are principally the urbanisation processes of gentrification and densification. The effects of these processes are expected to result in changes to the city's climatic variables, albedo values, landscape morphology, biogeochemical services, drainage systems leading to recurrent incidences of floods and health hazards and to result in a progressive decline in biodiversity composition. Conclusions may show how densification has created conflict rather than solutions and demonstrate the need for spatial strategic plans and participatory decision-making.

**Keywords:** Gentrification, Densification, Urban growth, Ecology, Sustainability, Kano city

### **Pindaré Basin: Tools for Sustainable Natural Resource Use, Conservation Strategies and Territorial Planning in Maranhão State, Brazil**

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The Pindaré River Basin (PRB) is subjected to serious erosive processes at the margins of the river, resulting from activities such as sand mining for construction as well as other forms of environmental pollution and degradation. The PRB is located in a transitional zone between the Amazon and Cerrado biomes of Brazil and supports high biological diversity. Considerable efforts are needed to evaluate and monitor the impacts of degradation and fragmentation on biodiversity and natural ecosystems, in order to better identify ways to improve management practices in the PRB. This is mainly required in river systems in Maranhão, where rural developments occur unplanned and educational activities on health are being implemented by the Open University of Brazilian National Health System (UNA-SUS). The objective of this study is to find solutions for adequate conservation planning of the PRB, with a focus on identifying the tools that may be used to obtain information and knowledge for policy decision-making in natural resource management and monitoring of biodiversity. This study was carried out within the Zutuia sub-basin of the PRB. The impacts of human land use activities on aquatic ecosystems were monitored with the LAPSUS model, which was used to simulate erosion processes and sedimentation within the river. The Digital Elevation Model and land use maps were used to undertake modeling of the river system. The effect of erosion and sedimentation on aquatic biodiversity could be detected at the level of subsistence fishing indicators, small-scale farming and fishing activities in one locality in the upper Zutuia. An

investigation was undertaken to determine whether increased erosion, leading to the silting up of streams and sedimentation, was affecting aquatic habitats and causing the population decline of fish species and other vertebrates caught for food. In order to propose a biodiversity and ecosystem conservation strategy (scenarios), the study area was divided into 10,000 ha hexagons and a landscape-based approach was used to calculate a landscape index using FRAGSTATS. The results suggest that the landscape of the Zutuia sub-basin has a critical fragmentation, with half of the hexagons containing less than 10% native vegetation and only 23% of hexagons identified as well preserved. These results were used to propose landscape management actions as the main recommended strategies to improve biodiversity conservation in the study area. The results showed that more erosion and sedimentation was occurring in the central/north part of the sub-basin, where the majority of human land use activities are located, including railway and migrant population activity. An assessment of alga species indicated that some areas of the river were disturbed by sewage deposits. The study results permitted solutions to be proposed to move towards sustainable development in the sub-basin.

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## **Assessment of Landscape Fragmentation in Izmir, Turkey**

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Urbanisation, road infrastructure, agriculture and industrial applications are among the main reasons for landscape fragmentation. Landscape fragmentation has a number of effects on almost all components of landscapes including aesthetic, ecological, historical, and recreational qualities. E. g. tranquility, scenery and landscape character (Canters, 1997). Landscape fragmentation also divides, reduces and isolates habitat patches (Taylor et al., 1993; Forman et al., 2003). For this reason landscape fragmentation is regarded as an important environmental indicator by professionals of environmental science. Systematic, objective and quantitative landscape indicators are needed to be understood in urban landscapes and they should also be integrated in urban planning studies. In this study Izmir city, which has been showing a rapid process of urban development, is analysed from the viewpoint of landscape fragmentation. Landuse change and road infrastructure development are evaluated over different periods of time (1984, 1990, 2000 and 2009) and fragmenting elements are analysed. This study not only measures the landscape fragmentation in Izmir city but also reveals the effects of fragmentation on different landscape types and their functions. Planning proposals are made accordingly and the need for landscape management to establish a balance between urban activity and natural habitats that suffer from human dominated areas is emphasised.

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## **Land Use Management, Ecosystem Services and Biodiversity–Developing Regulatory Measures for Sustainable Energy Crop Production**

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According to European and German energy policies, the proportion of renewable sources comprising the energy supply is to be increased significantly in the coming years. The extended cultivation of energy crops has both positive and negative economic, social and environmental effects. It can lead to conflicts and impacts on groundwater, soils, biodiversity and the overall appearance of the scenery. There is a demand for suitable instruments to regulate energy crop cultivation and to reduce the impact on ecosystems and landscapes. Since it includes economic, ecological and social aspects, we see the concept of Ecosystem Services as a suitable tool to safeguard and to enhance sustainable land management. The poster describes our methodology with a participatory approach using the concept of Ecosystem Services, scenario developments, evaluation of model results and joint conclusions, which allows us to develop appropriate and widely accepted planning and other instruments influencing biomass production towards more sustainable practices.

Looking at regulatory measures like laws, subsidies, planning guidelines and regulation, it can be shown that guidelines exist but they are not sufficient. Together with stakeholders, there will be a search for improved or modified regulation mechanisms that are widely accepted. Results gained from this participatory approach will be converted into recommendations for both practice and decision makers, a core intention for current research activities in the field of sustainable land use.

## **Space and Time scales of Landscape Services**

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Ecosystem services are always bound to spatial units, and they manifest themselves in spatial differentiations, in various dimensions and scales. They are also a subject of partly rapid changes, concerning both the factual level and the value level. It is useful to combine the ecosystem service concept with the landscape concept, and to define landscape services. Landscape can better be connected with structural and process-related interactions (“pattern-process relationships”) than can ecosystem services. Moreover, they may integrate various scientific disciplines (interplay between humans and their environment, the more contextual view), they are relevant for practical spatial planning, and more familiar to practitioners (also allowing public participation)(e.g. Termorshuizen and Opdam, 2009, Kienast, 2010). We take landscape services for a special case of ecosystem services, on the one hand. On the other side, the landscape approach is wider and more complex as it includes in addition to physical aspects aesthetical, cultural, psychological, and utilitarian aspects alike, viewing landscape as a hybrid system, with the interplay of nature, society and technology.

Landscape services are related to special landscape patterns; i.e. particular combinations of landscape elements and landscape units. There are interactions and therefore spatial concordances among different services. Frequently, there are particularities regarding supply and demand: services can be delivered at one place but used at another place (spatial trade-offs: benefits here – costs there). Service provision as well as valuation aspects (stakeholders, decision-making) are depending on scale issues. For the sampling of data and the assessment of services, suitable units of reference are necessary.

Time aspects manifest themselves in changes of services (for example caused by impacts), in scenario analyses, in temporal differences concerning the supply and demand of services, in temporal trade-offs (benefits now – costs later), or in changes in judgments as to value.

As a methodical guideline, we recommend the EPPS-framework (Ecosystem Properties, Potentials and Services - Grunewald and Bastian, 2010, Bastian et al., 2011). This framework aims at the differentiation between the potential performance of ecosystems and landscapes and the service actually used or demanded by the society. This is important for various issues, such as the suitability and carrying capacity of ecosystems (and landscapes) for planning and management purposes as well as for governance schemes.

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## **Spatiotemporal Changes of Zayandehroud River Water Quality in Response to Change in Landscape Patterns**

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Quantifying landscape patterns and change is essential for the monitoring and assessment of the ecological consequences of land use change and human interference. This study focuses on the effects of changing landscape patterns and dynamics (changes in landscape patterns through time) on the water quality of the Zayandehroud River, which is the most important river in central Iran. The rapidly increase in water demand and water pollution due to population growth, industrial and agricultural development around the river in Isfahan province over the past decades, is causing the water quality of the Zayanderoud River to severely degrade. Therefore, monitoring of Zayandehroud water quality is critical, especially due to the concern that freshwater is becoming a scarce resource in this region of Iran. The main goal of this research is to characterise land use change in the Zayandehroud River basin since 1990 and to examine how landscape patterns (including Number of Patches, Edge Density, Largest Patch Index, Fractal Dimension and Shannon's Diversity Index) influence water quality parameters (including BOD, COD, EC, pH, and TDS) measured at several stations along the river. Land use and land-cover maps of the area were prepared using maximum likelihood classification of the multi-temporal Landsat5 (ETM) images taken in September 1990, 2001 and 2008. To quantify landscape patterns various metrics such as NumP, ED, LPI, AWMPFD and Pland were calculated. Pearson correlation test and regression analysis will be applied to assess the relationship between landscape indices and water quality. The results of this study can be used to establish and implement effective water management at the landscape scale in this region.

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## **Agricultural Landscapes and Public action for Biodiversity: a French National Perspective**

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The research program “Public Action, Agriculture and Biodiversity” (DIVA) of the French ministry of environment aims at providing science-based results and methods to foster biodiversity protection and management. Since 2003, twenty projects have been funded covering all four French metropolitan biogeographic regions and a large variety of farming situations and cultural landscapes. The climate in France varies from Atlantic temperate, to continental, alpine, and Mediterranean. The proportion of different agricultural land uses varies between regions but similar cropping and livestock systems are found. Within each region, the landscape can be opened or characterized by a hedgerow network. This is an opportunity to build a general picture of biodiversity as it relates to agricultural policies under different environmental conditions and to propose novel forms of public action.

**The diversity of elements of biodiversity:** no institution aims at managing “biodiversity”, even if overarching policies such as the Rio Convention have this global objective. Each public or collective action deals with a specific segment of the range of species. Large endangered emblematic species benefit from policies aiming at protecting them one at a time. For instance, scavengers such as vultures feed on sheep carcasses. To restore the vulture population, squaring policies must allow farmers or NGOs to feed the vultures; this necessitated the assurance that no sheep disease would be spread by vultures. This led to changes in the EU regulation of squaring. Most of the time, a group of species is at stake, for instance weeds, carabids, grassland plants or insects in fish ponds. In this case, habitats are protected (as in the EU habitat directive). An important lesson of the projects is that the local richness of any group is about a tenth of the study area's (region) richness. This is true for aquatic and terrestrial components, plants, birds and insects. This means that beta diversity, linked to landscape heterogeneities, is a key feature to manage.

**Lessons for public policies design and implementation:** The diversity of the implementation of public policies and biodiversity management strategies is also the rule at regional and farm scales. All these results provide information that helps promote other strategies than the usual European agri-environmental measures that focus on field scale alpha biodiversity. This reinforces the importance of the spatial, cultural and technical components of biodiversity, i.e. the importance of a multiple scale framework for biodiversity management. This implies a shift in the definition of “good practices” from field to landscape scale. Practices must vary from field to field. The integration of a spatial dimension in biodiversity management is consistent with other key aspects, such as the necessity to maintain or restore ecological connectivity, or to grow a diversity of crops and to use different cropping practices within farms and landscapes. This is a means to integrate a biodiversity component within farming systems. This would also help overcome the difficulties of agri-environmental policies in achieving their goals.

## **Ecotoxicology and Macro- and Landscape ecology – Time for Integration**

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Despite considerable progress of ecotoxicology, the central questions in this discipline, such as “What are the effects of toxicants on biodiversity and ecosystem functions and services?” remain to be answered. We argue that if such questions are to be answered, methods and concepts of ecotoxicology should be integrated with macro- and landscape ecology. Furthermore, we show that such integration is currently methodologically possible and show examples of mesocosm and field ecotoxicological studies.

*First example* – In the ECOLINK project we aimed at establishment of the ecosystem level dose-response relationships depending on regional biotic characteristics and local abiotic/biotic factors. We conducted a parallel mesocosm (300 little artificial ponds) experiments in Europe (Leipzig, Germany) and Asia (Karasuk, Western Siberia, Russia) and investigated zooplankton communities’ responses to insecticides. These experiments have shown that community sensitivity varied markedly between the treatments, with the lowest-observed-effect concentration (LOEC) differing by a factor of up to 100. The series with the lowest availability of food and strongest competition was the most sensitive to the toxicant (Stampfli et al., 2011). Furthermore, it was revealed that intraspecific competition plays a key role in the species response to toxicants. These findings indicate that environmental context is much more important for ecotoxicological evaluation than assumed previously.

*Second example* – We develop trait-based indices SPEAR bioindicators for detection and quantification of ecological effects of pesticides and other toxicants over large spatial scales (Liess and von der Ohe, 2005). These bioindicators allow detection of the toxicants effects that are not detectable by conventional taxonomy-based analyses due to effects of confounding factors and natural variability (for the theoretical background of the trait-based approaches see e.g. McGill et al., 2006). The studies in several regions of Europe show evidences that, in the field, pesticides can have effects at concentrations more than 100 times below the concentrations that can cause effects in the standard laboratory tests. One reason for these differences is that organisms in real-world ecosystems are exposed to multitudes of biotic and abiotic stressors that are present in the environment but absent in standard toxicity tests. Application of the trait-based metrics allows to separate effects of toxicants from the effects of those additional stressors (Beketov and Liess, 2008), and furthermore shows that understanding the toxicants effects in the context of the real-world systems is much more important for ecotoxicological evaluation than assumed previously. These examples show the urgent need to integrate ecotoxicology and macro- and landscape ecology.

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## Creating Effective Scientific Knowledge: The Potential Role of Evidence-based Design Guidelines

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Creating desired landscape change requires integrating and transferring scientific knowledge in a manner that it can be used effectively by decision-makers. Cash et al. (2003) proposed that the effectiveness of knowledge transfer is influenced by three characteristics of science: saliency (relevance to decision making), legitimacy (fair and unbiased information that also respects stakeholders' values), and credibility (scientific adequacy). Other factors of effective knowledge transfer include accessibility and usability (Dilling and Lemos 2011). There are many approaches to integrating and transferring scientific knowledge; each with its own strengths and weaknesses. Examples include decision support models/apps, systematic reviews, newsletters/blogs, wikis, text books, research literature databases, and evidence-based guidelines. Guidelines can offer tangible, easy-to-understand principles applicable for local planning and design. This presentation will focus on the development and evaluation of evidence-based design guidelines for conservation buffers to determine if these guidelines produced effective knowledge for decision-makers. Over 1,400 research publications were synthesized and distilled in the publication, *Conservation Buffers: Design Guidelines for Buffers, Corridors, and Greenways (Guide)*. Illustrated rules-of-thumb are provided for designing buffers to improve air and water quality, protect soil, enhance habitat, increase economic productivity, create recreation opportunities, and beautify the landscape. Anecdotally, the *Guide* appears to have some traction among decision-makers; over 10,000 copies have been requested and the publication has been translated into Chinese, Spanish, French, Korean, and Mongolian. To formally assess the *Guide*, an evaluation was conducted using interviews and a web-based survey of those who had requested the English version of the *Guide*. The majority (79%) of respondents indicated that they found the *Guide* to be a useful and effective resource for planning and design, while 77% agreed that the *Guide* presented research in a practical manner. More than half (59%) of respondents stated that they would recommend the *Guide* to others while 4% of respondents did not find the *Guide* to be useful. Based on this study, evidence-based guidelines may play a role in integrating and transferring knowledge to affect landscape change however there are challenges and issues that should be considered. Some of the challenges include the significant time investment to develop guidelines and planners' desire and need for regionally specific information.

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## **A Typology of Multi-criteria Decision Aids (MCDA) for Designing Multifunctionality in Local Landscapes**

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Real landscape multifunctionality has been defined as accomplishing different functions on the same land unit at the same time (Haaland et al. 2011). One of the key steps in planning and designing real multifunctional landscapes is comparing environmental and socio-economic functions to identify synergies and conflicts and then deciding how to achieve the desired mix of functions on a single land unit. Designing for several functions requires a multi-criteria decision aid (MCDA) for analyzing function compatibility, weighing tradeoffs, and developing a final plan; often with incomplete data and indeterminate levels of impact. The principle aim of a MCDA is not to produce a solution but to construct something that helps decision-makers take part in creating the solution (Munda et al. 1994). Some examples of MCDA include landscape function indicators, alternative scenarios, integrative optimization models, and transdisciplinary expert systems. It is useful to consider attributes of MCDA under a typology to assist in selection of a suitable MCDA for a specific project as well as to inform research and development of new MCDA that can improve multifunctional planning and design. This typology is not intended be a comprehensive analysis or review of the subject, but rather as a conceptual framework useful for understanding some of the key considerations that are inherent in any MCDA approach.

The typology includes five elements: (1) function inclusiveness, (2) data input, (3) integrative strategy, (4) output, and (5) transparency. Function inclusiveness is the range of environmental and socio-economic functions that a MCDA is capable of addressing. Data input takes into consideration the different types of data or knowledge that may be used in the method; quantitative, qualitative, or mixed. The third component describes the strategy used to integrate and analyze the data under a multi-criteria framework. Output is the format in which the integrated information is presented and used to aid decision-makers in creating design solutions while transparency is concerned with the overall understandability of the MDCA by decision-makers. This typology will be applied to several MCDA to explore the diversity of approaches and to foster discussion on challenges, barriers, and opportunities to using these types of tools. Recommendations for future research and development of MDCA to enhance designing for multifunctionality in local landscapes will also be discussed.

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## Using a Function-based Design Matrix Tool: A Multifunctional Ecobelt Example

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The concept of multifunctionality suggests that landscapes can provide multiple environmental, economic, and social functions and it is often considered a prerequisite for sustainable land use. One type of landscape multifunctionality involves attaining different functions on the same land unit at the same time (Brandt and Vejre 2004). Achieving multifunctionality on local landscapes requires them to be designed and managed to capitalize on ecological interactions and synergies while reconciling conflicts and tradeoffs. Landscape functions can be produced or enhanced by altering components of landscape structure such as vegetation type and configuration, topography, hydrologic routing, terrestrial community, and connectivity (Hobbs 1997). A method for comparing functions and their associated landscape structural requirements is necessary for determining compatibility between functions, weighing tradeoffs, and developing a final plan.

A function-based design matrix tool is one approach that allows land managers to compare landscape structure design criteria for each function. The simple matrix format allows design information from empirical studies, expert opinion, and local knowledge to be recorded, synthesized and used in a systematic manner. This format may also be useful to inform scientists on how the knowledge they produced can be applied in landscape planning and design; and on the remaining gaps in the knowledge base that need to be addressed by research (Nassauer and Opdam 2008). Using the matrix tool, land managers can identify criteria that are compatible as well as those that are in conflict. Compromises often will be required to reconcile conflicts and optimize a final design. Among well-matched criteria, one may be more-stringent and will determine the final design, such as vegetation type. For conflicting criteria, concessions may produce a design that provides acceptable, albeit less than desired, levels of each function. If an acceptable compromise cannot be found, then the desired functions cannot be performed on the land unit and other locations will be necessary to acquire the desired functions. To illustrate the use of the function-based design matrix tool, an ecobelt example at a rural-urban interface will be used, where the functions desired include economic production, water quality, biodiversity, recreation and aesthetics. Strengths and weaknesses of this method will be discussed and recommendations for future research will be suggested.

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## **Combating Landscape Fragmentation – Environmental Planners’ views on Using Network Based Connectivity Analysis in Conservation**

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For many species living in urban and suburban landscapes the potential habitat is often very fragmented which according to metapopulation theory can lead to species extinctions. Although land use planners often have a range of tools at hand when they assess ecological values of green areas in a landscape context, it is less common that they have access to easy-to-use tools where effects of landscape fragmentation are taken into account. Recently, network analysis has been proposed as a user-friendly and credible method to assess the ecological impact of landscape fragmentation. The method is suggested as being particularly suitable for land use planners since it can assess the importance of individual green areas in terms of their contribution to upholding the connectivity of the landscape.

In order to elaborate this potential benefit further, we present an interview-based study of ecologists employed by municipalities in the Stockholm region in Sweden. All interviewees had at least a basic understanding of the network perspective. We report the opinions and expectations of municipal ecologists on network analysis as tool for analyzing and communicating ecological values of green areas. What benefits and limitations do they see in using network analysis for ecological assessment? Have they got access to other methods for quantifying the consequences of landscape fragmentation?

Preliminary results indicate that a majority of the interviewees thinks that the network approach would be a valuable tool in the planning process since it delivers pedagogic, credible and quantitative assessments of landscape fragmentation. Hence, the benefit of the network approach seems to be significant if put into practice in land use planning, by identifying the impacts of landscape fragmentation. However, the need for acquiring empirical grounded estimates of species dispersals capabilities in an urban context was stressed by many of the interviewees.

## **Assessing the Impact of Climate Change on Landscape: Going Beyond Land Use to Formulate Spatial Planning Strategies**

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The interaction of natural and human factors is influenced by many factors, including climate change, effecting both natural processes and human activities. This chain of effects is causing changes in both the landscape pattern and the related functions and ecosystem services. To assess these effects, it is important to have insights in the geographically differentiated impact of climate change, such as increase of the mean temperature and winter precipitation, having

different consequences for soil properties, biodiversity, forests, agricultural activities, and others. Based on this knowledge, it is possible to assess changes in different landscape types, which are determined by soil properties, land use, elevation and cultural qualities, and effects on the landscape heritage. The overall assessment of climate change and the impact on landscapes is needed to develop spatial planning strategies, including adaptation and mitigation measures anticipating to possible effects of climate change in Flanders (Belgium). Therefore, a relevant landscape typology for the Flanders region is necessary as a reference base, susceptible to be affected by climate change. In this paper, the methodology for determining landscape types is proposed and the sensitivity of the landscape types to climate change is assessed. This is illustrated for the case study of the 'Kempen', situated in the north-eastern part of Flanders. In a first phase, information themes significant for climate change are selected: a land cover map derived from the topographical map (1/10.000) of 2009, the soil map of Belgium (1/25.000), and a digital elevation model with resolution 5m. Secondly, the themes are converted into raster data and combined into one RGB colour composite. The object-based image analysis software Definiens Professional (former eCognition) is used to compile a segmentation based upon the composite image, The resulting polygons are seen as landscape areas. For each area, the corresponding attributes, based on land use, soil properties and topography, are calculated in the third step, as well as a selection of landscape metrics indicating the composition and configuration of the areas. Fourthly, the landscape types are defined using latent class analysis and cluster analysis. Lastly, the paper gives the onset about the assessment of the sensitivity of the landscape types affected by climate change. In this phase, sensitivity as well as vulnerability maps are produced. Also indicators for landscape heritage were compiled, indicating the amount of heritage that could be affected by flooding, drought, etc. The combination with the sensitivity maps gives an indication for the vulnerability of landscape heritage.

**Keywords:** Flanders (Belgium), GIS-analysis, Integrated landscape and heritage management, Landscape typology, Climate adaptation and mitigation

## **Impact of Historical Land Use Changes on Ecological Networks Using GUIDOS Software**

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Within the project TransEcoNet (Transnational Ecological Networks in Central Europe, <http://www.transeconet.eu/>) the historical development of ecological networks in the region of the Saxon Switzerland (South Eastern Germany) is analysed. Given that nearly no historical data is available on the development of ecological networks over time the GUIDOS software (Graphical User Interface for the Description of image Objects and their Shapes) is used as a tool for identifying possible historical ecological networks.

Five different time periods (1780, 1880, 1900, 1992 and 2005) are analysed using a specialist approach. The assumption is that certain species, the so called specialists are using more or

less disturbed and semi-natural parts of a landscape as home ranges like forests, natural grasslands, hedges, old fallow land and orchards. The various land use types of the different time periods are classified into suitable and unsuitable habitat for these specialists. Because agricultural areas around 1780 and 1880 were far less intensively used than after the industrialisation around 1900 and can therefore also be considered as suitable habitat for specialists. Thus, this approach gives the opportunity to identify land use change in time, space and quality and is therefore a good tool for showing the historical development of ecological networks.



Figure 1: Example of the analysis of the ecological network in the Krietzschwitz region in the Saxon Switzerland area (Germany) with GUIDOS for 1780 (right) and 2005 (left)

**Keywords:** Historical analyses, Ecological networks, GIS, GUIDOS software, Central Europe

## Urban Ecology and Seasonality of Blowflies (Insecta, Diptera) in Brasília City, Federal District, Brazil

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Urbanisation and its possible effects on biodiversity conservation has led to greater interest in studies on the dynamics and characteristics of urban ecosystems. The urbanisation process and implementation of new agricultural areas are leading to the fragmentation of original habitats of the Cerrado, the second largest biome of Brazil (e.g., Myers et al., 2000). The arthropod communities in urban environments tend to be more diverse than those in non-urban environments and some *taxa* may benefit more with urbanisation than others (McIntyre, 2000). The general goals of this study were to identify the possible relationships between the different degrees of perturbation in richness, composition and abundance of blowflies species and to identify possible relationships between different degrees of perturbation and temporal and

spatial variation in population dynamics of blowflies species. The study was carried out in Brasilia City, Federal District (15°47'30,9''S; 47°53'06,89''W) between July 2010 and June 2012. Fifteen areas in three different degrees of human perturbation (low, intermediate and maximum) were selected and classified by means of GIS. Flies were caught using wind oriented traps fabricated from transparent type 2 L pet bottles. Baits composed of 30 g of ground beef were left for 48 hours at room temperature to allow putrefaction to occur and exposed every 30 days for 30 consecutive hours. The abiotic parameters measured for this study were temperature, relative humidity, precipitation and cloudiness. Six species of blowflies were collected over the monitoring period, including *Chrysomya megacephala* (N = 4,501) and *Chrysomya albiceps* (N = 1,484), the two most abundant species in the three areas of perturbation. *Lucilia eximia* (N = 9) and *Chloroprocta idioidea* (N = 9) were only collected in the minimal and intermediate areas of perturbation. No significant difference was found between the number of individuals of *C. megacephala* collected in the three areas of perturbation (N = 21,  $F_{2,18} = 2.121$ ,  $P = 0.149$ ). However, significant difference was found between the number of individuals of *C. albiceps* collected in the three areas (N = 21,  $F_{2,18} = 3.854$ ,  $P = 0.040$ ). Only relative humidity appears to have negatively affected the number of individuals of *C. albiceps* collected in the area of minimal perturbation ( $r^2 = 0.561$ ,  $F_{1,5} = 6.396$ ,  $P = 0.053$ ). *Chrysomya megacephala* and *C. albiceps* are invasive species (Guimarães et al., 1979; Greenberg & Szyska, 1984) that were mostly collected within the city area. However, the presence of *Lucilia eximia* and *Chloroprocta idioidea* in the city area indicates that there is a good quality of green spaces within the city and that these species may be good biological indicators.

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## Identification and Measurement of Anthropogenic Effects in Landscapes

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As a consequence of anthropogenic pressure, landscapes change; deforestation is a well-known example of this type of human-driven landscape change. Landscapes change

from entirely natural to anthropogenic or cultural, in which landscape composition is marked by land covers and uses directly related to the civil society, such as degraded vegetations, agriculture, urban zones, or road networks. Landscape dynamics can be quantified by landscape pattern analysis. Many landscape metrics are available to capture the different features of pattern change. As a consequence of the pattern/process paradigm, the ecological consequences of the observed dynamics can be linked to ecosystem processes and characteristics, such as biodiversity. By means of a series of case studies linking field observations of fauna and flora with cartographic and demographic data, the importance of pattern analysis and landscape management is underlined, as well as the diversity in types of anthropogenic landscape change. Conclusions are drawn with regard to the ecological impact of landscape change. Guidelines are formulated for the characterization and analysis of anthropogenic effects in landscapes by means of pattern analysis.

## **Spatial Scaling of Species Abundance Distributions: Patterns and Predictions**

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In this work we explore the implications of the patterns exhibited by the moments of species abundance distributions to predict species relative abundance at spatial scales hitherto not sampled. Although species abundance distributions are central to the description of the diversity of an ecological community and have played a major role in the development of theories of biodiversity and biogeography, most work on species abundance distributions has focused on one single scale. Here we look at the evolution of species abundance distributions as a function of area and describe its scaling properties with a view to providing tools for estimating the relative abundance of species at large spatial scales. We base our analyses on the moments to the species abundance distribution. The reasoning is the following: if we know how the moments behave as a function of area then we can extrapolate the moments and reconstruct the probability density function. In fact, probability theory tells us that the moments are the coefficients of the Maclaurin expansion of the characteristic function, which is the Fourier transform of the probability density function hence, there is a relationship between the moments and the probability density function. The latter approach, however, is not practical in real situations and we use here a method based on discrete orthonormal Tchebichef moments. To exemplify the technique we use data on tree and shrub species from a 50ha plot of a tropical rainforest in Barro Colorado Island, Panama. First, we assess the application of the method within the 50 ha plot and, then, we predict the species abundance distribution for larger areas up to 500ha. The results predict for areas above 50 ha a clearly bimodal distribution with one of the maxima occurring for the singletons abundance class, therefore predicting that the rarity of tropical rainforest trees (identified by the number of singletons and doubletons) is not abated when area increases.

# Current Patterns and Future Prospects of Urban Nature Conservation – The Case of Southern Sweden

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Urban nature provides local ecosystem services such as absorption of air pollutants, reduction of noise, and provision of places for recreation, and is therefore crucial to urban sustainable development. Nature conservation in cities is also part of the global effort to halt biodiversity decline. However, urbanisation creates landscapes with different characteristics and prerequisites compared to for example forests and agricultural landscapes (Grimm et.al. 2008). The dominance of human activities results in land-use changes that compromise many ecological processes and a high degree of ecological and social heterogeneity generates a mosaic of different land uses in urban landscapes. Such urban characteristics force forward a reconsideration of nature conservation planning and management, e.g. why, where and how to protect urban nature in a purposeful way. The aim of this project was to examine the current urban nature conservation and discuss its future role in the urban landscape. The project was performed in the southern part of Sweden and examined: i) the present characteristics of nature conservation in urban landscapes, ii) the effects of establishment of nature conservation areas on land use patterns in the surrounding urban landscape, and iii) how spatial and temporal scales are recognized in practical management of urban nature conservation areas. Sweden is an interesting study area due to its long and strong traditions in both nature conservation and urban planning. Both quantitative and qualitative methods were applied, e.g. statistical analyses of official databases, spatial analyses, interviews and text analyses. The examination of all 1869 nature reserves in southern Sweden showed that they are fewer, but larger and have a higher diversity of land covers in urban landscapes (Borgström 2009). They are also based on a higher number and different objectives than rural nature reserves. The patterns found seem to be a reflection of the urban context rather than a conscious adaptation to the specific urban characteristics. Analyses of 15 urban nature reserves showed that urbanisation adjacent to these areas followed the general urbanisation patterns in the cities and no additional increase or limitations in urban settlements could be detected. In general, there was a lack of social and ecological linkages between the nature conservation areas and the urban landscape and practical management showed a limited recognition of cross-scale interactions (Borgström et al. 2006). The results indicate a conceptual and physical isolation of urban nature conservation areas that risks decreasing the public support for nature conservation, cause biodiversity decline, and hence impact the generation of ecosystem services. A major future challenge is therefore to transform current conservation strategies to become integrated into overall urban governance. Seeking social-ecological synergies is at the core of such integration, where urban planning is proactive and concerns landscape multifunctionality, cross-scale strategies and border zone management.

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# Are Neutral Landscape Spatial Patterns Influenced by Different Algorithm Simulators?

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Landscape ecologists have increased their understanding of landscape metrics behaviors considerably, as well as explored a myriad of aspects relating to habitat fragmentation by analysing computer simulated landscapes using different algorithms. The ability to independently control for landscape cover and spatial aggregation is one of the major benefits which will help to spread the use of neutral landscapes in this field. However, simulated landscapes have important drawbacks and have been considered too simplistic to properly represent real landscapes. The behavior of different algorithms used to generate simulated landscapes across a variety of habitat cover and aggregation was investigated to assess and compare their general results. Four different landscape generators were used: QRule (Gardner & Urban 2007), which is based on fractal geometry; Bolker (2007); Keitt (2000), which uses two-dimensional discrete Haar wavelet with Hurst exponent; and Boscolo (2007), which has an exponential aggregation function. For each algorithm binary landscapes with 14 levels of habitat cover (from 5 to 70% in 5% steps) and 11 aggregation levels (from 0 to 1 in 0.1 steps), orthogonally distributed were generated, with 100 replicates of each combination of cover and aggregation, totalling 15,400 per algorithm. The spatial organisation of each generated landscape was measured using six indices from SDMTools in R 2.10.1. These included Mean Patch Area (MPA), Proportion of Core habitat (CORE) considering a 1 pixel edge depth, Mean Perimeter-Area Ratio (MPAR), Patch Cohesion Index (COEH), Aggregation Index (AI) and the Largest Patch Index (LPI). Each index had different patterns of variation but most of them presented mixed responses to land cover or aggregation. In general, two groups of landscape generators with similar behaviors were found. The QRule and Bolker produced smooth, almost linear variations in all indices, with strong effects from land cover observed on LPI and CORE at all aggregation levels. Conversely, QRule and Boscolo produced similar threshold behaviors for almost all indices, with remarkable sudden changes in index values for LPI versus land cover and for AI, COEH and CORE against aggregation. In summary, it was observed that results were algorithm-dependent and that this may have severely influenced the comparison between previous studies based on different simulated landscapes, thus affecting the ecological understanding of biological systems. Extreme caution should be taken when analysing results obtained from simulated landscapes, especially when extrapolating them to natural systems.

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## **Pollination within the Landscape Context: What Do We Know and What Should We Know?**

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Several studies in the last decade have shown that landscape changes can impact composition, abundance and behavior of pollinator assemblages and are considered the main cause of pollination services limitation in agricultural systems. The compilation of these results can help to identify underlying patterns and gaps in knowledge that could subsidise the development of research and conservation guidelines, and thus contribute to the design of landscape level policies to counteract pollination deficit. The objective of this study was to review the current knowledge on the effects of changing landscape structure on pollinators and pollination services in natural and agricultural ecosystems. In July 2010 a search of the Web of Science database (<http://portal.isiknowledge.com/>) was undertaken using the following key-words in the “topic” field: “Landscape AND Pollination” and “Friendly landscape AND Pollinator”. The search returned 178 scientific articles of which 133 (75%) were directly related to the response of pollinators to landscape changes. These earliest study was published in 1987 but the majority of studies were published between 2001 and 2010 in 56 journals. Most of the journals specialised in biological conservation and ecology with almost no focus on agricultural sciences. The first scientific work to directly address the effects of habitat spatial distribution on pollinators was undertaken in the central Amazon, Brazil. However, subsequent research was conducted mainly in northern temperate regions. The majority of the studies approached pollination issues only at the patch level. Among these studies most did not provide exact information on patch sizes. Few studies considered large-scale landscapes and half used buffering zones around patches or sample sites to estimate landscape structure. In addition, the inter-habitat matrix was sparingly addressed until 2005 and gained importance in publications only after 2006, indicating a general growing interest in landscape permeability and functional habitat connectivity. Most importantly, this review indicates a general strong positive influence of the amount and proximity of natural areas on diversity and abundance of pollinators. Habitat loss and fragmentation change population viability and are therefore the likely main drivers of pollinator decline around the world. To provide adequate conservation of pollination services in the landscape context the critical levels of habitat loss above which mass pollinator extinctions become highly probable, leading to the collapse of plant-pollinator interactions, need to be determined. Future studies must focus on developing new technologies for environmental management and monitoring, which can deal with multi-scale approaches and integrated pollinator friendly landscape planning, leading to positive results for agricultural production.

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## Democratizing REDD through Participatory Landscape Planning in Laos

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Reduced Emissions from Deforestation and forest Degradation (REDD) intend to provide incentives for forest conservation by rewarding carbon efficient management practices. Entangled in international payment for ecosystem services (PES) paradigms and national REDD implementation strategies, local REDD projects are struggling with adaptation of a global scheme to local circumstances. Like many developing countries where agriculture and natural resources represent livelihood mainstays for a mostly rural population, Land Use Planning (LUP) has been used in Laos as core policy instrument to address the trade-offs between environmental and socio-economic goals in sustainable development. The Lao national REDD strategy envision LUP as key instrument for the local implementation of REDD. REDD payments would provide foremost, long-term incentives for local stakeholders to comply with land-use plans and commit to community-based long-term monitoring activities. REDD contract would be signed by all parties at the end of a participatory landscape planning process depending on the amount of carbon emission that would be abated under the collectively designed landscape scenario. However, evaluations of current LUP practices in Lao PDR have revealed large discrepancies between intended goals and actual outcomes of LUP due to on-the-ground implementation issues compromising effective realization of the plans.

In this paper, we introduce an innovative approach to LUP and illustrate its relevance to REDD by a case study in the northern uplands of Laos. A negotiation support platform involves multiple-stakeholder groups into land use discussions and clarification of land-carbon ownership rights. Spatial visualisation tools are used to enhance local participation in LUP and adaption to the local circumstances. Participatory 3D Modelling brings a vertical dimension which facilitates the comprehension of the landscape and intensifies interactions around a physical media. This ‘boundary object’ becomes a support for negotiating future landscape-change scenarios among multiple stakeholder groups, i.e. villagers, extension agents, district officers. People with different backgrounds and experiences are provided with a greater understanding of the relationships between landscape and resources. A learning approach based on a role-playing game is used to increase awareness of local stakeholders on the possible consequences of their land use planning decisions on their livelihoods. By facilitating local assessment of socio-environmental issues and allowing local stakeholders to reflect on their future, this spatially-explicit approach provides a valuable alternative to ‘high-tech scientific methods’ inaccessible to local stakeholders. It contributes thus to reshaping power and knowledge relations that have long biased LUP implementation in Lao PDR in favour of top-down government plans and that could potentially undermine the realization of REDD at local level. Importantly, our LUP-based approach to REDD allows for an easier access to the knowledge that is required for REDD negotiations at local level.

## Effects of Double-crested Cormorants (*Phalacrocorax auritus* Less.) on Island Landscape, Vegetation and Seedbank

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The unique plant community on Middle Island situated in the western basin of Lake Erie, Canada, has been greatly modified by double-crested cormorants (*Phalacrocorax auritus* Less.) whose population has increased enormously in the last two decades. Three pairs of cormorants first nested on the island in 1987. Since then the population has increased steadily and numbers peaked at approximately 6600 nests in 2002 and 2004. In 2009, there were 3809 nests with densities varying across the island. The island is 18.5 ha in size, approximately 300 m north-south by 1100 m east-west. Over the years the landscape was greatly modified by cormorants due to effects on the vegetation. The aims of this study were to assess the impact of cormorants on island tree canopy, understorey vegetation, soil seedbank, and soil chemistry. The ultimate objective was to assess the resilience and recovery potential of the vegetation community should cormorant nest densities decrease significantly. Landscape imagery was taken from 1995. Forty-three point stations were established in a grid system covering the entire island and included a gradient of cormorant density. The herbaceous and woody vegetation was surveyed over two years and tree crown damage was assessed at each point station. In 2008, soil samples were collected for both chemical analysis and a seedbank inventory.

Aerial photos of the island showed that the forest cover has been reduced by 40% from 1995 to 2006. Tree crown density recorded at each station revealed that cormorant nest numbers were negatively correlated with crown density. Tree crown density used as a proxy for tree damage represents the cumulative impact of several years of nesting cormorants and is consequently considered an integrative measure of cormorant effects over time. Cormorants affected not only the tree canopy where they nested but also the understorey vegetation. The vegetation identified in quadrats adjacent to the soil seedbank sampling included 30 species, 13 of which were also found in the seedbank. Conversely, cormorants appeared to have little influence on seedbank richness, abundance and composition. The total number of seedlings identified in the seedbank study was 5137 (or 15,023 seedlings m<sup>-2</sup>) from 40 species. *Lamium purpureum* constituted 66% (9,905.2 seedlings m<sup>-2</sup>) of all seedlings emerging from the seedbank. The 39 remaining species comprised less than 10% of recorded seedlings.

Plant species richness was impoverished compared to the vegetation survey conducted prior to cormorant colonization. Of the 25 rare vascular plant species identified in past surveys (1948-2003), seven species were still found in 2007-08 either in the vegetation, in the seedbank or in both. Exotic plant species were very common; they represented 33% and 40% of species in the seedbank and the aboveground vegetation components, respectively. There was little relationship between aboveground vegetation and seedbank composition. The presence of cormorants modified the natural levels of nutrients on the island. The composition of the aboveground vegetation community may have been altered by cormorants through effects on phosphorus levels. However, there was no significant relationship between nitrogen and vegetation composition. Likewise, there was no correlation between nutrient levels and seedbank composition.

Damage caused by cormorants poses an important threat to unique island plant communities. Efforts to reduce cormorant impacts should continue in order to ensure the long-term persistence of native plant communities, including species of conservation interest.

## **Influence of Local and Regional Factors on the Soil Seedbank Pattern of Riparian Habitats in Ontario, Canada**

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Wetland and riparian habitats have declined considerably in Canada. Those remaining are threatened by agricultural impacts, most notably by fertiliser and pesticide inputs. A study was undertaken in Ontario (South Nation River watershed, south of Ottawa, ON) where agriculture is the dominant activity. The objective was to describe the plant seedbank diversity in areas of low and high agricultural impact along riparian banks of the South Nation River and its tributaries. The reserve of viable seeds present in soil and on its surface is an integral part of a plant's life history, and represents the temporal and spatial dispersion of plant populations. The role of the seedbank in determining future recruitment is especially critical for species growing in disturbed areas. The soil seedbank may also be important in restoring native vegetation of impacted sites. This study aimed to determine the effects of local (vegetation components and soil structure) and regional (habitat cover) factors on species richness, abundance and composition in these areas.

The South Nation River is 177 km long and covers 3915 km<sup>2</sup>. Thirteen paired sites were selected in low and in high impacted areas (n=26). Sites were paired based on their location and their similar physical characteristics; low impacted sites were always upstream from the paired high impacted sites. Land cover identified in a 500 m radius around each study site revealed that the average percent agriculture cover was 80% around high impacted sites and 60% in low impacted sites while percent forest was significantly lower in high impacted sites. For the seedbank study, soil cores (n=18/site) were collected in April 2010. The seedling emergence method was used to determine seedbank richness and composition. Soil samples were kept under greenhouse conditions for one year and all seedlings were identified as they germinated or were transplanted into small pots for identification at a later phenological stage. Vegetation along the riparian banks was surveyed twice in 2010 in 16 1m<sup>2</sup> quadrats per site (8 on each side of the river). In particular, the abundance of the invasive plant *Phalaris arundinaceae* was measured at each site. Soil structure (% clay, silt and sand) was also determined at each site.

Species richness of the seedbank was higher in low impacted sites which also contained a significantly higher number of native plant species of high conservation value. However, there was no difference in weed species richness and plant species composition showed no clear pattern between low and high impacted sites. There was a clear separation between the

seedbank and the riparian vegetation composition. The percent cover of *P. arundinaceae*, which covered greater than 50% of quadrats in sites surveyed, explained some of the difference in species composition of the seedbank ( $r = 0.40$ ). Weed richness decreased with an increased cover of *P. arundinaceae* ( $r = -0.42$ ). There was no influence of *P. arundinaceae* on native plant species. High clay content of the soil was negatively correlated with species of high conservation value ( $r=-0.49$ ). Additionally, at the landscape level, higher percent agriculture in a 500 m radius around the sites negatively influenced species of conservation interest. Results suggest that local and regional factors act together to influence species composition of the seedbank.

### **Peri-urban and Rural Landscape Structures: Influence on Dispersal of the Asian Tiger Mosquito *Aedes albopictus* at a Local Scale.**

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The dispersal of the Asian Tiger Mosquito *Aedes albopictus* has been studied in a semi-urban area on Réunion island, which is one of the most common habitats for both female and male mosquitoes.

A series of experiments using a mark-release-recapture technique was carried out on a 2 ha site. The size of *Ae.albopictus* populations was estimated using several models. Wild populations were estimated to be between 10,000 and 30,000 individuals on the release site, depending on the season. The dispersal behaviour and the distribution of *Aedes albopictus* showed high disparities. In order to investigate those disparities, the major landscape structures of the site were recorded using landscape ecology tools and their influence on the dispersal of the insect was estimated. Several indices were included in a model which was run and assessed in order to optimise the release of sterile males as part of a future vector control strategy.

### **Parks & Benefits: Landscape Sustainability in and around Nature Parks**

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The core of landscape sustainability is carrying capacities understood as limits or standards not to be exceeded in order to protect the supporting landscape system. They are results of political decision processes among stakeholders, balancing use and protection preferably based on scientific and/or experiential cognition. Many historical examples show that such carrying capacities depend on a common commitment among stakeholders to a long-sighted protection of the landscape system acknowledged as the main interaction between man and nature. However, 'Mediation among stakeholders is irrelevant if it is based on ignorance of the integrated character of nature and people'(Gunderson and Holling 2002). This is the main reason why general models for sustainability are so difficult to develop. However, a nature park designated to fulfill protection purposes through stakeholder cooperation might fulfill the conditions of using carrying capacity as a management instrument, provided that the stakeholders respect the goals, or that the authorities have means and intent to ensure that these goals will be respected among the stakeholders. Nature parks in Europe are traditionally open parks with emphasis on nature conservation. Increasing visitor flows and cuts in staff resources has put focus on the management of visitor carrying capacities and their relation to landscape structure and zoning. At the same time park authorities face falling public appropriations and receding focus on their conservation functions compared to recreation and settlement. The constant priority of the balancing of nature protection and economic utilization gives rise to various experience with land use and visitor management relevant for sustainable development also outside the parks.

In European nature parks the handling of visitor carrying capacities related to Natura2000-sites and their included habitat type areas is a priority theme for the sustainable management of nature parks. A comparative analysis of conditions and initiatives related to visitor carrying capacities in 8 nature parks in the Baltic region has been carried out, based on Natura2000-designations and -statistics. Outside the parks focus is put on park-stakeholder relations and the landscape adaptability of feudal agricultural structures. Many nature parks are related to cultural landscapes with a high concentration of manorial estates with strong traditions in multifunctional land use typically combining agriculture, forestry, hunting, settlement and recreation. The spatial and sustainability characteristics of the landscapes produced by these holdings compared to modern monofunctional agricultural enterprises are analyzed. Some land reform related suggestions to landscape ecologically relevant measures that can support a more landscape adaptive land use and protection in agricultural landscapes are formulated.

Stakeholder involvement in management of nature parks will be emphasized as important experience for landscape management and planning outside parks, based on the general frame of the European landscape convention.

**Keywords:** Nature parks, Natura2000, visitor carrying capacity, manorial estates, sustainable landscapes, European Landscape Convention

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## **Which Green, Where and for What? Green Management in the Green City Salzburg**

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Salzburg is a UNESCO world heritage city, worldwide known for its baroque city and embedding into nature. It represents a unique connection of urban and natural elements of the landscape. The presentation will show how this city consists of green elements, located and designed originally in historic times of the last 4 centuries for very specific purposes and how they serve for actual needs. A special landscape quality was developed over time by frequent adaptations and changes by holding the idea of a green city – the Salzburg Cultural Landscape.

Outgoing from the structuring of the Salzburg as urban landscape into different urban landscape patches (types) and their green analysis it will be shown how this historically designed green is actually serving for modern needs of a European Green City. The actual landscape planning program for Salzburg will be explained and evaluated by functional and locational aspects of urban green (Breuste, Riepel 2008).

Outgoing from the four nature types natural, agricultural, garden and urban, different development and functional perspectives will be explained on selected examples.

The approaches are investigations on:

- Analysis of the urban green in the cultural Salzburg landscape by structuring of the urban area into landscape types,
- Determination of ecosystem services of urban green (Bolund, Hunhammar 1999) in these urban landscape areas,
- Evaluation of the development strategies and management of the municipality Salzburg for the urban green.

Recommendations for further handling of urban green with experiences from the Salzburg case will be developed (Kennedy, Kennedy 1997).

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# Practicing Urban Ecology – the Concept of Eco-cities to Improve Ecosystem Services

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Ecosystem functions and services provided by urban areas become more and more important (Bolund & Hunhammar, 1999). The positive and negative influences of urban settlements, especially towns and cities are actually frequently calculated to reduce the impact and destruction of ecosystem services and to improve these services. This strengthening are connected with the development of the idea of an ‘ecological’ or ‘eco’- city, an already for some decades existing idea in architecture and urban development (Tjallingii 1995).

The term eco-city is more and more widespread in use and in many countries are eco-cities in construction, e.g. in China more than 40. A critical review of the targets to develop ecosystem functions and to reduce impact is strongly necessary (European Council 2003) to give orientation and to support real positive development. This can only be done on the basis of qualitative and quantitative evaluation criteria for negative impacts and supportive ecosystem functions. Such evaluation criteria sets are still in development, but preliminary tools are already available (Kennedy, Kennedy 1997, Breuste, Riepel 2007).

The paper presents a review of implementation of urban ecological knowledge into urban practice on the examples of eco-city projects and its evaluation by qualitative and quantitative criteria worldwide. The perspective includes three level of evaluation: buildings and open spaces, neighbourhoods and districts and complete cities all as eco-cities in existing building stocks and as new designs. Special emphasis will be given to European (Breuste, Riepel 2007) and Chinese examples.

There is no doubt that an evaluation tool for ecosystem services in eco-city concepts based clear qualitative and quantitative criteria is necessary, adaptable to different ecological and cultural surroundings. This can support sustainable urban planning in particular (Ndubisi 2002).

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## **Wetscapes, - a new Way to See Wetlands in Landscapes.**

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The Millennium Ecosystem Assessment in 2005 reported that *the degradation and loss of wetlands is more rapid than that of other ecosystems. Similarly, the status of both freshwater and coastal wetland species is deteriorating faster than those of other ecosystems.* It is clear that wetlands need a strong focus on conservation, restoration and management - can a landscape ecology approach be of help here?

Central to the science of landscape ecology is that landscapes are an ecological matrix of patches, boundary types, barriers and networks. And that the matrix heterogeneity is controlled by flows of species, genes, energy, nutrients and especially, *water*.

One of the key attributes of the matrix must be heterogeneity. There are several landscape scale features useful to have clarified for this discussion, principal among them being texture, change and design. The ideal landscape texture is a coarse-grained matrix containing fine-grained areas. The consequence of this for protected spaces (such as Wetlands of International Importance) is that no matter what quality of management goes into them, it is for nought unless the surrounds and connections are also well managed. And here connections mean species movements, flows of energy, nutrients and especially, water.

Climate change and the changing quality of soil and water will influence the survival of the world's biodiversity and directly affect human livelihoods. Dispersal barriers and intrusion by alien species and genotypes represent the norm in most landscapes nowadays and, increasingly, in seascape too. Conservation strategies must deal more effectively with risks and uncertainties, and adopt an adaptive management style – adjusting our actions based on learning. Adaptation to climate change reinforces a focus on the delivery of ecosystem services within and outside of protected areas. We need to focus on managing at the level of landscapes, seascape and river basins, as well as on placing protected areas along a management continuum.

Using the idea of landscape ecology discussed above, the best future for wetlands in a landscape is to have some small, clearly vulnerable sites protected and managed within an overall landscape where wise use of wetlands is the key management principle. Using then the ideas of integrated river basin management and integrated coastal zone management at the land/sea interface, it should be possible to create wetland landscapes – wetscapes for short. Wetscapes would encompass clear protection objectives where these are critical, but set these objectives in a broader sustainably managed land/seascape.

Large land-coastal-sea-scape areas (Wetscapes) incorporating sites of high biodiversity importance, but managed from a whole of landscape standpoint, represent the best way to achieve the combined objectives of wise use and wetland conservation espoused by the Ramsar convention on wetlands. Additionally, such wetscapes would also serve to discharge obligations under the Convention on Biological Diversity (CBD) and Convention on Migratory Species (CMS), as well as regional Biodiversity related conventions. With a focus on managing landscapes for the optimum performance of protected areas in times of rapid and unpredictable change, such a tool would also allow other site-based initiatives, such



as world heritage and Biosphere reserves of UNESCO to be better presented and managed. Further, such a concept also links well with community conservation initiatives, especially indigenous protected areas.

Using examples from Europe, Australia and China we show how these concepts can be developed in practice.

## **The History and Ecology of Fire in the Mojave Desert, USA**

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- 1) summarize the pre-historic and historic history of fire in the Mojave
- 2) describe the recent fire record (1972 to present) using our burn severity fire atlas and analyses derived from it
- 3) explain the current land management concerns associated with fire in Mojave
- 4) evaluate the relationships between precipitation regimes and fire occurrence and explain the implications for:
  - a. current fire management
  - b. future fire management in the context of climate change
- 5) provide an overview of our fuels/fire hazard assessment monitoring plan for the Mojave Desert

## **Landscape-scale Declines in Forest Health across Southwest Western Australia**

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The southwest Australia Ecoregion located in the southwest of Western Australia (SWWA) is Australia's only globally recognised 'biodiversity hotspot'. Changes in landscape scale processes have increasingly affected this region, influencing and changing its unique and diverse flora and fauna. Specifically, SWWA has experienced a declining trend in rainfall since the early 1960's. The future projections are unanimous in that this trend will continue at a rate of 1-5 mm per year. This change in water availability is thought to have an increasing negative impact on the health of the endemic tree species and related ecosystems in this region. In SWWA, only very few large-scale surveys have been conducted measuring canopy health across the geographical range of *Eucalyptus* species. One key forest ecosystem in SWWA is dominated by the canopy tree species *Eucalyptus wandoo* (wandoo). This species has shown various phases of decline and recovery over the last 50 years; however, the trend in overall health over time across its range was never assessed. The aim of this research was to identify the main drivers of wandoo ecosystem health at the landscape scale (i.e. covering its entire geographical range). Wandoo crown health was assessed in 2002 and 2008, and a suite of environmental and climate factors were collected to investigate the relationships between wandoo crown health, climate and the landscape. The results of this investigation indicated a declining trend in health at the extremities of the climatic range of wandoo. This correlated with the lower rainfall areas where wandoo occurs in SWWA, indicating that the declining trend in rainfall is likely to decrease the range of wandoo dominated ecosystems. This result is one of the few clear examples of the impacts of climate change on forest health at the landscape scale in southwest Western Australia.

## **Applications of the Index of Biodiversity Potential - A Community Design and Planning Tool for Optimizing Landscapes for Biodiversity**

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The Index of Biodiversity (IBP) potential is a land planning and design tool that was developed to help land owners, communities, and municipalities systematically plan for biodiversity in their landscapes. The IBP is being applied in primarily built environments including community master planning efforts in Singapore with the Urban Redevelopment Authority and the Singapore National Parks Agency. Many elements of the approach have also been applied in more than a dozen other large-scale, high-profile international community planning efforts led by AECOM.

The IBP provides a framework for creating and comparing potential biodiversity performance of alternative land plan scenarios and developing landscape master plans and biodiversity-oriented landscape design guidelines. The IBP relies on quantitative measurement of attributes of actual and/or planned landscapes within two overarching categories:

- Pattern attributes: shape, size, connectivity, and total area of habitat
- Structural attributes: habitat types and variety of habitat types

IPB scores from 1 to 5 are possible for landscape areas based on scoring criteria that are defined by the planning team for each project context. Scoring criteria and thresholds are defined based on several "keystone" attributes of local ecosystems and infrastructure such as the average native vegetation canopy width and height; edge effect relationships for indicator

species; native ecosystem structural drivers (processes); or widths of connectivity “barriers” such as roads or sidewalks. Plan IBP scores are evaluated using a combination of Excel-based calculations and GIS and/or by-hand measurements.

The first step in the IBP process involves “site calibration” to determine priority areas for preservation, to frame goals for biodiversity enhancement, and to customize IBP scoring criteria. Many projects seek to create a plan that achieves improved biodiversity value relative to the existing condition, a historic natural condition, or a business as usual development scenario “benchmark”. The second step involves developing alternative design and/or program scenarios and measuring IBP performance against the benchmarks. The final step includes assessing cost/benefit relationships, selecting the optimal program scenario, and creating biodiversity design guidelines and implementation plans.

At the design scale, the IBP can help prioritize implementation of native plant landscape typologies or favourable landscape patterns. At the community planning level, the IBP can support design guidelines for individual parcels to achieve a desired level of performance across an entire community or planning area. The IBP can also be used to compare performance of different projects across municipalities or regions. One of the greatest benefits of the IBP is that it allows many opportunities for creating customized calibration and design solutions for specific contexts considering the wide variety of conservation priorities, native ecosystem structure and pattern, and project economics while providing a meaningful comparison of potential biodiversity benefits.

Biodiversity performance is one of the ecosystem services elements included within AECOM’s comprehensive approach to developing environment- and cost-optimized community sustainability programs using the proprietary Sustainable Systems Integration Model (SSIM)<sup>TM</sup> and methodology.

## **Urban Landscape Optimization within Comprehensive Sustainability Planning**

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Sustainability planning efforts for communities, campuses, and municipalities, including Climate Action Plans and Sustainability Master Plans, often address multiple disciplines including mobility, energy, water, and ecosystem services to create comprehensive sustainability programs. This session will discuss applied analysis, planning, and modeling approaches for optimizing landscapes for ecosystem service within comprehensive sustainability planning projects led by AECOM. AECOM is a global company with over 40,000 employees engaged in a wide range of high-profile, large-scale sustainability planning and design efforts.

Optimizing community landscapes for sustainability requires leveraging ecological opportunities, evaluating costs and benefits, responding to stakeholder values, and balancing priorities across multiple land use disciplines. The session will address the opportunities and challenges of complex, multidisciplinary planning efforts; the increasingly important role of

landscape ecology concepts in sustainability planning and design; and how integrated, multidisciplinary performance modelling can help optimize overall program costs and benefits. The session will also include a discussion of AECOM's Sustainable Systems Integration Model (SSIM)™ and methodology that includes a process of baseline analysis, alternative scenarios modelling, benchmarking and performance measurement, and strategies for tracking and optimizing cross-disciplinary co-benefits. The following landscape themes and tools included in the SSIM™ process will be covered:

- Urban Biodiversity Planning – The Index of Biodiversity (IBP) potential is a landscape ecology oriented planning and design tool that relies on the measurement of landscape structure and pattern attributes and was developed to help land owners, communities, and municipalities systematically plan for biodiversity in their landscapes.
- Landscape Carbon Planning – Landscape carbon storage targets are often based on estimation of past, present and proposed landscape carbon regimes. Design measures can include urban forestry strategies, ecological restoration, and avoided impacts to landscape carbon pools.
- Local Climate Control – New modelling tools can provide measurements of the local climatic effects of urban design solutions by measuring surface reflectance, vegetated land cover, and urban microclimate patterns.
- Community agriculture – Landscape food productivity can offset long-distance food delivery emissions and provide a variety of other social benefits. Estimating productivity and costs of agricultural measures is based on assessment of ecological capabilities and agricultural practices.

The session will emphasize how these landscape and ecosystem services elements are programmed within the bigger picture of comprehensive sustainability programs. Case studies will include community master planning efforts at Jurong Lake and Marina Bay Districts, Singapore; Superstition Vistas Sub-regional Sustainability Vision Plan, Arizona, USA; East Edisto, South Carolina Sub-Regional Sustainability Plan for a forestry to mixed-use land use conversion; and/or award winning planning for the Portland Metro Nature in Neighborhoods program.

## **Simulating the Long-term Effect of Timber Harvesting on Forest Biomass in NE China**

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Forest biomass is the basis for quantifying forest productivity, net productivity and the carbon cycle. It plays an important role in mitigating global climate change and contributing to regional and global sustainable development. Timber harvesting has been the main anthropogenic disturbance affecting forest biomass, especially before the implementation of the Natural Forest Protection Project (NFPP) in China. The NFPP has been carried out since 1980 to classify management and reduce harvesting intensity. In this study forest biomass was

modelled in a timber harvesting scenario using LANDIS 7.0 PRO and based on a site density module. The following observations were made from modeling results:

- (1) The change in forest biomass demonstrated that the current harvesting scenario can match the original forest succession and maintain forest growth rates. The current harvesting rate, forest growth and regeneration rates can compensate the biomass levels reduced by historical logging activity.
- (2) The biomass change curve for each species showed complex trends under a harvesting and no harvesting scenario: the coniferous tree (*pinus, larix*) biomass was found to be higher under a harvesting scenario, indicating that harvesting promoted forest regeneration and growth. Biomass differences in spruce and fir trees were found to be relatively small.
- (3) The biomass of frontier species was found to initially decrease under a harvesting scenario and then reach a stable state in the long-term. The biomass change in birch trees in a temperate forest showed the same trend. A protected tree species, *tilla*, increased in biomass in a harvesting scenario in contrast to a scenario without harvesting. Coniferous tree species showed the same trend. The dynamics of oak tree biomass was complicated and fluctuations were observed in simulations.

LANDIS7.0PRO successfully simulated the dynamics of forest biomass on large spatial and temporal scales in the Small Khing'an Mountains. The results of these simulations can be used to supply the theoretical basis and support for sustainable forest management.

## **The Interaction between Landscape Qualities, Residents' outdoor Recreation and Their Well-being**

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With the shift to service society recreation for mental and physiological self-regulation has become an increasingly important landscape function in particular in urbanised regions (Korpela et al., 2008). Recent research literature mainly based on experimental studies provided considerable evidence that visits of near-natural everyday landscapes promote psychological and physical health (Hartig, 2004). Little, however, is so far known as to which are the physical requirements for landscape recreation areas and which are the effects of people's outdoor recreation on their health and psychological resilience. In our project we tried to find answers to these questions by investigating them in three urbanised regions in Switzerland with different cultural backgrounds (a German, French and Italian speaking regions). In each region, a standardised questionnaire including a regional map for recording spatial explicit data on often visited recreation areas was sent to a random sample of residents (N=1200 each). Multivariate GIS-based analysis of the data revealed that several physical characteristics of the recreation areas appeared to be significant predictors for outdoor recreation intensity. Analysis of variance confirmed that people performing outdoor recreation frequently assessed themselves as significantly healthier and more resilient than the rest of the

sample and also indicated – while work-loads were controlled – significantly lower work strains. The implications of the findings for the landscape management will be discussed.

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## **Zonation of Biodiversity in the Forests of Satoyama-like Landscapes in the Philippines**

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Many landscapes in the Philippines are equivalents of the Japanese satoyama (Buot 2008a, 2008b, Buot and Okitsu 1999, Buot and Osumi 2004, Sopsop and Buot 2011, Fukamachi et al., 2003, Nakamura 2010). These are mosaics of patches composed of villages, agricultural lands and forests. The zonation of biodiversity in forests of selected satoyama-like landscapes in the Philippines were documented.

Woody species along altitudinal zones were studied in bioculturally significant forests including Mount Pulag (northern Luzon), Mount Akiki (northern Luzon) and Mount Mayon (southern Luzon) using transects and cluster and ordination analyses. The dendrograms obtained from the cluster analyses showed lower elevation woody species encroaching in higher altitudes. A critical analysis of the observed pattern of vegetation zonation in these forest landscapes was done comparatively. Environmental issues such as biodiversity loss, habitat degradation, deforestation, and bioinvasion were evident. Concerns for environmental rehabilitation and ecological restoration through appropriate sustainable management practices were elucidated.

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# Agricultural Landscapes: How Their Structure and Dynamics Affect Biodiversity

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Agricultural landscapes are characterised by a spatial and temporal heterogeneity of crops. Crops vary according to farm patterns, crop succession and farming systems. They affect biodiversity at several spatio-temporal scales.

At an intra-annual scale dynamics is due to crop phenology, sowing and harvesting dates. At a pluri-annual scale it is due to crop successions and on a larger time scale to changes in farming systems. It is important to consider these temporal changes when considering the crop mosaic and its effects on species distribution and population dynamics.

We present concepts and metrics to describe these spatiotemporal heterogeneities and their relationships with biodiversity parameters. At the intra-annual scale we show that differences in phenologies of adjacent crops partially drive the movement of species as aphids and carabids (*Pterostychus melanarius*). At a pluri-annual scale the frequency in a mosaic of a crop as grassland in a crop succession drive the species richness of solitary bees; the dynamics of the whole crop mosaic control carabid species composition as well as the abundance of a beneficial species (*Pterostychus melanarius*). Over a period of decades, changes in farming system lead to the modification of species composition over a range of taxa. We present the spatial and functional relationships between metrics. If coarse scale metrics constrain the fine scale ones, there is still a heterogeneity of ecological conditions at all scales.

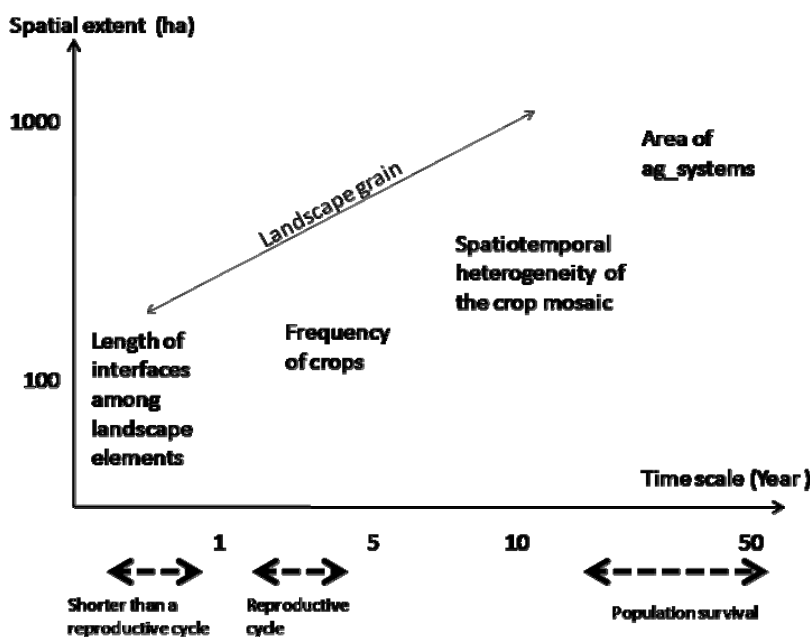


Figure: landscape metrics in the time/ spatial frame

[www.osur.univ-rennes1.fr/zoneatelier-armorique](http://www.osur.univ-rennes1.fr/zoneatelier-armorique)

## **Mapping Ecosystem Service Supply, Demand and Budgets**

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The capacity of ecosystems to supply humankind with goods and services strongly depends on biophysical conditions. Based on these biophysical conditions, characteristic types and patterns of land cover emerge. The intention of human land use is to modify the natural land cover in order to optimize the supply of particular ecosystem services. By linking relevant spatial land cover information with appropriate biophysical and statistical data from monitoring, surveys, modeling or interviews, the capacities of different land cover types to supply ecosystem services can be calculated. As results, spatio-temporal patterns of human activities and resulting ecosystem service supplies are attributed to spatially explicit landscape units in GIS. The results are presented in form of maps, which are powerful tools exploring high potentials for visualization of complex phenomena. Moreover, also the locations of demands for ecosystem goods and services can be calculated and mapped. By merging the information from the ecosystem service supply map with the ecosystem demand map, ecosystem service budgets can be calculated and attributed to spatial units. The supply of ecosystem goods and services should match the societal demands, if self-sustaining systems and a sustainable utilization of natural resources are the targets of environmental management. We present a framework based on matrices that link spatially explicit landscape units to ecosystem functions and ecosystem service supply, demand and budgets. Case study results from Germany, Finland and Bulgaria, where the method was applied, will be shown.

## **Geomorphic Influences at the Alpine Treeline Ecotone in an Era of Climatic Change**

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Many animals in alpine environments alter the landscape through zoogeomorphological processes such as denning and burrowing, digging for food, and trampling (Butler, 1995; Butler *et al.*, 2009). Large ungulates such as deer, elk, mountain goats, and bighorn sheep create scraped daybeds and trample the landscape, and secondarily influence geomorphology through their food browsing habits. Carnivores such as grizzly and black bears create annual burrows on steep mountain slopes, and create widespread, seasonally varying excavations in search of food (Butler, 1992). Numerous species of burrowing mammals including gophers, ground squirrels, and marmots create widespread areas of sediment displacement, sediment churning, and resulting spoil mounds (Butler and Butler, 2009). Spatial variations in soil trampling and bioturbation associated with animal disturbances may determine where tree seedlings become established at treeline in areas undergoing climatic change. Fossorial



animals, including (but not limited to) gophers, marmots, and ground squirrels, excavate burrows in areas of finer-grained soils, and create spoil mounds of finer-grained sediment deposited onto the coarser sediment of the adjacent landscape. Burrows may act as sediment traps for additional eolian influxes that enrich the soil, and may also act as sinks for surface runoff from snowmelt and rainfall, further concentrating fine-grained sediments. Fine-grained, moist soils may facilitate seedling establishment at treeline. Food caching of pine nuts obviously facilitates seedling establishment. Excavation of food sources may result in fine-grained soil deposited at the surface, but this soil may become excessively dried, or eroded by wind and running water. A conceptual model is presented that illustrates the positive and negative feedbacks associated with the role of animals and their possible influence at alpine treeline.

As ecotones shift in response to global climatic change, zoogeomorphic zones of influences and intensities may also be affected. Animals dependent on alpine habitat and subalpine meadows for food sources, some such as grizzly bears with significant geomorphic impacts, face issues of habitat change and, in some cases, vital habitat disappearance. Climatic change at treeline will also affect abiotic geomorphic processes such as frost churning, solifluction and turf exfoliation, snow avalanching, and fire. Examples are presented that illustrate current processes that may be substantially affected by climatic warming and associated drying at treeline. This paper presents several suggested pathways of change that may have particular impacts on geomorphic processes at the alpine treeline ecotone, where closed canopy forest gives way to alpine tundra. Examples are drawn from several charismatic western United States National Parks (Whitesides and Butler, 2011).

## **Effects of Landuse on GHG Emissions from Steppe Soils in Inner Mongolia**

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Steppe ecosystems are one of the dominating terrestrial ecosystem types worldwide covering large areas of Eurasia, North and South America. In China around 4 million km<sup>2</sup> are covered by natural grasslands. In view of the vast extent of steppe ecosystems even relatively low fluxes of greenhouse gases such as N<sub>2</sub>O and CH<sub>4</sub> from such soils may significantly affect the respective atmospheric concentrations. In an effort to further clarify the role of steppe regions and livestock management for the site and regional sink and source strengths or source for atmospheric greenhouse gases multi-year and multi-site flux measurements were performed in the catchment area of the Xilin river, Inner Mongolia. Our results indicate that livestock stocking rates are a key factor determining the magnitude of N<sub>2</sub>O as well as CH<sub>4</sub> fluxes in such regions and that long-term, entire years spanning measurements are needed to better constrain flux magnitudes and to improve our understanding of the principal drivers of GHG exchange. Against our expectations we found that N<sub>2</sub>O emissions decreased with increased stocking rates exchange, mainly due to changes in the magnitude of spring-thaw N<sub>2</sub>O

emissions which are dominating annual budgets. Moreover, our results showed that for inventorying regional CH<sub>4</sub> exchange, landscape variability, livestock CH<sub>4</sub> emissions and hot spots such as feedlots need to be considered.

The entire study also revealed that C and N fluxes and soil C and N stocks of the investigated steppe systems are extremely vulnerable to changes in climate and land management (Butterbach-Bahl et al., 2011). This has to be considered for developing sustainable management options.

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## **Urbanization Diversifies Vegetation Phenological Patterns in Arid Environments: Interactions among Vegetation, Climate Variability and Urbanization**

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Cities have become the main habitat of modern humanity and emerged as a ‘new frontier’ for ecological research. Urbanization transforms vegetation dynamics and ecosystem processes which are controlled primarily by climate in arid and semi-arid regions. We investigated how urbanization affects vegetation phenology and its coupling with climate in two metropolitan regions: the desert Phoenix metropolitan area of southwestern United States and the semi-arid grassland city of Hohhot in China. In Phoenix, our analyses employed Normalized Difference Vegetation Index (NDVI) from MODIS and spatially interpolated climate data from a dense network of meteorological stations. Analyses were stratified by detailed land cover and soil texture information. In Hohhot, we conducted detailed field observations of flowering and leafing phenologies of several tree species (54 sites) and simultaneously collected data on temperature and humidity during two growing seasons at 35 sites by mounting I-button data loggers on trees. To upscale this fine scale phenology to the level of MODIS pixels we analyzed vegetation characteristics and land cover at each site. These detailed field data were used to derive phenological models and compare phenological metrics (start, end, and length of season, the timing and peak value of growth, rates of greening and senescing).

Findings in Phoenix show that croplands and urban areas exhibit growth multimodality, which is usually found in riparian areas of the region but absent in the native desert. Agriculture is characterized by the shortest growth length and fastest greening and leaf-out rates. Conversely, urban vegetation stays photosynthetically active for longer periods. Desert NDVI is regulated by 2-5 month accumulated precipitation, but riparian vegetation is uncorrelated with rainfall.

NDVI spatial patterns are best predicted by climatic variables near the peak of annual growth. Spring and summer NDVI patterns are in better agreement with precipitation accumulated over longer time periods, while early autumn growth is strongly correlated with immediate and one-month rainfall. Temperature correlates negatively with desert but positively with riparian NDVI. Our results confirmed that soil characteristics are important in translating precipitation into water available to desert plants and supported the ‘inverse texture’ hypothesis. Managed vegetation growth is decoupled from precipitation and completely unsynchronized with natural desert vegetation.

Our preliminary findings in Hohhot suggest budburst and leaf appearance and falling can differ by several days. These differences are explained by temperature which in turn depends on location of each site, density of trees, and the surrounding land cover. Another important factor is active maintenance, such as more frequent plant watering in some parks and grass seeding. Trees grown along major roads have earlier timing of budburst and leafing and longest growth length compared to those in the mountain foothills to the north and wetland to the south of the urban core area. Overall, our findings provide new insights into the interactions among vegetation growth, climate variability, and urbanization in dry lands.

## **Expected Changes in Air Pollution and Atmospheric Deposition Effects on Forests in North America and Europe**

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Air pollutants of highest importance for direct toxic effects on forest ecosystems are ozone, sulfur dioxide, hydrogen fluoride, nitrogen dioxide, ammonia and nitric acid vapor. In addition, various forms of atmospheric deposition, both wet and dry, affect integrity and health of forest ecosystems due to their acidifying or fertilizing (eutrophic) effect. Potential impacts of air pollution would depend on geographic location and climatic condition of the forest as well as various abiotic and biotic factors. From the geographic perspective, proximity of a given forest ecosystem to air pollution source areas (such as industrial and agricultural centers or major urban centers or transportation routes) would be of the highest importance. In this context also potential exposure to the long-range transported polluted air masses would be of high importance, especially for the long-lived air pollutants such as ozone. Responses of forests would depend on climate, especially availability of water and temperature that affect uptake of pollutants by plants and their defense potential. In general, temperate zone forests are more affected by wet forms of deposition than forest of the arid and semi-arid zones for which dry deposition effects are much more important. Expected effects of air pollution and atmospheric deposition on forests will be discussed for North America and Europe for the next few decades. This will be done for various scenarios that take into account predictions of population growth, changes in technology, geopolitical aspects, climatic change, land use management strategies, and other factors. Special emphasis will be placed on two specific geographic areas – California and Central Europe.

# Landscape Controls for Post-fire Tree Recruitment in a Chinese Boreal Forest

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Fire is an important disturbance agent in boreal forest ecosystems of the Great Xing'an Mountains. Fire shapes landscape dynamics due to alteration of age structure and post-fire tree recruitment. Examining landscape controls for post-fire tree recruitment is a key to understanding forest landscape dynamics in this region. Seedling patterns after exposure to fire is a strong indicator for future forest succession trajectories (Baker et al., 2006; Johnstone et al., 2010). The two most common post-fire succession models in a boreal forest include: (1) Self-replacement, when the same tree species dominate both the pre-fire and post-fire canopy; and (2) Relay succession, when early succession species dominate in initial stages of regrowth and are then gradually replaced by late succession species (Kurkowski et al., 2008). This study analysed the relative influences of various landscape controls (site condition, pre-fire vegetation and fire characteristics) on post-fire tree recruitment and their marginal effects. Analysis was conducted using a boosted regression tree method and data collected from sites burned in 2000, located within the Huzhong Forestry Bureau area.

Results showed that: (1) The relative influences of landscape controls on post-fire broadleaf seedling density are different from those on conifer seedling density. Fire severity was the most important control for conifer tree recruitment, while slope was the most important control for broadleaf tree recruitment; (2) Forest type was the most important control for post-fire conifer seedling proportion, followed by fire severity; (3) Tree recruitment was higher in areas with middle fire severities rather than areas with low and high fire severities; (4) Relay succession is the main succession mode in the Great Xing'an Mountains. However, self-replacement succession occurred in the areas where the pre-fire forest type was dominated by mature conifer forests or broadleaf forests.

**Keywords:** Succession trajectory, Tree regeneration, BRT, Boreal forest landscape, Fire, Great Xing'an Mountains

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## **Do simulated landscapes reflect the fractal geometry of real landscapes?**

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For the last decade, spatially explicit modeling has provided important contributions on the effects of habitat fragmentation on population dynamics. Part of this literature make use of neutral landscape models, which assume random patterns of habitat distribution, as their spatial information. However, in real landscapes the premise of completely random habitat distribution is not valid and fractal geometry is being extensively used to generate complex spatial patterns of fragmented landscapes. While there are arguments in favor of using fractal geometry in modeling studies, little information exists on whether these generated patterns fully represent the complexity found in nature. Moreover, little is known regarding the use of fractal geometry as an efficient measure of changes in the spatial configuration of landscapes with different proportion of habitat. Our objective was to evaluate the fractal geometry of real Brazilian fragmented Atlantic Forest landscapes along a gradient of forest cover and analyze how their fractal geometry vary with scale. Additionally, we compared these results with artificial landscapes generated by established fractal geometry algorithms found in the literature. We developed a computer program to calculate edge fractal dimensions using the second method of box count. From satellite based forest maps we selected real Brazilian Atlantic Forest landscapes from 5 to 95% forest cover at 1% intervals. We clipped each landscape at three different scales: 6x6 km, 12x12 km and 24x24 km. There were 50 randomly assigned replicates for each scale and forest cover. The shift point average algorithm was used to generate simulated fractal landscapes using five Hurst exponent values (0.1, 0.3, 0.5, 0.7, 0.9) for each 1% of habitat cover. The same three landscape scales mentioned above were simulated. Our results show that for the scale of 6x6 km, real landscapes were more similar to simulated landscapes with greater spatial auto-correlation and more regular edges ( $H = 0.9$ ) and that with increasing scales there was a small variation in the most similar Hurst exponent ( $H = 0.7$ ). From these results we observed that Atlantic Forest landscapes show very distinct fractal patterns and that the only variation was evident in the type of landscape scale. Also, real Atlantic Forest landscapes are, on average, more aggregated and have more regularly shaped patches compared to simulated landscapes. This pattern, however, may vary in other regions which have suffered different disturbance processes. Spatially explicit landscape models should evaluate the structural patterns generated by habitat loss and fragmentation in real landscapes before setting their simulations up. This would ensure better strength and realism of modeling studies aiming at the conservation of fragmented landscapes.

## **Nitrogen Dynamics and Hydrological and Biogeochemical Processes within a Riparian Landscape, Southeast China**

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The riparian landscape is a unique transitional zone between terrestrial and aquatic environments, characterised by abrupt changes in hydrological and biogeochemical patterns. This study investigates hydrological and nitrogen (N) biogeochemical processes within a riparian landscape in Southeast China, based on water and nutrient balances and *in situ* incubations. Results showed that 65.3 - 92.1% of water flows, more than 99% of ammonia-N and 86 - 100% of nitrate-N entering the riparian landscape are retained within the landscape. Continuous *in situ* incubations indicated that nitrification in surface soils could contribute as much as 24% - 80% of the final nitrate content in soil, accounting for 56% of the nitrate content, on average. Denitrification rate ranged from 0.03 - 7.02 mg N m<sup>-2</sup> d<sup>-1</sup>, displaying a negative correlation with nitrification rates. This suggests that nitrification and denitrification processes are actively coupled in such systems and play critical roles in determining the amount and speciation of N entering stream channels.

**Keywords:** Riparian landscape, Nitrogen Dynamics, Nitrification, Denitrification

## **Ecological Response to Surface Water Allocation in a Human-Dominated Watershed: a Case Study of Heihe River Basin, Northwestern China**

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Exploring the relationships between oasis landscape patterns and hydro-ecological processes in arid areas, which are strongly influenced by water resource conditions, is becoming a popular topic with many challenges in landscape ecology. It is one of the most important issues facing the ecological protection and rehabilitation of arid areas. In the decades before 2001, an increasing local population and the social-economic development of the upper reaches of the Heihe river basin have resulted in a large increase in surface water resource use. Consequently, many serious ecological and environmental problems exist in the Ejin natural oasis, which is located in lower reaches of Heihe river basin. The Ejin natural oasis has been in danger of disappearing in particular, because of the complete lack of surface water provided from the upper reaches of the Heihe river, continuously unavailable since 2001. Since 2001 appropriate yearly volumes of surface water have been allotted to the Ejin oasis from the upper reaches of the Heihe river by the Chinese government to prevent the continuation of an ecological crisis and restore the environment. Based on field investigations,

remote sensing and GIS, changes in the Ejin natural oasis landscape spatial pattern were analysed at different temporal and spatial scales, before and after surface water allocations were provided (1987~2001~2009). Interactions between the oasis hydro-ecological processes and oasis landscape pattern change were discussed. Ecological restoration of the degraded arid landscape relating to surface water allocations in a human-dominated watershed was evaluated. Three Landsat TM/ETM+ images from 1987, 2001 and 2009 were collected to analyse the characteristics of oasis landscape spatial pattern dynamics in recent decades. MODIS Normalized Difference Vegetation Index (NDVI) time-series data from 2001 to 2009 was obtained to aid in the analysis of vegetation restoration of the natural oasis landscape. Statistical annual runoff data (1987~2009) prepared by Water Conservation Bureau of Ejin Banner was also collected to explore the correlation between NDVI trends and annual surface water allocation quantity. The main findings from these results included that: 1) the area of oasis decreased between 1987-2001 (before allocation of surface water) and increased between 2001-2009 (after allocation of surface water), however, the area of desert simultaneously increased between 1987-2001 and then decreased between 2001-2009; 2) landscape diversity and ecological stability of the Ejin oasis after surface water allocation was much higher than before surface water was allocated; 3) based on MODIS NDVI data analysis from 2001 to 2009 arid vegetation in the Ejin natural oasis obviously recovered; and 4) vegetation degradation and recovery were significantly related to surface runoff water quantity, before and after surface water allocations were provided.

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## **Sexual Segregation in Elephant Seals at a Global Scale and Potential Effects of Climate Change**

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Elephant seals are among the most sexually dimorphic and polygynous species of all mammals, and show segregation between males and females in foraging grounds. The following hypotheses on the origin of sexual segregation were tested: different energetic requirements, different reproductive requirements and different thermal requirements. Predictions of the thermal requirement hypothesis was also analysed in the context of expected global climate change. Website and bibliographic sources were used to obtain information on elephant seal distribution and environmental predictors at a global scale. Kernel models were also used to represent foraging trips and MaxEnt distribution models to predict the present and future suitability of ocean regions. Male and female elephant seals showed differences in their ocean habitat distribution. Females were found to inhabit warmer waters more than males and males used shallower waters more than females. Males also

showed a trend towards inhabiting more productive waters, however, this result was not statistically significant. In a global warming scenario, elephant seal populations will move to higher latitudes and more overlap will occur between females and males in Antarctic waters. These results support the thermal requirement hypothesis: due to their relatively small body size females are metabolically constrained and have a thermal limit in water temperature. However, males are able to use the coldest waters of the polar regions due to their large size and thick blubber layer. More interactions between elephant seal sexes and between members of different colonies are expected in foraging grounds in a simple global warming scenario.

## **A Model of Science-Practice-Policy Interface in Local Land Use Planning**

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Researchers' responsibility towards potential users of research results does not end with their publication in scientific journals. Linking scientific knowledge with local practices and policies is an essential task of participatory action-research, especially in developing countries where institutional linkages between research, extension and local communities are loose or even inexistent. In this paper we present an experimental approach that brought together scientists, development practitioners and local communities to collectively negotiate landscape changes. This initiative, initially supported by a consortium of national and international researchers, is part of a country-wide government policy on land use planning. Successive stages in participatory landscape design are described, starting with a multi-level diagnostic study on land use planning in Lao PDR that aimed at drawing lessons from past experiences in an attempt to overcome implementation problems faced by previous land use planning approaches. Secondly, intensive interdisciplinary research was conducted over a two-year period in Viengkham District, Luang Prabang Province. Scientists together with local stakeholders investigated historical changes in landscapes and livelihoods, assessed forest biodiversity and local use of natural resources, and explored future landscape scenarios. Thirdly, they translated their understanding of local circumstances (i.e. problems faced by local communities and policy makers and human & financial capacity to tackle these problems) into a landscape design approach that is generic and adaptive enough to be applied at the national scale in accordance with the Participatory Land Use Planning (PLUP) guidelines developed by the government. Over 5 days, members of the village land management committee are involved in a series of learning and design activities. After elicitation of local knowledge related to landscapes and livelihoods, a role-play called 'PLUP Fiction' involves the villagers in a learning experiment based on a virtual landscape. Participatory 3D modelling is then used as a 'boundary object' to facilitate the negotiation between stakeholder groups and the visualisation of alternative landscape scenarios. A



Geographic Information System is coupled with a simple cost/benefit analysis model that is parameterized by the villagers themselves. Facilitators can capture real-time information on the different areas of the land use plan under discussion and present corresponding socio-economic and environmental returns. Through iterative design, the villagers gradually refine their landscape plan and test the introduction of innovative cropping and animal husbandry systems by changing the parameters of the simulation. The fourth stage of the approach consists of building capacity to gradually make local stakeholders autonomous in landscape planning and engage them in a long term monitoring program, which is necessary to regularly revisit their plans.

This experience showed that scientist engagement in community-based landscape design and management is key to the success of land use planning. Both the activity of landscape design and the resulting design patterns are improved when landscape ecology science is put in the hands of local stakeholders.

### **Searching for Viable Pro-poor REDD+ Landscapes**

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Reducing emissions from deforestation and degradation (REDD) is viewed as an effective way to mitigate climate change by compensating stewards of forested areas to minimise forest land conversion and protect forest services, such as carbon storage and sequestration. This paper examines the degree to which people and institutions in specific landscapes are able to meet REDD+ requirements, which include state efficiency in organising and facilitating REDD+ implementation, equitable forest and carbon rights, opportunity costs and local organisational capacity to negotiate the conditions of REDD+ implementation. Beyond carbon storage and sequestration, this paper assesses the possible impacts of REDD+ on co-benefits, i.e. economic development and poverty alleviation on one hand, ecosystem services such as biodiversity on the other hand, in nine landscapes along the forest transition curve in Bolivia, Brazil, China, Cameroon, Ethiopia, Ghana, Indonesia, Laos, China and Vietnam. It was found that landscapes at the beginning of the forest transition phase (Cameroon, Indonesia, Bolivia and Brazil) will have most potential for REDD+ because of high forest cover and low population density, conditions that provides greater benefits per

capita and minimise opportunity costs. Landscapes at the very end of the transition phase (Vietnam, China) will also have the most potential for REDD+ because they already have increasing carbon stock and do not have to off-set opportunity costs. In order to increase landscape level participation in REDD+ schemes across landscapes, which is currently low, awareness about REDD+ needs to be significantly improved. Enhancing local governance, which includes developing transparent distribution of benefits, clear rights, capacity to participate in decision-making and negotiate technical aspects of REDD+, will also be critical to recruit support for REDD+.

## **Cultural Landscapes of the Upper Samalá River Basin, Western Highlands, Guatemala.**

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Cultural landscapes are those where people have left an imprint of their beliefs, technology and symbols on the natural landscapes (Mateo, 2008). Therefore, they are the reflection of culture and its relationship with nature. As Sauer (1925) points out, “*culture is the agent, natural areas the mean and the result is cultural landscape*”. This, coupled with Santos’ (2008) concepts of space and geocological approaches, were used in this research in order to identify the cultural landscapes of the upper Samalá river basin in the western highlands of Guatemala. This basin is characterised by a high population density of 446 hab/km<sup>2</sup> in which 74% of the population is indigenous. The basin also has a unique multicultural context in which three different cultures live: Mestizo (western), Maya-Kiché and Maya-Mam (indigenous). These cultures reflect similar and different patterns of land use as well as symbolic and morphological elements.

Research included identification of cultural landscapes within natural landscapes (geosystems) and recognition of cultural elements. Communitarian maps made by different organised groups of Maya-Kiché and Maya-Mam communities were analysed together with field data relating to space, morphology, use of landscape and symbolic references. A qualitative assessment of landscape identity based on Harmony, Coherence and Singularity was done. According to this analysis a strong identity for a cultural landscape will positively fulfill requirements.

A total of 35 different cultural landscapes were identified based on natural landscape backgrounds and their morphological and symbolic elements. A total of 15 types of cultural landscapes were classified according to cultural elements. A map with the location of these cultural landscape types was created using symbols. The map was not to scale since many of the landscapes overlap with each other and therefore exact borders could not be identified. Nine of these cultural landscapes showed a strong landscape identity.

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## **The Wilder the Better in Biodiversity Conservation? Comparing Two Prioritisation Approaches in Peneda-Gerês National Park**

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Considering all the political and social resistance that many biodiversity conservation projects encounter, as well as the trade-offs that often need to be made, prioritisation of areas for conservation should be an important item on scientists' and policy-makers' agenda. We assessed the performance of two methods of prioritising areas for conservation in the Peneda-Gerês National Park in Northern Portugal. One approach is based on species distribution data and focuses on the maximisation of the number of rare or vulnerable species. The other approach maps wilderness areas using the presence of human infrastructure as a proxy for the anthropic impact on the landscape. It is based on the idea that less impacted areas are more valuable for conservation. The results of the two approaches were assessed based on the number of species and the percentage of high-value natural habitats that would be protected under each of the two approaches. We also assessed the level of aggregation of the selected areas as higher aggregation allows conservation areas to be more easily protected.

The analysis showed comparable performances between the species-based approach and the wilderness-based approach in terms of the number of species and the high-value habitat cover, however, the former gave slightly better results. Among species indicators, the best results were provided by rarity. The level of aggregation was higher for the wilderness approach as the results showed a continuum of values for the territory of the park.

We conclude that for situations where a particular species or habitat are targeted for conservation, the species-based approach is more beneficial. But considering the limited number of species for which species distribution data exists and the uncertainty related to the minimum area to ensure the conservation of a species, the wilderness-approach might offer a simple and effective alternative methodology. The wilderness-approach makes use of readily available data and involves less effort. In conclusion, this approach selects aggregated priority areas and tends to select areas with fewer conflicts with local populations as it prioritises areas with low human population.

# Measuring Biodiversity in Cities – Using the Singapore Index on Cities' Biodiversity

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With an increasing population residing in urban areas and the exponential growth in the number of cities, it is imperative that biodiversity conservation lies in the hands of city dwellers. We can best manage only what we can measure. However, most environmental indices pertain to countries and not cities, while those that consider cities focus on environmental parameters like energy consumption, water quality, etc. and not biodiversity. Conventional wisdom assumes that biodiversity and urbanisation are incompatible. However, studies have indicated that urbanisation can sometimes increase species richness (McKinney, 2008), alluding that the relationship between urbanisation and biodiversity richness is far more complex. Hence, to assist in the evaluation of the achievement of the 2010 target of significantly reducing the rate of biodiversity loss at the city level, it was essential that a self-assessment tool be developed for cities.

At the 9<sup>th</sup> Meeting of the Conference of the Parties to the Convention on Biological Diversity, Singapore agreed to facilitate the development of an evaluation tool for biodiversity conservation efforts for cities. In partnership with the Secretariat of the Convention on Biological Diversity and the Global Partnership on Cities and Biodiversity, Singapore organised two technical expert workshops to design a framework for a biodiversity index. Three broad categories including: 1) Native Biodiversity Found in the City; 2) Ecosystem Services Provided by Biodiversity in the City; and 3) Good Governance and Management Practices, formed the pillars of the index framework, supported by 23 quantifiable indicators. A User's Manual for the City Biodiversity Index (Chan, Calcaterra, Elmqvist, Hillel, Holman, Mader & Werner, 2010) was written to assist cities. As much of the biodiversity data is collected by academic institutions while city councils are the agencies responsible for the application of the Index, an attempt was made to match them (Chan & Djoghla, 2009).

This paper charts the rationale for the development of the self-assessment tool, the elements of the Singapore Index, the processes involved and other applications of the Index.

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# **Enhancing Biodiversity in Cities by Applying the Singapore Index on Cities' Biodiversity**

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More than half of the world's population lives in cities. Global trends show that there is an increasing number of cities and cities are becoming more populated. However, the quality of life in cities depends on biodiversity for all their needs. It is often assumed that urbanisation and biodiversity cannot co-exist. However, several cities such as Curitiba, Brussels, Edmonton, Montreal and Singapore have shown that rich biodiversity can be found in cities. Some studies have supported the observation that urbanisation sometimes increases species richness (McKinney, 2008). To more objectively and scientifically evaluate the biodiversity conservation efforts of cities, a self-assessment tool was developed for cities.

At the 9<sup>th</sup> Meeting of the Conference of the Parties to the Convention on Biological Diversity, Singapore agreed to facilitate the development of an evaluation tool for biodiversity conservation efforts for cities. In partnership with the Secretariat of the Convention on Biological Diversity and the Global Partnership on Cities and Biodiversity, Singapore organised two technical expert workshops to design a framework for a biodiversity index. Three broad categories including: 1) Native Biodiversity Found in the City; 2) Ecosystem Services Provided by Biodiversity in the City; and 3) Good Governance and Management Practices, formed the pillars of the index framework, supported by 23 quantifiable indicators. A User's Manual for the City Biodiversity Index (Chan, Calcaterra, Elmqvist, Hillel, Holman, Mader & Werner, 2010) was written to assist cities. As much of the biodiversity data is collected by academic institutions while city councils are the agencies responsible for the application of the Index, an attempt was made to match them (Chan and Djoghlafl, 2009).

Although the Singapore Index was originally developed as a self-assessment tool, other applications surfaced. The indicators could also be used as guidelines for the enhancement of biodiversity in cities. Examples of this application are highlighted in this paper.

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## **Study on Landscape Ecology Structure Change of Different Landuse Types**

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In the last forty years many disturbances have occurred in the mudstone area of southwestern Taiwan. Bare mudstone areas have increased three times during the past 10 years and these changes have been integrated as spatial information using GIS, to understand the Spatial Structure and Landscape Ecology metric. The changing landscape is due to road construction and human activity that reflects the sensitivity of bare mudstone and the evolving mudstone landscape. Ecological factors such as patch shape factor and Shannon evenness factor have significant canonical correlation with water quality. The expected trends, causes, destruction of ecosystems and the potential danger of mudstone areas were analysed in this study. Trends in landuse changes in mudstone areas are similar to the expansion of bamboo areas, but opposite to that of woodland areas. This shows that changes in mudstone landscapes are likely to have a relationship with the unification of forest areas. Mixed forest areas are likely to decrease because of the dominance of bamboo areas. It is therefore considered necessary to change the unified bamboo land into a mixed forest landuse type. Edge indices have the same trend as patch indices. Edge indices represent the exchange of energy, materials and nutrition flow between patches. Patches analysed from 1997 were found to have fragmental distribution and higher edges. This suggests that greater transportation of energy, materials and nutrition flow resulting from storms reduced earth resources and decreased vegetation growth. As a result the expansion of mudstone and bamboo areas increased during 2000. As the landscape of the study site reached a steady-state, other vegetation types were found to invade and add to landscape fragmentation. Determining the key factors affecting the environment and ecosystem of landscapes will help to establish relevant environmental laws for these landscapes.

## **Patch-level Performance analysis of an Urban Green Landscape for Cooling Effects in Shenzhen, China**

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Green infrastructure is a popular concept for upgrading urban green space systems and has been used as a coherent framework for urban smart development and conservation planning. It consists of a set of hubs connected by links, which provide various ecosystem services that contribute to the quality of life in cities (Benedict and McMahon, 2000). Hubs are woodlands, grasslands, wetlands and other natural or semi-natural areas with known or potential ecological value. Links are corridors that connect hubs to each other. A significant area of green infrastructure research is related to the identification and mapping of ecological networks (Wickham et al., 2010). The identification of what hubs should be included and the

rank of hubs is the primary step of network mapping. In existing literature it is more popular to identify hubs from the perspective of biodiversity conservation than ecological processes (Van Herzele and Wiedemann, 2003; Wickham et al., 2010); that is, most of studies emphasise hubs as an origin or destination for wildlife. In a city, however, ecological processes active in green spaces play important roles in sustaining an urban climate and environment. These include processes such as decreasing the Urban Heat Island effect (UHI) and improving air quality. The aim of this paper is to quantify the relationship between the cooling effect and the patch-level pattern indices of urban green spaces. This will help to identify the minimum green cooling island that may be the criteria of mapping green infrastructure hubs in cities.

In this study, Shenzhen in China is used as the case area. Temperature and green space distribution information were obtained using remote sensing data including Landsat TM images and aerial photos. Based on a 3 x 3 km mesh (Chang, 2008), the mean temperature difference and pattern metrics were calculated in GIS and Fragstats 3.3 respectively, and their correlation analysed in SPSS. Results show that in built-up areas when the total area of green spaces is lower than 40%, the green space patch is smaller than 1 hm<sup>2</sup> and this did not markedly decrease the surrounding temperature. When patch space is greater than 1hm<sup>2</sup>, the larger its size or the more complex its shape is, the higher its cooling effect. However, when the total area of green spaces is greater than 40%, the more complex the green patch shape, the greater its cooling effect will be. Therefore, this indicates that the size of green patches or parks in urban green space systems should be at least 1hm<sup>2</sup> in order to maximise the cooling effect in these spaces.

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## **What Scale can Reflect the Interaction between Landscape Structure and Species Diversity in Rural Areas of Taiwan?**

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Taiwan is a relatively small country with high landscape heterogeneity and high fragmentation, particularly in its rural areas. It is necessary to find a suitable scale to study the ecological phenomena in such areas. In this study, the concept of hierarchy is used to discuss what scale reflects the interaction between landscape structure and different species. Birds and

butterflies were used as representative species of different ecological status and their cross-scale interactions were discussed.

The study site is the Miaoli Sanwan township that is situated in a traditional rural landscape of Taiwan. Based on the theory of landscape structure and hierarchy theory, spatial information was calculated for different areas and grid scales using eCognition 4.0, ArcGis 9.2 and Fragstats3.2. The core-scale of birds and butterflies considered to significantly reflect the change in landscape structures were found. This was followed by a discussion on the relationship between biodiversity and landscape structures at different scales, specifically for birds and butterflies.

Findings show that the core-scale of birds and butterflies are different and that the difference in core-scale reflects the differences in ecological characteristics. The core-scale of birds represents the concept of home range and that of butterflies reflects flying distance. A home range reflects the life history of a bird: its defensive zone, eating area, and habitat food density. The flying distance of butterflies represents their daily needs and their migration to new habitats. The results suggest that biodiversity is required to preserve woodland and farmland areas and that the relationships between landscape structures and species are different.

This study suggests that different species have different ecological processes that dominate at different scales. Cross-scale research can contribute to the understanding of landscape integrity of an ecosystem. In landscape planning applications, different strategies and approaches for habitat construction need to be addressed in response to changes of scale.

## **An Overview of China's Wildland Fire Characteristics and Fire Suppression Policy over the Last Two Decades (1987-2007): Suggestions for Forest Fire Management Planning in China**

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Understanding the spatial and temporal characteristics of forest fires is essential for fire management planning (Genton et al., 2006; Hering et al., 2009; Wittenberg and Malkinson, 2009; Yang et al., 2007). Yearly forest fire statistical data was collected for each province of China from 1987 to 2007. Spatial and temporal characteristics of China's forest fires were analysed during this period. Analysis showed that there were great spatial variations of forest area burned; 67.25% of the total burned forest area ( $2.21 \times 10^6$  ha) was located in northern and northeastern China, while 80% of the total fires (170,541) occurred in southern part of China, including southwestern (28.52%), southern (28.0%), central (7.35%) and eastern areas (27.27%). It was also found that fire suppression only has a short-term (<10 years) effect on reducing forest fire occurrence. This analysis has significant implications for forest fire management planning in China. The construction of facilities for forest fire prevention should be given priority in eastern Inner Mongolia and northern Heilongjiang provinces. Forest fuel treatments with an interval of ~10 years should be incorporated in future forest fire



management planning. An approach for balancing the dual roles of forest fires is suggested. Forest fires in the WUI, aesthetic and scenic areas should be suppressed, while forest fires should be allowed to extinguish naturally in other areas.

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## Application of Comprehensive Ecological Risks Assessment Method in Urban Area: A case study in Huaibei City

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Various and complex ecological risks occur widely in urban ecosystem. Conventional assessments specific for single types of ecological risks are not comprehensive enough to evaluate the degree of ecological risk. They also make it difficult to meet multiple needs for urban sustainable development and management. In this paper a research framework has been developed to evaluate urban ecological risks spatially and more comprehensively. Three primary kinds of ecological risks including natural disasters, environmental pollutions and ecological impacts caused from urban spatial expansion, are considered in this framework. Firstly, a preliminary analysis of natural, economic, social, environmental and urban structural conditions was implemented to generate the input variables for the upcoming effect and exposure analysis. Secondly, the analytical effect was investigated for occurring probability, influence range and intensity of each ecological risk. The degree of vulnerability and exposure range of each land use type was also quantified through exposure analysis. Finally,

both single and comprehensive ecological risk degrees were computed to provide the scientific basis for policy making in urban ecological planning. Urban areas in Huaibei city were chosen for the application of the system approach. Major ecological risks in Huaibei include flood, drought, water pollution, air pollution, land subsidence and ecological service degradation. Single and comprehensive ecological risk degrees were calculated according to the system approach. On the basis of these analyses spatial strategies for urban ecological planning were proposed for incorporation into assessment results.

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## **Linking National Forestry Reform to Actual Timber Management in Southeastern Peru**

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Efforts to keep forest extraction sustainable, and balanced with conservation objectives, have been at the core of the international forestry agenda. Tropical forests in South America represent some of the last intact forests in the world which contain valuable, widely-traded neotropical timber species (e.g., big-leaf mahogany). Peru, a tropical country of high biodiversity, is currently one of the largest exporters of big-leaf mahogany. In 2002, Peru established its first legal framework to promote sustainable forest management through the enactment of the New Forestry and Wildlife Law. This study combines a landscape ecology framework and spatial analysis tools to evaluate the relationship of past and current legislated forestry reforms and timber concession management in the maintenance of forest areas in the Tahuamanu province, Madre de Dios, Peru. Methods used in land use land cover (LULC) classification assess how forest degradation has occurred at specific sites and how the development of the most recent Peruvian forest policy framework and timber harvesting have produced spatial patterns and transformed the landscape. The analysis assumes that policies pertaining to the forestry sector affect LULC and these policies leave imprints on the landscape within a one to two year satellite-image interval, meaning that policies acting in 2001 may be visible in 2002/2003. This study combines remote sensing, forest fragmentation analysis and the effects of forestry policies and reveals a change in landscape homogeneity and heterogeneity as well as degree of fragmentation through the years. The results confirm that the timber-concession landscape is dominated by large forested patches as shown by the stable largest patch and contagion indices, both of which indicate relatively homogenous forested landscapes and the dominance of forest. Further, a relationship between the development of the forestry policy framework and logging activity history is eminent throughout the study. The findings provide crucial data on the pattern and rate of forest transformation at a critical scale level (and in the early stages of disturbance), which will help facilitate the future monitoring of a biodiversity hot spot area that is in danger of forest degradation. Such monitoring will be important, as future processes emanating from timber activities are expected to produce spatial patterns and transform the landscape, since

livelihood systems revolve around the forestry sector in this area of Southeastern Peru. The assessment of landscape dynamics by incorporating a policy forestry framework within landscape ecology considerably improves our understanding of the impacts of complex policies on the environment.

## **How do Landscape Patterns Impact on Surface Urban Heat Islands? - Finding a Way to Mitigate the Urban Heat Island Effect**

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Landscape patterns, as the spatial composition of landscape patches, have been claimed to greatly impact on landscape processes (Turner, 1989) such as the Urban Heat Island (UHI) effect (Weng et al., 2007). It has been claimed that some landscapes, such as wetlands and green areas, can act as UHI sinks, while others (e.g. built-up areas) as UHI sources. To improve urban sustainability it is better to include more vegetation or wetlands in urbanised areas. However, this results in the tradeoff of increasing facility costs in large cities. Since landscape patterns are thought to affect landscape processes, is it possible to balance this tradeoff by maximising the cooling effect of vegetation and wetlands by rearranging urban landscapes? This paper aims to investigate how landscape patterns impact surface Urban Heat Islands and thus serve to mitigate UHI effects through landscape design and planning.

An area of Beijing was chosen as a case study and fine resolution QUIKBIRD images (pixel resolution: 2.5m) were used to map landscape types in this area. Land surface temperatures (LST, pixel resolution: 60m) were obtained from Landsat 7's ETM+ data for this areas from the same period. Landscape patterns, including fractional character and connectivity, were examined and correlated with LST. This was undertaken by using a 24 x 24 moving window to calculate the landscape metrics of the landscape map. This method was chosen because a pixel of 60 m resolution corresponds to 24 x 24 pixels of 2.5 m resolution.

The result showed that not only do landscape types contribute differently to average surface temperature, but also that the pattern in which these landscapes were formed and connected affect average surface temperature. Consequently, by rearranging landscape patterns, urban climate may be improved to some extent.

**Keywords:** Landscape pattern, Urban heat island, Land surface temperature, Connectivity

## **Valuing the Ecosystem Services of Satoyama Landscape - A Case Study of Noto Peninsula, Japan**

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Satoyama landscape is a traditional rural landscape in Japan, which mostly consists of mosaic elements of forested hills, farmlands, settlements and reservoirs. These landscape elements interact and are closely associated with agricultural activities. Noto Peninsula, located in the north of Ishikawa Prefecture, is a microcosm of Satoyama where agriculture, forestry and fisheries are closely intertwined. Depopulation, ageing and the ensuing decline in agricultural activities has resulted in ecosystem degradation and threats to local biodiversity. Recently, the Japanese government has made efforts to restore the traditional managed landscape. Compared to the recent initiatives by all levels of government, citizens, NPOs and NGOs, the benefits to the Satoyama ecosystem are less understood. This study values the outputs generated by the Satoyama ecosystem, eg. Food production, climate regulation and recreational values. It is expected that results will be used as credible baselines to assess current policies relevant to local environmental conservation.

## **Traditional Village Landscapes on Small Islands - A Case Study of Okinawa Prefecture, Japan**

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A traditional village landscape in Okinawa features clustered settlements surrounded by planted tree belts and meandering roads to protect the village from strong winds. Such a green landscape, which is assumed to be planned or reformed based on the Feng Shui concept originating during the modern Ryukyuan period approximately 300 years ago, is well preserved in Okinawa Island and its nearby isolated islands. But it is still a mystery to historians as to when and how these villages were built with tree lines. This research aims to clarify the layout of village landscapes and the structure of planted tree belts in the small islands and to discuss the traditional management of woods near human settlement. The research results are expected to contribute to the understanding of the relationship between humans and nature and to propose traditional landscape planning systems with ecological and cultural contexts.

## **Simulating Impacts of Larch Caterpillar (*Dendrolimus superans*) on the Fire Regime and Forest Landscape in Da Hinggan Mountains, Northeastern China**

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Larch caterpillar (*Dendrolimus superans*) is very common in Da Hinggan Mountains of China, affecting the fire regime and forest ecosystem change at large spatio-temporal scales. In this study, we used a spatially explicit landscape model, LANDIS, to simulate effects on fire regime and the forest landscape under four larch caterpillar disturbance intensity levels scenarios in the Huzhong area. In the simulation, larch caterpillar disturbances decreased fine fuel load and increase coarse fuel load in the 300 simulation years; decreased fire frequency in the first 200 simulation years; and decreased the fire intensity and fire risk in the early and late stage of the simulation. Larch caterpillar disturbances decreased the percentage area of larch cohorts; increased the white birch proportion; and increased the degree of aggregation of white birch as a result of its strong seed dispersal and colonization ability. Disturbance also decreased the mature and over-mature larch cohorts and increased all cohorts of white birch, especially the mature and over-mature cohorts. Larch caterpillar disturbance decreased the stability of forest landscape. It is suggested that forest managers take measures to prevent insect outbreak to ensure the sustainable management of forest ecosystem.

**Keywords:** Forest landscape, Larch caterpillar, Fire, Disturbance, LANDIS

## **Cultural Landscapes in the Loess Plateau, China: Types, Functions and Environmental Significance**

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The Loess Plateau, as the one of origins of Chinese Civilization, has been inhabited by humans for more than 500,000 years. As a result of human utilisation, many man-made landscapes were developed by human construction at the loss of large amounts of natural landscapes. However, with the further expansion of human activity, some significant cultural landscapes in the Loess Plateau are faced with potential disappearance. Rediscovering the value of these cultural landscapes and their timely protection is crucial work. Traditional cultural landscapes in the Loess Plateau include Loess-caves, Traditional-folk houses and Temples. Among these landscapes, Loess-caves are the most important and widely-distributed. These caves are normally divided into three building types: Exposed-caves (EC), Subsided-caves (SC) and Isolate-caves (IC). This landscape can also be divided into different groups by its function, such as a Protruding-cave (located on the roof of the main caves and used for monitoring), an Inlaid-cave (located inside the main caves and used for storage), Guest-cave (used for guest reception), and a Kitchen-cave (used for cooking). As well as

normal human usage, the Loess caves are also of high value in terms of environmental sustainability. Firstly, the Loess-caves are low-carbon buildings. Since Loess-caves are made of loess, which is a natural and widespread material in the Loess Plateau, little detrimental effects are generated in the building process compared with modern buildings. Secondly, Loess-caves are energy-saving buildings. Since the thick walls of loess keep the caves from excessive heating in summer and from cold in winter, a pleasant environment remains inside the cave and extra air-conditioning is not required. Thirdly, the Loess-caves are also noise-proof. The caves may provide a quiet environment for occupying humans. Additionally, the Loess-caves are radiation-proof, earthquake-proof, fire-proof and wind-proof. However, the environment-friendly Loess-caves are disliked by young people and are currently being lost in the Loess Plateau.

**Keywords:** Loess-cave, Culture landscape, Environment-friendly building, Loess plateau

## The "Pot of Clear Water" of Poyang Lake and Its Implications

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Protection of water bodies while developing a socio-economy is a challenging task for lake regions of many developing countries. Poyang Lake is the largest freshwater lake in China, with a total drainage area of 160,000 km<sup>2</sup>. In spite of the rapid development of the socio-economy in the Poyang Lake region in the past several decades, water in Poyang Lake is of a good quality and is known as the "last pot of clear water" in the Yangtze River Basin in China. In this paper, reasons for the "last pot of clear water" in Poyang Lake were analysed to understand and demonstrate how economic development and environmental protection can be coordinated. In addition, landscape ecology principles were applied to examine the connectivity of the basin components and its implications for sustainable watershed management. There are three main reasons for the coordinated development at Poyang Lake: 1) the unique geomorphologic features of Poyang Lake and the short water residence time; 2) the matching of the basin physical boundary with the administrative boundary; and 3) the implementation of "Mountain-River-Lake Program" (MRL) with the ecosystem concept of "mountain as source, river as connection flow, and lake as storage". In addition, a series of actions were taken to coordinate development, utilisation, management and protection in the Poyang Lake basin. Our key experiences are: considering all basin components when focusing on lake environment protection is a guiding principle; raising the living standard of people through implementation of various eco-economic projects or models in the basin is the most important strategy; preventing soil and water erosion is critical for protecting water sources; and establishing an effective governance mechanism for basin management is essential. This successful, large-scale model of basin management can be extended to any basin or lake region in developing countries where both environmental protection and economic development are needed.

**Keywords:** Poyang Lake, Landscape ecology, protection of water environment, experience, implication

# Reconsidering the Effects of Cascading Dam Constructions on River Ecosystem: A Multi-scale Ecological Network Perspective

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The isolated perspective of considering the environmental impact of an artificial engineering works has dominated in decision making over the last century. For large development projects on rivers, the importance of incorporating cumulative environmental impacts has not received significant attention until recently (Chen *et al.*, 2011). Consideration of potential impact pathways may still be difficult without appropriate measurements. By using information-based ecological network analysis, the present study identified and quantified the integrated ecological impact resulting from cascading construction that carves the river basin landscape. Taking Lancang river of Longitudinal Range-Gorge Region (LRGR) as a case study, we developed an ecological network model for the 13 river subsystems divided by the large dams constructed, and evaluate the ecological conditions of each sub-basin before and after dam construction on temporal and spatial scale. Based on the multi-scale network model, the cascading effects water quality and aquatic animals were evaluated for a scenario of all the 12 dams operating. By harnessing information-based ecological network analysis to the consideration of cascading effects on an impacted river ecosystem, this study provides a new way to perform such research. The process and results promote reconsideration of the understanding of indirect effects of very large human engineering at whole-ecosystem or even landscape scale.

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# Relative Importance of Water, Energy, and Heterogeneity in Determining Regional Pteridophyte and Seed Plant Richness in China

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Environmental variables, such as ambient energy, water availability, and environmental heterogeneity have been frequently proposed to account for species diversity gradients. How taxon-specific functional traits define large-scale richness gradients is a fundamental issue in understanding spatial patterns of species diversity, but has not been well documented. Using a large dataset of regional flora from China, contrasting spatial patterns and environmental determinants between pteridophytes and seed plants, which differ in dispersal capacity and environmental requirements, were examined. Pteridophyte richness showed more pronounced

spatial variation and stronger environmental associations than seed plant richness. Water availability generally accounts for more spatial variance in species richness of pteridophytes and seed plants than energy and heterogeneity do, especially for pteridophytes, which have a high dependence on moist and shady environments. Thus, pteridophyte richness is disproportionately affected by water-related variables; this in turn results in a higher proportion of pteridophytes in regional vascular plant floras (pteridophyte proportion) in wet regions. Most of the variance in seed plant richness, pteridophyte richness, and pteridophyte proportion explained by energy, was included in variation that water and heterogeneity accounted for. This indicated the redundancy of energy in context of this study. However, heterogeneity is more important for determining seed plant distributions. Pteridophyte and seed plant richness is strongly correlated, even after the environmental effects have been removed, implying functional linkages between them. Our study highlights the importance of incorporating biological traits of different taxonomic groups into the studies of macroecology and global change biology.

**Keywords:** Habitat heterogeneity, Pteridophytes, Seed plants, Species richness, Water-energy hypothesis

## **Interactions of Carbon, Water and Energy in China's Semiarid Grassland Ecosystems**

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Landuse change and grassland degradation are two of the most critical problems ubiquitously found in arid and semi-arid areas of Northern China. To evaluate the effects of landuse change on the interactions of carbon, water and energy of semiarid grassland ecosystems, three paired eddy towers were setup in Duolun (a steppe and a cropland), Xilinhot (a fenced steppe and a restoring degraded steppe) and Kubuqi (a planted forest and a native shrubland). Based on the flux data of carbon, water and energy from 2005 to 2009, it was found that precipitation (PPT) played a dominant role in determining the carbon, water balance and energy partition. When  $PPT < 200$  mm, ecosystem net  $CO_2$  exchange (NEE) increased linearly with increasing PPT, but when  $PPT > 200$  mm, no significant relationship existed. However, evapotranspiration (ET) only showed a significant increase with increasing PPT when  $PPT > 200$  mm. There were significantly positive relationships between NEE with sensible heat flux and Bowen ratio. Human activity in cropland ecosystems not only resulted in a rapid shift between LE and H, but also triggered a decrease in latent heat fraction because of a shortened growing season for crop plants. Although plowing and harvesting activities caused carbon release, croplands still showed higher carbon sequestration than steppes due to stronger photosynthesis activity of crop species. There were no significantly different ET and ET/PPT ratios between fenced and restored steppes, however, the restored steppes show obviously stronger carbon uptake ability than that of fenced steppes. Compared with native shrubland, planted forest did not increase carbon sequestration, but significantly increased the water loss of ecosystems. This indicated that large area tree plantations might result in the loss of groundwater resources.



## Roads effect on the biodiversity for slope aspects and valley topography

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Slope aspect and valley topography affect biodiversity protection during road construction. These characteristics are important considerations, especially for some decisions that are required such as where to set wasted stone and soil or where to locate wild life passages. Vegetation plots in one valley near the Deqin county section of G214 in northwest Yunnan province was investigated. Measurements including  $\alpha$ -diversity and  $\beta$ -diversity were obtained for different slope aspects within the valley topography. Birds observations at this site and other plots were recorded every 6 km along the site road. Results showed: total species presented, average species number per plot and Shannon-wieners indices. Pielou and Simpson indices for wood plants in southwest (SW), northeast (NE) and north (N) slope aspects were higher than those of northwest (NW) and south slope aspects (S). Richness of herb plants on the south slope was found to be less than on other slope aspects. Jaccard indices for S-SW, WN-EN, SW-WN were less than 0.15 and that of EN-N was less than 0.4. A significant difference in  $\alpha$ -diversity between herb and wood plants was found and also between slope aspects. High  $\beta$ -diversity was also observed for valley topography. The number of bird species and total average numbers of birds for each plot indicated that areas with a valley topography were richer than that of non-valley plots. This investigation suggests that valleys serves as a landscape for an abundant, rich and changing plant biodiversity and also a landscape supporting an abundance of wild animals. Suggestions were provided to combine bridges and wildlife passage to strengthen the connectivity for roadsides.

**Keywords:** Slope aspect, Valley, Biodiversity, Road

## Eco-hydrological Processes and Patterns in Arid Inland River Basins

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Northwestern China, accounting for one fourth of China's total land area, is characterised by its inland geographic position, drought continental climate, fragile terrestrial ecosystems and basin-rang landscape pattern. It has two outstanding features; abundant natural resources and a fragile environment. Numerous inland rivers begin in northwestern China and they are the basis for sustaining human survival and economic and social development. The ecosystems of inland river basins are connected by water. Mountain areas are the formative region of water resources consisting of ice-snow melting water in the alpine belt, rain in the middle mountain forest belt, and bedrock fissure water in the lower mountain belt. Plain oasis areas are the consuming and transformatives regions of runoff. Desert area are the regions lacking in water

resources. The eco-hydrological processes and patterns are quite different from those in eastern monsoon regions and the Qinghai-Tibet alpine areas of China. Over the last 50 years great changes have taken place in the natural ecological processes under the pressures of economic and social activities centered on water resources exploitation and utilisation in the vast northwestern inland river basins. These are represented by the Tarim River basin, Heihe River basin and Shiyanghe River basin. The ecological processes and patterns occurring in areas of natural vegetation have been seriously affected by changing spatial-temporal water patterns, altered by human activity. Drying rivers, desertification and ecological degradation have seriously influenced and restricted the economic development and social progress of the vast northwestern arid land. Moreover, under the impact of global climate change and accelerating glacier melting and shrinking, rivers supplied mainly by glaciers will change abruptly with the occurrence of inflection points in melting glaciers. In combination with the status analysis of eco-hydrological research relating to water cycle and ecological safety under global change, this paper defines the focus and key issues of eco-hydrological processes and patterns research in inland river basins in northwestern China and aims to promote its further study.

**Keywords:** Eco-hydrological processes, Patterns, Ecological safety, Arid inland river

## **Modeling Nutrient Transport in Xintian Watershed, Pearl River Delta, using AnnAGNPS and GIS**

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The Pearl River Delta lies in South China in an area of accelerating economic development. The Delta is located in a southern subtropical monsoon climate region with a geology of southern red soil, where intense agricultural practices are implemented and chemical agricultural products are over applied. Due to the effects of continual storms, soil nutrients including nitrogen (N) phosphorus (P) are lost quickly with serious environmental consequences. In order to ensure regional water security and accelerate harmonious development of the economy and environment in the region, the study of agricultural non-point source pollution is highly significant.

Xintian watershed is a typical agricultural catchment, north of the Pearl River Delta. It has a total area of 1,334 ha and includes 540 ha of orchards, 487 ha of woodlands and 270 ha of paddy fields. Simulations of nitrogen (N) and phosphorus (P) loads in the Xintian watershed were performed using AnnAGNPS and GIS for four rain events in 2005. The degree of calibration was quantified by comparing simulated data with monitoring results. The model was also run to simulate annual pollutant loads in 2002 and 2003.

Simulations of rain events showed that the predicted results coincided with measured results but that the simulation of N was more accurate than the simulation of P. The annual simulation results found that the N load per area is  $46.34 \text{ kg hm}^{-2} \text{ a}^{-1}$  and the P load per area is

6.84 kg hm<sup>-2</sup> a<sup>-1</sup>. These results will be regarded as an important reference for environmental management and further evaluations of nutrient loads. Simulation results were influenced by a variety of parameters and associated uncertainties.

**Keywords:** The Pearl River Delta, Agricultural non-point source pollution, AnnAGNPS, GIS (geography information system), Pollutant loads

## A Case Study of Green Resource Change in Taipei City

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Understanding changes in landuse and land cover plays an important role in the study of rural, suburban and urban areas. Through the classification and analysis of landuse types over different time periods, the driving factors of landscape change such as when, where and how change occurs may be understood. This study applied a 2-period landuse data and cluster analysis in Taipei City to assess the changes in total landscape and individual landuse types as well as the clustered trends between neighborhood and landuse type characteristics. The results showed that between the years 1994 and 2007 the overall rate of landuse change was 20.87%. Analysing individual landuse types showed that the amount of forest area increased from 36.54% to 38.65% and the amount of built-up areas increased from 27.31% to 31.02%. In contrast, the amount of agricultural land declined from 11.00% to 6.77%, leading to a reduction of approximately 1152.3 ha (4.23%) in agricultural areas. Cross-over analysis showed that the relatively stable landuse types including forest, built-up areas and transportation areas, did not experience any significant change. However, wetlands, mines, exposed lands, water conservancy lands and agricultural lands were found to be continually deteriorating. Through cluster analysis of neighborhood characteristics, landuse changes were detected on a neighborhood scale. This analysis showed that the discrete degree between neighborhoods and urban green spaces was higher in 1994 than in 2007. I.e. the area of agricultural lands in neighborhood groups was relatively higher than in forest areas in 1994. In 2007, however, not only did forest areas in marginal agricultural lands decrease, but agricultural lands in marginal forest areas also decreased. Although urbanisation is increasing forest areas can still be preserved due to public environmental awareness. In contrast, peri-urban agricultural lands have rapidly been lost because of rising land prices and an increasing number of elderly farmers.

**Keywords:** Urban green resources, Land-use change, Cluster analysis, GIS, Landscape ecology

## **Do Landscapes Mediate the Effects of Pesticides on Bird Species and Communities?**

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Effects of pesticides on organisms have until recently been mostly investigated using an ecotoxicological approach. Yet this approach ignores important indirect ecological effects of pesticides on species and communities and their interaction with environmental factors. Recent studies have suggested that the degree to which an organism is exposed to pollutants depends on the complexity of the landscape. Thus the potential impacts of pesticides on biodiversity may vary with landscape characteristics. This hypothesis has not yet been addressed. In this study we aim to understand the effects of pesticides, landscape and their interaction on birds, at species and community levels. Birds were sampled in more than 300 cereal fields located in three different regions of France between 2006 and 2010. Firstly, it was found that pesticides alone have a negative effect on the abundance of farmland species (that nest within fields or on the margins), especially on specialist species as generalists seemed to be unaffected. Secondly, specialists of non-farmland species (that breed in vegetation patches adjacent to fields) were also negatively correlated with pesticide use. Finally, it was found that effects of pesticide did not vary with landscape complexity (mixed vs simplified farmed landscape) whereas the landscape alone had a strong effect on community composition.

These results suggest that pesticides have wide and complex negative effects on species living from within cereal fields to those nesting beyond field limits. Species are unequally affected by pesticide use, with specialists being more at risk than generalists. Effects of pesticides and landscape on species abundance and community composition are independent but this has to be confirmed at other spatial scales.

## **The Characteristics and Management of Dangsang Forests as Old Sacred Forests in Korea**

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The traditional village forests of Korea are a unique cultural landscape with a history of more than several hundred years. Traditional village forests in Korea are largely recognised as Bibo forests with a main function of protecting villages. However, the characteristics of traditional village forests in Korea have been redefined as being composed of Dangsang forest (sacred forest) and Bibo forest (feng-shui forest) (Choi and Kim, 2009). Although the value of Dangsang forests is well investigated by experts as representing the Korean rural cultural

landscape, Dangsan forests have not been recognised by many Korean people. Therefore, the sacred Dangsan forests have significantly deteriorated because of ignorance of their value. The objective of this study was to rediscover the authenticity of the Dangsan forests to help restore this environment and value of this cultural landscape.

Dangsan forests are holy places where Dangsan rituals are held. Although many Dangsan forests have disappeared because of the abolition of Dangsan rituals, villages still have maintained Dangsan forests. In general, Dangsan rituals are held in the evening of January 15 by the lunar calendar. Dangsan forests have at least one of three components; the Dangsan tree (divine tree), stone tower and/or shrine. Ancient remains only retain value when the remains retain their authenticity (UNESCO; E Relph 1976). Although almost all of the sacred forests in Europe have disappeared, the cultural value of a sacred forest high is highly rated (Nigel D, et al. 2006). In this study we investigated several cases of authenticity loss of Dangsan forests through degradation. A number of management schemes have been suggested to renew the authenticity of Dangsan forests.

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## Traditional Village Forests and Dangsan Forests as Old Sacred Forests in Korea

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The traditional village forests of Korea are a unique cultural landscape with a history of more than several hundred years. The characteristics of the traditional village forests of Korea have been reported by Choi and Kim in 2009, who defined them to be composed of Dangsan forest and Bibo forest (Table 1). The objective of this study was to investigate the characteristics of Dangsan forests (sacred forests) and Bibo forests (feng-shui forests) in Korea and to evaluate their environmental and cultural value.

Dangsan forests are a holy place where Dangsan rituals are held. Although many Dangsan forests have disappeared because of the abolition of Dangsan rituals, there are still many villages currently maintaining these forests. Dangsan forests have at least one of three components; a Dangsan tree (divine tree), stone tower and/or shrine. The major Dangsan tree species are *Zelkova serrata*, *Pinus densiflora* and *Celtis sinensis*. Although Dangsan forests

are not recognised by many Korean people, the value of these forests has been well investigated and recognised as representing the Korean rural cultural landscape.

Table 1. The concept of traditional village forests in Korea (Choi and Kim, 2009)

| Specification            | Dangsan forests                  | Bibo forests                      |
|--------------------------|----------------------------------|-----------------------------------|
| Philosophical background | Animism                          | Feng-shui                         |
| Meaning of the space     | Sacred place                     | Protection from natural disasters |
| Components               | At least one of three components | None of the three Components      |

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## **Agroparks - The European Landscape Convention and a European way to regional sustainable landscape development through land use integration**

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Rural landscapes are presently undergoing a process of functional segregation which threatens to overcome all attempts at local decision making, inhibiting attempts at a transition to sustainability. The homogeneous wheat belts of North America and Europe, the plantations of postcolonial Africa, South East Asia and South America and the urban sprawl around our megacities are examples of this global tendency. The segregation trend has had a long history in Europe and has traditionally been balanced by the establishment of nature protection zones, designed to conserve valuable landscape resources by protecting them from exploitation. This has led to a problematic separation of our landscapes into A and B landscapes, or even landscapes and non-landscapes, where landscapes are protected areas with a high priority concerning protection and ecological management, and non-landscapes are all of the other areas of Europe, in which environmental management increasingly conforms to the principles of liberal economy.

Based on a national study of privately owned largeholder manorial estates in Denmark including a detailed case study conducted in one of the survey areas, we conclude that transition to landscape sustainability is held back by two main inhibitors, which currently makes it a *necessity* for rural agency to act unsustainably: (1) The global liberalized legal system which supports individual private ownership to land and thus restrains large scale decision making at a spatial scale to match the ecological problems at hand; and (2) The global agri-industrial growth and competition regime, which demands a mounting one-sided

focus on establishing competitive economies of scale in rural landscapes.

Our results indicate that in areas where these two regimes of rural governance are repressed by other land use drivers, a transition to sustainability may become possible. This is the case in the privately owned manor landscapes, which are examples of an integrated land use strategy which has developed over centuries, made possible through stable ownership conditions and a diversification of production activities. These landscapes integrate nature protection, agriculture, settlement and recreation in complex structures of management. They could serve as an example for future sustainable landscape planning at a larger scale, supported by regional regulation. The European Landscape Convention (ELC) supports such an alternative avenue of development, and can be considered a vision for more integrated types of landscape planning and management also outside protected areas (ELC 2000). The ELC highlights the common right to the landscape for all its inhabitants, and as such provides a singularly European approach to landscape planning which should be attempted at a larger scale on public lands in order to mitigate the democratically as well as ecologically dangerous influence of large scale agricultural capitalism.

**Keywords:** European Landscape convention, Land use integration, planning Manorial estates

## **Application of LANDIS II Model to Predict the Temporal and Spatial Changes in Forest Land Cover in South Korea**

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Sustainable management of forest ecosystems is required not only to cope with climate change but also with the rapid changes in social and economic development. To satisfy various social requirements while maintaining the fundamental functions of forest ecosystems, the spatially explicit simulation system which enables to diagnose and predict the structure and functions of ecosystem in long term by balancing relations between conservation and use of forest ecosystem are needed. As a forest landscape simulating tool, Landis-II provides insight into the spatial and compositional impacts produced by forest-management alternatives (Gustafson et al, 2000). However, the model hasn't been verified about the application into South Korea. In this point of view, we performed a case study to examine the applicability of Landis-II model in predicting the spatial and distributional change in forest cover. Two approaches used in verifying applicability of the model can be summarized into: (1) comparing the changes of spatial patterns and species composition between simulated results and current status of the forest, and (2) predicting future forest structure and species distribution over time by different timber harvest schedules. We constructed database of latest single decade including spatial patterns, species related information and history of the forest. Based on the database of previous 10 years, spatial and species composition change in forest land cover was simulated over time and the results were compared with current forest. Timber harvest schedules, used for prediction of future forest structure were specified with different harvest types, harvest ages, harvest species and plant regimes after harvest. Different management alternatives resulted in

producing diverse future forest structures differing from spatial patterns and structure of forest, such as composition of species, fragmentations of patches and opening size of harvested area.

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## **Maintaining Vegetation Composition and Structure across the Landscape: Implementation and Effectiveness of Wildlife Habitat Strips in Areas Covered by the Tasmanian Forest Practices System**

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Wildlife habitat strips (WHS) are corridors of native (uncut) forest that are retained in production forest areas to assist in achieving biodiversity objectives, primarily the maintenance of vegetation composition and structure across the 'off-reserve' landscape. They are prescribed in the Tasmanian *Forest Practices Code 2000* and, as such, they are a requirement under the Tasmanian *Forest Practices Act 1985*. They are typically 100 meters in width and primarily located along rivers but must also include links up slope and across ridges and maintain connectivity between catchments and formal reserves.

Implementation of the WHS provision has been achieved at the landscape scale on public land. However, implementation on private land has been problematic due to multiple landowners. We present information on the areas of public land that have been set aside from wood production as WHS, and the range of forest types and habitats that are captured in these areas. We also present case studies where WHS have been applied on private land to capture biodiversity values (such as threatened species habitat) and promote linkages with neighbouring reserves.

To test the effectiveness of WHS a long-term research project was established in wet eucalypt forest in Tasmania. Fifty-two vegetation plots were established in 1993 across areas that had been intensively logged, WHSs situated between logged areas and in unlogged control areas. The plots were surveyed in 1993 (immediately after logging) and then again in 2005 for floristic composition of vascular flora and forest structure.

The floristic and structural composition of plots was compared between land management areas and over time using classificatory analysis and ordination. Results showed that logged



coupes were significantly different to control plots in both floristic and structural composition, particularly in the composition of late successional species. WHSs were not significantly different to the control plots, although some edge effects were noted, such as a loss of species sensitive to edges effects (e.g. drying). The study suggests that WHS can fulfil a useful role in maintaining mature forest structure and composition, at least in the short-term, in landscapes subject to intensive forest management. The long-term effectiveness of WHSs, however, depends on their width and placement in the landscape. Late-successional forests should be preferentially retained in production areas where such forests are uncommon. Similar considerations may apply to new management systems (e.g. variable retention) designed to retain biodiversity across the landscape in older forests

## **Ecosystem Services and Sustainable Development in Cities in Developing Countries – Social and Cultural Challenges**

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“Africa is urbanising faster than any other continent and African urban populations will probably double their 2007 level of 373.4 million as early as 2030“ (Tibaijuka, 2010). Urbanisation is impacting on biodiversity and ecosystems on various scales and modifies existing ecosystems, creating unique urban environments which can still provide valuable ecosystem goods and services, as described by Boland & Hunhammar (1999). The concept of ecosystem services is being increasingly used to describe how biodiversity and ecosystems are linked to human well-being (Elmqvist, 2011) and should be placed at the core of sustainable urban development. Although this realisation is a global priority, developing countries are experiencing certain unique social and cultural challenges related to the implementation of planning and management practices based on ecosystem services (Roberts et al., 2005).

In this presentation, examples of some of the challenges will be given in the form of case studies of public and private green areas in the Tlokwe Municipal area in the North-West Province of South Africa. In terms of the economic value of green areas, preliminary results will be presented showing a contrast with the trend of increasing property values with proximity to green areas in developed countries (Tyrväinen, 1997). Green areas in most cities in developing countries are seen as a luxury, mainly because most role players do not realise its intrinsic value. Comparing the plant diversity and ecosystem services provided by private gardens, which are highly valued by their owners, with public green areas could enhance perceptions of the values of all green urban areas. It could also convince planners and policy makers to guide a process of integrative, economically driven, green space planning. Additionally, garden studies have indicated that socio-economics and culture have influenced plant diversity and specific ecosystem services provided by plant species (Lubbe et al., 2010).

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## **Soil organic and inorganic carbon vertical distribution and its relation to soil taxa and landscape position in the Pampas Region, Argentina**

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The importance of agroecosystems as a sink for CO<sub>2</sub> has been accounted for. Soils have recently gained more attention within the global change debate as the largest terrestrial carbon (C) pool. A satisfactory quantity of soil organic and inorganic C is considered crucial for sustainable agriculture and for mitigating C flux to the atmosphere. A decline in soil C normally decreases crop productivity and alters the ability of the soil to act as a sink for atmospheric CO<sub>2</sub> and therefore, to impact on global climate change. Different soil types are related to landscape positions and spatial distribution. These factors may have an impact on many of the processes that take place in ecosystem functioning and thus in soil C stocks and its vertical distribution. Knowledge of the C pool for each soil taxa and across landscape positions is necessary for the Pampas Region, since it is considered one of the most suitable areas for grain crop production in the world.

The goals of this work were: (1) to examine the association of SOC and SIC content with soil taxa, landscape position and at different soil depths; and (2) to examine if SOC and SIC storage at the landscape scale could be extrapolated at a regional scale. The analysis was based on > 200 soil profiles (Argiudolls, Hapludolls and Natracuolls in Buenos Aires province) from the National Institute of Agricultural Technology (INTA) database. SOC and SIC (kg/m<sup>2</sup>) were estimated at each soil taxa, profile (0-2m depth) and landscape position (summit, shoulderslope, toeslope). Results show that soil taxa and landscape position significantly affected the storage and vertical distribution of SOC and SIC. Soil types differed along landscape position. At a regional scale soil types affected SOC and SIC vertical distribution in a more similar pattern than at the landscape level. In general terms, soil C content and depth distribution can be extrapolated from lower to higher ecosystem levels.

# Ecological Implications of Parcel Size in the American Exurban Landscape

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We posit that in American exurban landscapes, developers' decisions about parcel size, parcel type, and preservation of pre-existing trees in the subdivision process dramatically affect subsequent exurban land cover, and that these developer decisions constrain subsequent homeowner behaviors and management of these parcels. Our study examines landscape patterns and processes at the parcel level based on data gathered in in-depth interviews with 26 exurban homeowners in Southeast Michigan, USA, as well as site photographs, aerial imagery, and GIS ecological zone maps derived from field work on their properties (Currie et al., In prep). Our analysis suggests apparent relationships between land cover on residential parcels in exurban southeast Michigan, developer decisions, and homeowner behavior. In particular, we classified exurban residential parcel land covers into two categories: Zone of Care (ZOC), or the area under heavy homeowner maintenance (primarily mown lawn), and Beyond Zone of Care, where less homeowner management occurs and ecosystems have greater vertical structure and habitat potential. We found that lot size dramatically affects land cover on exurban lots, with extent of ZOC linked with property size up to a threshold, beyond which the proportion of property not in the ZOC is on average, a larger proportion of lot size. These findings complement those of Robinson (2009) in a study of 2673 parcels in three Southeast Michigan townships on a slightly larger lot-size range. He found that areas of maintained lawn within exurban parcels maintained the same shape and spatial pattern but proportionately less area as lot size increased, and that forest patch size and proportion increased with increasing lot size. Our examination of land cover at the parcel scale has implications for habitat patch aggregation, biodiversity, carbon sequestration, and other ecosystem services within the exurban landscape matrix (with residential properties .5 acre/.2 hectare or larger), the fastest growing land use in America (Brown et al., 2005).

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## **An Analysis of Turkish Legislation in relation to Air Pollution**

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Air pollution has been a major concern since the middle of the 20th century because of increasing anthropogenic pressure. National and international efforts have been made to obtain agreements on air pollution mitigation and these have been incorporated into national legislation. This issue has been taken seriously in Turkey and is reflected in scientific, technical, legislative and institutional arrangements. Legislation is a significant part of the solution for reducing air pollution. Many laws have been accepted in Turkey since the ratification of the Constitution of 1982. In addition to this, international agreements on air pollution have also been ratified by Turkey. Many steps have also been undertaken to address this issue during Turkey's EU membership application process.

In this study, we aimed to compile mandates from international agreements and EU Directives which bound Turkey's legislation in relation to air pollution. Laws from the Turkish legislative system were then evaluated. Finally, a gap analysis was undertaken on national legislation relating to the responsibilities emerging from international agreements and laws. This analysis revealed the position of the legislation of the country and suggested steps to be taken to continue the reduction of air pollution.

## **Using Historical Maps to Understand Ecological Patterns and Processes**

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Since 10-20 years there is an increasing interest to incorporate effects of temporal changes when analysing effects of landscape change on species diversity or species patterns. Primarily the use of historical land cover maps, sometimes as old as 300 years are used as tools to understand landscape dynamic and how it is related to various driving forces, e.g., environmental or socioeconomic conditions. Recently, there is an increase of using old maps from all over the world in landscape ecological studies. By using old historical maps with more modern maps or remote sensing data from the 20th century in geographical information systems (GIS) it is possible to illustrate the land-use/cover change (LUCC) over time. The importance of historical maps lies in their possibility to demonstrate LUCC as basis for various further studies, e. g., modelling patterns of organisms or ecological processes over time. The new possibilities with using modern techniques in geography with ecological theory provides an excellent platform for cross-disciplinary research and particularly to answer some of the most urgent questions in conservation today, i.e. how much does past patterns influence present species occurrences in fragmented landscapes and what can we do about it. In the symposium we want to focus on old historical maps and their potential to reveal ecological patterns and processes in various habitats in the contemporary landscape.

## **From the Mountains to the Sea: Carbon Sequestration and Nutrient Accumulation by Riparian, Alluvial Floodplain and Tidal Wetland Soils**

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Wetlands exist along the hydrologic continuum that spans headwaters, riparian zones along low order streams, alluvial floodplains of rivers and, finally, tidal wetlands of estuaries and coasts. Along this continuum, wetlands vary with respect to frequency, duration and depth of inundation and, hence, their ability to transform, store and export materials.

I measured carbon (C) sequestration, nitrogen (N) and phosphorus (P) accumulation and sediment deposition in riparian, floodplain and tidal wetland soils spanning the continuum from the headwaters to the sea of the Altamaha River along southeastern Atlantic coast USA. Carbon sequestration and soil N accumulation were low at either end of the continuum, in riparian wetlands and in estuarine salt marshes. The greatest C sequestration and N accumulation occurred in the upper- and mid-reaches of the estuary, in tidal freshwater marsh and brackish marshes. In contrast to C and N, sediment deposition and P accumulation were greater in upper portions of the continuum, in riparian and alluvial floodplain forests than in tidal wetlands downstream. Across all wetland types, C sequestration generally was 100 g/m<sup>2</sup>/yr or less. Nitrogen and P accumulation was <10 g /m<sup>2</sup>/yr and <1 g P/m<sup>2</sup>/yr, respectively.

Fresh- and brackish-water tidal wetlands, at the interface of land and sea, are hotspots for the biologically active nutrient cycles of C and N on the landscape. Here, soil organic C and N stocks and accumulation are at their maximum, driven by low gradient flow and frequent (twice daily) tidal pulsing with mostly fresh water. Geologically-driven P and mineral cycles predominate in upper reaches of the continuum where freshwater pulsing is less frequent.

### **Linking Climate, watershed transit time, and in-lake processes: Mechanisms to explain highly variable trophic status in Clear Lake, Riding Mountain National Park, Canada**

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We conducted in-depth analyses of hydrology and biogeochemistry in a watershed and lake to determine mechanisms responsible for highly variable interannual trophic status (oligotrophic to eutrophic) in a large lake in Riding Mountain National Park, Manitoba. Here we link transit time –dependent fluxes of Phosphorus and Calcium from watersheds to in-lake scavenging of Phosphorus by calcite precipitation. Models were used to determine the

sensitivity of lake trophic status to climatic change and variability.

Surface and subsurface transit times through the mid-latitude boreal parkland watershed were inferred from natural water chemistry and hydrological analysis. Surface and groundwater samples were analysed for major ions and nutrients. Principal component analysis identified ion compositions associated with processes occurring in the surface and subsurface of landscapes, mainly weathering/leaching and evapoconcentration. Transit time distributions (TTDs) were also estimated from lake water budget and recession curve analysis. TTD was related inversely to the flux of phosphorus and directly to the flux of calcium and other base cations.

In Clear Lake, large concurrent increases in dissolved oxygen, pH and CaCO<sub>3</sub> saturation index were observed to occur simultaneously with large reductions in total and dissolved P scavenged by precipitation of CaCO<sub>3</sub>. Thus, photosynthetic activity is a negative feedback on ecosystem productivity, because it enhances phosphorus scavenging. Further, the negative feedback depends on the loading of Calcium and Phosphorus from the watershed.

Mathematical models constructed to link climate, flowpath, and transit time in the watershed, with in-lake processes show that drier climatic conditions result in lower phosphorus loading, with relatively high scavenging of phosphorus by calcite and reduced phosphorus bioavailability. Wetter climate increases the yield phosphorus from the watershed relative to calcium. Lower calcium concentration in the lake decreases the amount of calcite formed and consequently reduces calcite scavenging of phosphorus. Thus, as phosphorus loading increases, it is also more bioavailable. Taken together, interannual variability in loading of water, phosphorus, and calcium, is are consistent with the observed high interannual variability in trophic status of Clear Lake.

## **Spatio-temporal Environment Patterns under Rapid Urban Expansion and its Effects on Vegetation, Shanghai, China**

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Since the reform and opening up of China in 1978, urbanisation has been rapid and extensive. Shanghai experienced fast urban expansion and growth in suburban areas after the 1990s. In the past 30 years, the quality of surface water, atmosphere and soil has declined dramatically and has significantly affected vegetation.

Shanghai's districts and counties can be divided into three different areas: urban, suburban and rural. Concentrations of major air pollutants are higher in urban areas compared to suburban and rural areas. Water quality has also declined, more so in urban areas than rural areas. Soil pollution is more serious in Shanghai than in most other cities in China. Soil quality was found to be worse in suburban rather than in rural areas (except during 1991 - 1995). When considered together, these results indicate that the environment spatial gradient in Shanghai

was consistent during the urban expansion process.

Surface water quality and the atmosphere in urban areas have gradually improved since the 1990s. The main air pollutants (except for nitrogen oxides) decreased, mainly due to the reduction in the burning of industrial and domestic coal. Nitrogen oxides increased because of the rapid increase in the number of motor vehicles. In suburban areas, surface water quality and soil quality improved since the mid-1990s, but there has been a gradual increase in atmospheric pollution since 2000. In rural areas, atmospheric and soil quality have been improving since the mid 1990s. In addition, there has been a significant increase in the temperature difference between urban areas and suburbs. This suggests that the Urban Heat Island (UHI) effect has been increasing, with the strongest pattern in autumn and the weakest in summer. The UHI effect also appears to be stronger at night than during the day.

Surface water quality appears to have had an inverse relationship with increasing urbanisation and GDP per capita (U-shaped curve), indicating a gradual deterioration between 1982 and 1990, and an improvement after 1990. An approximate N-shaped trend was observed for atmospheric quality, with a rapid deterioration occurring between 1982 - 1990 and a gradual improvement between 1991 - 2000, followed by deterioration after 2000. With increasing urbanisation and GDP per capita, soil quality has gradually improved since the "Eighth Five-Year Plan" period (1991-1995).

As a consequence of urbanisation, most remnants of indigenous vegetation now exist only on Sheshan Mountain, Da Jinshan Island and Xiao Jinshan Island. Plant species richness has rapidly declined in these areas. The number of species declined from 535 in the 1980's to 254 at the end of 1990's on Sheshan Mountain, and the number of species on Da Jinshan Island has fallen from 254 to 145. Weeds as an important component of urban vegetation, have decreased from 534 to 303 in species richness. Dianshan Lake is the largest water body in Shanghai and its indigenous aquatic vegetation has almost completely disappeared with some local species now extinct. Simultaneously, large numbers of non-native species have been widely used in cultivated vegetation and more than 300 non-native species were recorded in the Shanghai rare in 2004. This caused an abrupt increase in invasive species and natural ecosystems have since been significantly degraded.

Shanghai is typical of most cities under the pressure of urbanisation in China. The spatial-temporal pattern of environment quality and the ecological consequences could provide scientific evidence for the government to pay more attention to environmental protection and management. It could also be very helpful for decision-making in urban developments and for the conversion of Shanghai to an ecological city.

## **Landscape Indicators of Human Impacts on Riverine Systems – A Case Study of a Brazilian Urbanised Watershed**

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Various studies have investigated the relationship between landuse and water quality within watersheds, emphasising the proportion of certain landuse types such as urban landuses (Lee et al., 2009). Landscape indicators characterise watershed attributes, particularly relating to the relative proportion and spatial arrangement of natural and human-influenced land cover classes. However, in-stream measurements of limnological variables are important and are still required (Gergel et al., 2002). In this study the influence of the proportion of natural remnant vegetation, as well as the arrangement of forest patches along the watershed on water quality was investigated for a small, urbanised watershed. The study area is located in Sorocaba Municipality, São Paulo State in southeastern Brazil. The watershed has an area of 3.02 km<sup>2</sup> and is highly urbanised (70%). Through satellite image analysis (Landsat, 2005), eight forest patches were identified. Four of these patches were smaller than 1 ha and three of the patches were between 1 – 10 ha in size. The largest patch was 17.3 ha. Major patches were located in higher areas of the watershed. The relationship between area and perimeter of the patches was strong ( $r^2=0.98$ , significance  $\alpha=1\%$ ). Over the course of one year, monthly water samples were collected at one location and measurements of limnological parameters were obtained to assess variability. Results showed that Electrical Conductivity ranged from 89.8 - 408.0  $\mu\text{S}\cdot\text{cm}^{-1}$ , Dissolved Oxygen ranged from 0.7 - 4.0  $\text{ml}^{-1}$  and water flow rates ranged from 26.2 - 126.9  $\text{ls}^{-1}$ . It is clear that the percentage of remnant vegetation, as well as the arrangement of the forested patches, is not enough to maintain an acceptable water quality level in this riverine system. The assessment of both landscape indicators and water quality parameters confirmed the necessity of high level of intervention – perhaps even a complete reconstruction of ecosystems - and the appointment of priority areas for biotic intervention, particularly for revegetation (Hobbs & Cramer, 2008).

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## Research of Multi-function Landscapes in Chinese Station Squares

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With the rapid development of domestic cities and the improvement of living standards, people are paying more and more attention to their quality of life and surrounding environment. As a result, the requirements of urban landscapes and the amount of land needed to meet these requirements, has been increasing. Cities, however, are limited with respect to



the amount of available land needed to meet expanding urban requirements. Due to these limitations it is becoming more urgent to find ways of satisfying community urban requirements. To face this challenge, the concept of a multi-function landscape has become more widely spread internationally and this concept has only recently been investigated in China. This paper investigates the urban area of railway station squares to exemplify such situations in China. The concept of a multi-function landscape is introduced and defined through the investigation of the characteristics and functions of station squares. By summarising the landscape planning of railway station squares in different regions in China and their associated customs, suggestions towards creating a multi-function landscapes in these urban areas were developed. This paper provides a reference for the development of multi-function landscapes in China.

**Keywords:** Multi-function landscape, Railway station squares, Landscape planning

## **An Assessment of Ecosystem Vulnerability Caused by Land Use Change: A Case Study in the Pearl River Delta Region, China**

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Land use change has affected almost every aspect of the earth and has been causing many environmental and ecosystem problems. Studying ecosystem vulnerability of land use change could help maintain the sustainable use of land resources and function of ecosystems. This study investigated ecosystem vulnerability in a coupled human-environment system by modeling and assessing the potential impact of land use change on an ecosystem and on the socio-economic adaptive capacity of the system. A model was applied to the Pearl River Delta Region of Southeast China, to assess future impacts on ecosystems and their adaptive capacity, as well as ecosystem vulnerability on both quantitative and spatial scales. The follow methodology was used: (1) **Simulation and forecast of regional land use change:** the expansion of construction activity and the reduction of arable land and eco-service land were the main features of land use change in the study area between 1985 and 2005. Improved CLUE-S modeling was used to forecast future land use scenarios in the study area. A spatial correlation factor was added to the spatial allocation module of CLUE-S, by which the spatial correlation effect was considered and the fit was improved. The Tietenberg resources allocation model, which takes into account an increasing population, was added into the non-spatial allocation module to ensure the benefits of land resources were maximised. Two land use changes were modeled and analysed, a planning-oriented land use change scenario and a scenario based on current land use change rates; (2) **Impact of land use change on ecosystem vulnerability:** based on land use change modeling as well as eco-service function calculations, the relative change method and fuzzy assessing method were used to investigate the potential impact and adaptive capacity on ecosystem vulnerability, respectively. The HSV visualisation method was then used to determine ecosystem vulnerability caused by land use change in the study region from 1985 to 2020, on both spatial and quantitative scales.

**Keywords:** Ecosystem vulnerability, Land use change, Adaptive capacity, Pearl River Delta Region

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## Precise Stand Structure Mapping Based on Airborne Lidar Technology

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The use of the newest methods and technologies of airborne laser location, high resolution digital photography and global positioning satellite systems, provides new opportunities for remote sensing monitoring and inventory of forest resources. The high efficiency of laser location (more than 200 thousand pulses/measurements per second) in combination with centimeter spatial resolution of digital aerial photography, results in a highly accurate (approximately 10-15 cm) coordinate definition of trees' and tree stands' morphostructural parameters by satellite geopositioning systems. These technologies also allow three-dimensional visualization of remote sensing data in geoinformation systems, which can be used to develop effective algorithms for the research of forest resource structure and dynamics, and guarantee a real-time automatic extraction of forest inventory parameters. The development and application of such high-end technologies for aerospace forest monitoring is critical and essential for the boreal zone, in particular, for vast regions of Siberia, where current methods of forest inventory are not effective, are highly time and funds consuming and do not provide the required accuracy.

**Keywords:** Airborne lidar technology, Digital aerial photography, Satellite geopositioning, Stand structure mapping, Siberia

## Conservation of Sub-Tropical Grasslands in the Eastern Himalaya: A Landscape Level Approach

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The matrix of riverine grasslands and grassland-forest mosaics in the Ganges and Brahmaputra river valleys, in the eastern Himalayan foothills, are some of world's tallest and most productive (Lehmkuhl, 1994). These tall grassland forest mosaics are the last remaining examples of subtropical tall grasslands in the Indian subcontinent and contain some of the highest densities of tigers, rhinos, and ungulates in Asia (Lehmkuhl, 1994). These grassland mosaics are maintained by a suite of disturbance processes including flooding, fire and grazing. Manas National Park, a world heritage site and a tiger reserve with an area of 519 sq. km, is situated in the North bank landscape of Assam. A socio-political change in the North bank landscape led to a disruption in management practices in the Park (Sarma *et al.*, 2008). These changes lasted over 15 years and as a result, fire regimes and grazing practices were affected. Wild populations of herbivores and carnivores suffered huge declines due to a lack of protection. Coupled with changes in river flow, these changes have led to significant alterations in the grassland community at both a local and regional level. Recent observations have shown an increase in the spread of species that are dominant in drier ecosystems, as well as the presence of tree species in areas previously occupied by grasslands. Therefore, this suggests that savanna grasslands are changing into woodlands. This dynamism is probably driven by the interacting effects of environmental variation, changing management regimes, human interactions and ecosystem feedbacks. The system probably experiences fluctuating species composition and wide variation in population dynamics of plant species, however, none of this has been clearly documented.

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### **The Influence of Garden Design on Plant Diversity Patterns along a Socioeconomic Gradient in Northern South Africa**

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In contrast to the main focus of studies in developed countries, home garden research and development in developing countries over the last three decades has been aimed primarily at either ethnobotanical documentation of the diversity and uses of garden species, or the promotion of home gardening for nutritional improvement of low-income groups (Trinh *et al.*, 2003). Between 2007 and 2010 several home garden projects have been and are still being conducted by the Urban Ecology Research Group at the North-West University. The overall objective of these studies was to develop a better understanding of the plant diversity of homegardens, their structure and function in a city, town, rural settlement and deep-rural area.

The current study aims to compare garden design (traditional European approach versus a

specific ethnical approach, e.g. “tshimos”) and plant diversity with the mentioned home garden studies along a socioeconomic gradient. Socio-economic status is determined using variables such as monthly income, income generation, total number of residents per house, modes of transport and schooling status (Hope *et al.*, 2003). The degree of urbanisation surrounding the home gardens is also important and was quantified using fourteen demographic, physical and landscape metrics measures (Du Toit and Cilliers, 2011). The completed and ongoing studies provide a large dataset of home garden flora and the socioeconomic aspects of the rural, peri-urban and urban environments. Results have indicated correlations between species diversity (total, native, alien, medicinal, ornamental, vegetable, fruit trees), type of garden design, socioeconomic status and degree of urbanisation.

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## Identification of Suitable Habitat-Patches and Corridors: An Operational Tool for Habitat Planning and Conservation

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Landscape connectivity is considered a key issue for biodiversity conservation and for the maintenance of natural ecosystem stability and integrity. Many species refrain from moving between small, scattered patches of different resources and instead prefer to remain in one large patch. In this sense, habitat fragmentation constitutes the main driver of gene flow reduction. Maintaining or restoring landscape connectivity has become a major concern in conservation biology and land planning, for amphibians in particular. Indeed, the amphibian life cycle involves seasonal migration between terrestrial and aquatic habitats, which constrains them if they need to regularly cross an inhospitable fragmented landscape matrix. Thus amphibians become more vulnerable to land degradation and connectivity loss. Faced with the growing need for maintaining connectivity within patches relevant to amphibian spatial requirements, the aim of this study was to provide a method based on habitat suitability modelling and graph theory approaches to explore and analyse ecological networks.

The study focussed on habitat availability and landscape connectivity (Urban and Keitt 2001, Pascual-Hortal and Saura 2006) under the basis that connectivity is species specific and

should be measured from a functional perspective. The focus was on viable habitat patches, in relation to the ongoing need for large landscape connectivity. The planning for amphibian conservation and distribution patterns of the common frog was assessed. Maximum entropy modelling with environmental variables, based on forest patch distribution to predict suitable habitat patch distribution, was first used. In combination with considerations regarding landscape permeability, graph theory was applied through the use of Conefor Sensinode 2.2 and Guidos software (Saura and Torné 2009) in order to highlight the main habitat patches influencing habitat availability and connectivity.

Graph theory and network analysis have been established as promising ways to efficiently explore and analyse landscape or habitat connectivity. However, little attention has been paid to making these graph-theoretical approaches operational within landscape ecological assessments, planning and design. Work has been undertaken within a framework approach, in tandem with genetic considerations, to provide an operational tool for the identification of the effects of “landscape barriers and corridors” on the populations structure of the common frog and its terrestrial habitat requirements. Results show that this method appears to be a promising tool for landscape planning.

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## Effects of Spatial Disturbance on Forest Carbon Storage under Climate Change

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Climate change is a great challenge faced by humans. Forest carbon storage as an important part of the global carbon cycle is very useful for mitigating climate change. The objective of this study was to examine the effect of different factors on forest carbon storage. LANDIS software (a spatially explicit forest landscape model) was chosen for this study. LANDIS 7.0 PRO, the latest version of LANDIS, is able to simulate dynamics of forest carbon storage. A factorial experiment was designed to test the effects of climate, fire and timber harvesting. Three variables were combined to form 16 different scenarios. Climate change data was obtained from the modeling results of CGCM3 (coupled general circulation model). Fire and harvesting scenarios were based on the records obtained from local forestry administration. A simulation time scale of 300 years and a time step of 10 years was used for each scenario. ANOVA was used to test for significant differences between the 16 scenarios for 48

dependent variables (total carbon storage of all tree species and carbon storage of each species for each land type) using sample data chosen from 10, 20, 30 and 300 year time scales. The study site was located in Xiao Xing'an Mountain, the transitional zone from the temperate zone to the cold temperate zone, which is considered sensitive to climate change. In addition, this area is one of the most important bases of timber production in the region. It was therefore considered a suitable area to research the response of forest carbon storage to climate change and anthropogenic interference.

| Scenario number | Climate change            | Fire             | Timber harvesting |
|-----------------|---------------------------|------------------|-------------------|
| 1               | ModerateCGCM <sub>3</sub> | Fire suppression | harvesting        |
| 2               | Lower CGCM <sub>3</sub>   | Fire suppression | harvesting        |
| 3               | Higher CGCM <sub>3</sub>  | Fire suppression | harvesting        |
| 4               | Current climate           | Fire suppression | harvesting        |
| 5               | ModerateCGCM <sub>3</sub> | No               | No                |
| 6               | Lower CGCM <sub>3</sub>   | No               | No                |
| 7               | Higher CGCM <sub>3</sub>  | No               | No                |
| 8               | Current climate           | No               | No                |
| 9               | ModerateCGCM <sub>3</sub> | No               | harvesting        |
| 10              | Lower CGCM <sub>3</sub>   | No               | harvesting        |
| 11              | Higher CGCM <sub>3</sub>  | No               | harvesting        |
| 12              | Current climate           | No               | harvesting        |
| 13              | ModerateCGCM <sub>3</sub> | Fire suppression | No                |
| 14              | Lower CGCM <sub>3</sub>   | Fire suppression | No                |
| 15              | Higher CGCM <sub>3</sub>  | Fire suppression | No                |
| 16              | Current climate           | Fire suppression | No                |

## Landscape Constraints on the Distribution and Evolution of Civilization

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Ecological civilization is a popular ethos and has become a widespread discussion in both public society and the current academic community in China, similar to those had during the industrialization process in western countries in the 20th century. However, the nature and content of the concept and its relationship with other previous forms of civilization is quite controversial. The role of landscape in the development of and interaction between different civilizations is also a highly debated issue.

Based on a retrospective analysis of the concept of human-nature relationship over past centuries, this study attempts to link the development of civilization from original, to agricultural, industrial and post-industrial forms, with the spatial changes of civilizations from hill to piedmont, alluvial plain and sea shore areas, as well as the residential area transformation from natural habitat, to village and town, city and the recent trend of suburbanisation. The principal requirements of landscape features in successive stages of civilization were explored, as well as their effects on landscape structure. The constraints of

the spatial, biotic and abiotic characteristics of landscape on various forms of civilization were assessed. Economic, social and environmental aspects were considered and the driving forces of interaction between civilization evolution and landscape structure was discussed.

This paper summarises the necessary components of ecological civilization and suggests a framework for estimating ecological landscapes, as well as a conceptual landscape model for ecological civilization.

**Keywords:** Ecological civilization, Landscape characteristics, Civilization migration, Spatial pattern, Landscape constraint, Evolution, Scale

### **Selection of Distance Thresholds to Maintain Landscape Connectivity in the Shangyong Section of Xishuangbanna Nature Reserve, China**

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The loss of connectivity of forests has become a major threat for the conservation of biodiversity and wildlife migration. Based on vegetation data collected from the Xishuangbanna Nature Reserve in 2000 and Conefor Sensinode 2.2 software, the forest connectivity of the Shangyong section of Xishuangbanna Nature Reserve was analysed. Expected habitat availability and the potential migration patterns of Asian elephants were evaluated for four distance thresholds (800 m, 1,000 m, 2,000 m, 4,000 m, 8,000 m and 12,000 m), which were selected to compute forest patch value. The following four indices were chosen to analyse the distance thresholds in the Shangyong section of the forest reserve: number of components (NC), class coincidence probability (CCP), integral index of connectivity (IIC) and the probability of connectivity (PC). The results indicated that the NC value decreased but that the CCP, IIC, PC value increased between 800 m to 12,000 m. After comparing forest patch value for different distance thresholds, it was found that 2,000 m is the most appropriate distance threshold to ensure connectivity in the Shangyong reserve. These results show that distance thresholds should increase or decrease according to the extent of existing forest landscape connectivity and the different demands for animal or plant species.

**Keywords:** Landscape connectivity, Distance thresholds, Shangyong reserve, Important value index

### **Ecosystem Functions and REDD+; How and Where It Matters?**

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Climate change mitigation actions, particularly REDD+, are believed to have high potential for generating multiple benefits towards conserving and improving ecosystem functions such as biodiversity maintenance. However, this potential can only be realised at the aggregate level if the REDD+ program is explicitly designed to achieve these multiple goals. This is because local level outcomes can vary between negative, neutral and positive co-variation within ecosystem functions.

The high emissions generated in Indonesia in the land-based sector due to deforestation, forest degradation and peat-land draining and burning, has been one of the major points of international discussions on REDD+. Recognising its potential to contribute to climate change mitigation, the Indonesian government has made a commitment to significantly reducing emissions by 2020 through REDD+ as the primary mode of achieving this commitment.

This study was designed to explore where and under which conditions REDD+ implementation in Indonesia can automatically produce multiple benefits, or whether its implementation is neutral or harmful to other ecological functions at the landscape level. Land use/cover-dependent ecological function that is of importance to biodiversity maintenance at the landscape level is the major focus of the study.

Empirical findings suggest that agroforestry systems, as well as natural forests, can play an important role in maintaining biodiversity as habitat at the plot level and as corridors between core habitats. Furthermore, it was found that carbon stocks in some agroforestry system are comparable to forest plantations. These findings suggest that because of the dichotomy between forest and non-forest systems, the landscape level is not the best scale at which to represent and capture ecological functions. Land cover maps produced from medium resolution satellite images were used to recognise varying ecological roles. Tree cover was mapped in addition to forest cover and multi-species tree cover was differentiated from mono-species tree cover.

Emissions were estimated using a stock change approach; activity data was derived from land use/cover change analysis and carbon density was extracted from previous studies. Losses in ecological functions were quantified from core area loss and reduced connectivity in specific ecoregions. Spatial incompatibility between emissions and loss of ecological functions were identified in 38 ecoregions across Indonesia. Ecoregion-specific threats to ecosystem functions and the potential and prioritisation of single or bundled interventions were identified. Analysis was undertaken to predict future emissions and ecological function loss through modeling of land use change under different scenarios in two selected landscapes, in Sumatra and Papua. Current spatial maps and historical land use changes were used to predict business-as-usual land use changes and estimate emissions and ecological function loss associated with the land use changes. Revised spatial maps were used to model two land use planning REDD+ scenarios: (i) from a project and sector approach and; (ii) from a multifunctional landscape approach. Ecosystem functions predicted from projected land use changes were compared across different scenarios.



# Impacts of Human Activity on Landscape Heterogeneity of Mountainous Regions: A Case Study in the Upper Reaches of the Yihe River, Yiluo River Basin

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The impacts of human activity on landscape heterogeneity were investigated in the upper reaches of the Yihe River, the Yiluo River basin, where continued agricultural expansion into the remaining natural forests has become a major concern. Combining field investigations and remote sensing data, geographic information system techniques were used to analyse landscape dynamics since the 1980s. Results showed that woodland was the dominant landscape type. During the period of study, woodland, pond, and built-up landscape types had expanded in area, while grassland, riverine, and fallow field landscape types had declined. The area of arable land first increased between 1987 and 1999 and then declined between 1999 and 2008. The forest landscape had the largest Aggregation Index (*AI*) (Figure 1). Aggregation Indices of the Forest and Grassland landscape types increased, while Landscape Shape Indexes (*LSI*) and Perimeters—Area Fractal Dimension Indexes (*PAFRAC*) of these landscape types decreased. Alpine agriculture and built-up landscape types showed scattered distributions, presenting relatively high Landscape Shape Index (*LSI*) and Landscape Patch density (*PD*) values. Landscape Shape Index (*LSI*) values of cultivated land increased in the 1987-1999 period, then declined. Landscape dynamics were largely explained by terrain factors (elevation). Between 1987 and 2008, both deforestation and reforestation occurred predominantly in elevational bands below 1000 m ASL. At elevations above 900 m ASL, landscape types remained largely unchanged throughout the period under study. The grasslands showed similar dynamics to that of the forests.

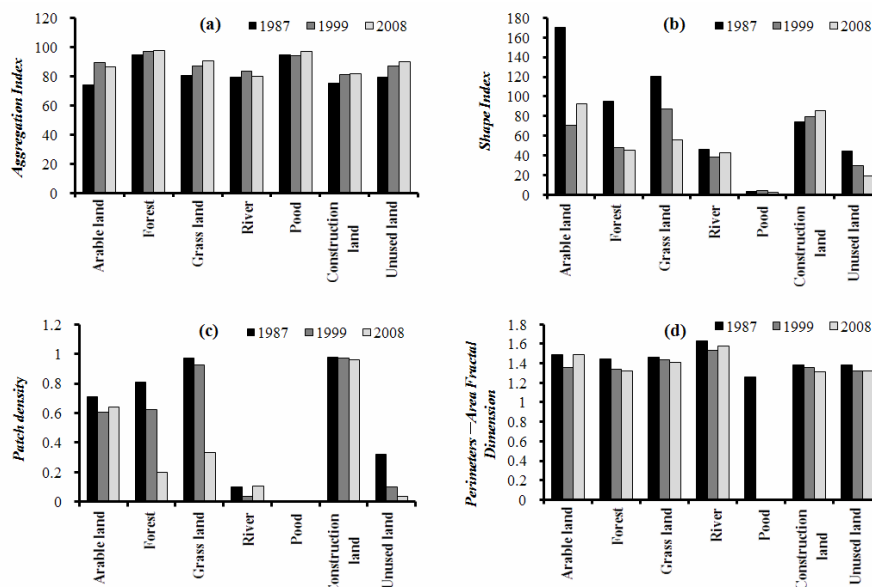


Fig. 1 Changes of the landscape metrics

## **Abundance of Parasitic Plants and Possible Influence on Urban Bird Population in The Megacity of Sao Paulo, Brazil**

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Mistletoes are a diverse group of parasitic plants found worldwide and infest many tree species. The majority of them are capable of photosynthesis but dependent on their host for water. Moreover, the mutualistic relation of these plants with birds is well known (who eat and disperse the seeds). Loranthaceae, the biggest family of mistletoes, has a tropical and subtropical distribution. *Struthantus vulgaris*, one of its genera, has a broad distribution occurring in South and Southeast of Brazil. Our goal was to investigate the abundance of *S. vulgaris* in urban trees growing in the campus of University of Sao Paulo, Brazil. We analyzed 700 trees in regards to: tree species, presence or absence of the hemiparasite and when present, the number of individuals per host. We identified 57 different tree species growing in the campus, but only 8 of them were infested by *S. vulgaris*. In total, 13% of the trees in the campus were infested. *Tipuana tipu* had the highest infection rate by the mistletoe (30%). More specifically, from the 198 individuals of *S. vulgaris* found on the campus, 168 of them were growing on *T. tipu*. This represents 84% of the mistletoe's population. *T. tipu* is originally from Bolivia and North of Argentine and was introduced in Brazil for urban arborization. This specie has samara fruits witch are not eatable by the birds. However, as this tree specie is the host of a huge population of parasites it has become a "source" of food for the bird population. We conclude that *S. vulgaris* is able to infest many tree species in an urban environment, which are mainly exotic species. One possible explanation is that they did not coevolved with the mistletoes, so they might not have any mechanism of defense against the parasite, making its infestation easier. Despite the fact that this hemiparasite decreases the fitness of their hosts, it might be very likely that these parasitic plants have a positive influence on the bird populations. Moreover, we suggest that future studies should consider mistletoes in the analyses of bird diversity in urban areas.

## **Towards Intentional Changes of Landscape Patterns in Intensive Agricultural Areas: The Case of Les Maskoutains (Quebec, Canada.)**

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The transformation of intensive agricultural zones has greatly affected the ecological, cultural and social functions of landscape. We are challenged today at maintaining their ecological and

social viability by reintroducing their multifunctional character. It is in this context that a group of mayors from municipalities representative of intensive agricultural zones in Quebec (Canada) have launched, in close partnership with a team of researchers, an effort to highlight the value and re-qualify landscape. This approach is aiming some intentional changes on the landscape patterns and, in doing so, is participating in one of today's main challenges in landscape ecology which is to extend the landscape ecology paradigm to include design (Nassauer and Opdam, 2008). It recognizes the necessity, to achieve this goal, for a close collaboration between scientists, planners, administrators and local stakeholders (Bohnet 2010). More specifically, it recognizes the need to establish a framework for reintroducing the multifunctional character of landscape by successively establishing: i) an assessment of landscapes capable of insuring shared knowledge of their ecological and sociocultural characteristics; ii) the identification and the public acceptance of the stakes of landscape and, iii) the elaboration of prospective scenarios enabling the emergence of a common view on the future of landscape. Once having established the project's context and procedure, this paper introduces the original approach that has been developed to landscape diagnosis and its resulting outcome. Supported by a holistic landscape concept (Tress and Tress, 2001; Ruiz and Domon, 2005), the approach stands on four dimensions: environmental (physical bases, biodiversity); evolutionary (the evolution of landscape patterns at various scales of perception); visual (elements of visual interest from an esthetic, historical and environmental point-of-view) and sociocultural (the perceptions and values of individuals). It thus contributes to the urgent development of tools needed for the consideration and integration of social and ecological knowledge.

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## **Ecological Logic of Clichy Batignolles Martin-Luther-King Park Compared to Olympic Park in Beijing**

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Clichy Batignolles Martin Luther King Park is in center of the BIA Clichy Batignolles, north-west of Paris, and now covers 4.3 ha. This park offers interesting aquatic environments: a wet ditch with plants, which can collect rain water to satisfy the water use of the park for 10 months per year; and a biotope pond of 3000 m<sup>2</sup> that is alimeted by reclaimed water and rain

water, self purified by specific plants.

This study attempts to highlight the logic of this ecological park by explaining the essential function of its hydraulic system. Landscape management of the water cycle used in this park is analysed. Different water functions in this park are also assessed: landscape, ecological and recreational (instead of water jets). The interaction between environment and artificial hydraulic installations are also high-lighted. For example, the principle and value of system recovery and rainwater recycling is compared with systems in Olympic Park in Beijing, which contains a wide dragon-shaped lake, conceived and constructed according to the traditional Chinese garden form.

This study contributes to the identification and explanation of common ecological ideas in both the current French and Chinese landscape design. The interaction and influence of both French and Chinese hydraulic techniques, from the time of the Garden of Versailles and the Summer Palace, were investigated through field work and further explorations of historical sources at the Garden of Versailles and Summer Palace.

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## **Linear Man-made Structures, Hydroscape Domestication and Ecological Consequences**

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A hydroscape refers to a landscape where water covers a large number of patches or large areas for long time periods. In a hydroscape water often plays a defining role in the formation of spatial patterns and the configuration of spatial processes. Levees, canals and roads are man-made linear structures. These structures are major stressors of hydroscares. This presentation reviews the general effects of these linear structures on ecological systems and the mechanisms that generate these effects.

Firstly, levees, canals, and roads interrupt natural physical and biogeochemical processes and fragment hydroscares. The most conspicuous impacts are exhibited in hydrologic changes, changes in the distribution and timing of presence, depth and flow of water. The hydrologic changes alter the state of physical conditions, chemistry, dissolved matters and sediments in water. Consequently, the physical regime at each location shifts, the geomorphic configurations of hydroscape mutate and the spatial-temporal characteristics, movements, and fates of the particles, chemicals and organisms change. The previously continuous patterns in hydroscares are punctuated by these structures.

Secondly, the physical and biogeochemical alterations influence populations and communities, and change the ecosystem functions of each hydroscape. This is because of: a) blockage of the movement and dispersal of organisms; b) creation of new habitats; c) creation of travel lanes, particularly for exotic species; d) edge effects; and e) alteration of ecological and hydrologic connectivity. These influences alter spatial compositions, temporal patterns and spatial processes of meta-populations, meta-communities and ecosystems. They lead to the decline and extinction of endemic populations, invasion of exotic populations, distortion of critical links in natural food webs, decreases in native biodiversity, degradation of ecosystem functions and loss of ecosystem services.

Thirdly, levees, canals and roads facilitate landscape domestication and increase human activities, including: alternation of land cover, agriculture, industrialisation and urbanisation. These activities generate severe environmental impacts including pollution, biodiversity loss and reduction of ecosystem services. Overall, the most significant impacts of hydroscape domestication are probably caused by the indirect effects of increased human social-economic activities.

## **Analysis of Land Use Scenarios for Urban Sustainable Development: A Case Study in Lijiang City**

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A scientific approach to urban planning is required to ensure environmental protection and ecological safety. This paper presents a range of urban land use scenarios and their implications for urban development and economic demand in the Old Town of Lijiang. Using

GIS and questionnaire analysis, three future urban planning scenarios were created based on data and storylines for the Lijiang region. In each scenario urban growth is found to occur due to population increases resulting from tourism and economic change. However, spatial patterns were found to differ due to varying assumptions regarding urban development processes or purposes. Modeling results successfully illustrate a range of possible land use scenarios for the future and provide useful inputs for starting discussions on future urban development planning. Urban planners could directly use spatial analysis results to optimise urban zoning. Information resulting from this project may also help the public to achieve better understanding of environmental pressures and problems faced by certain communities, thereby, helping them to rationally choose the best place for future settlement.

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## Comparative Analysis of Watershed Ecosystem Functions under Different Management Authorities

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Participation and cooperation of scientists, social economists, the public and the government is the key to effective natural resource management when considering the integration of ecosystems. In this paper, a comparative analysis approach was used to study the Lugu Lake watershed ecosystem, which is a trans-boundary lake located in both Sichuan and Yunnan provinces, in south-west China. The differences in management methods, environmental condition, social systems and economic systems were compared first between the Lugu Lake watershed ecosystem in Sichuan area of the watershed and in the Yunnan area of the watershed, at various scales. To compare their watershed ecosystem functions, a key environmental elements index system was created and forest stand structure, vegetation index and agricultural production were calculated in both the Sichuan and Yunnan areas of the watershed. The driving force for the Lugu Lake ecosystem function was analysed and countermeasures for trans-boundary watershed management were provided.

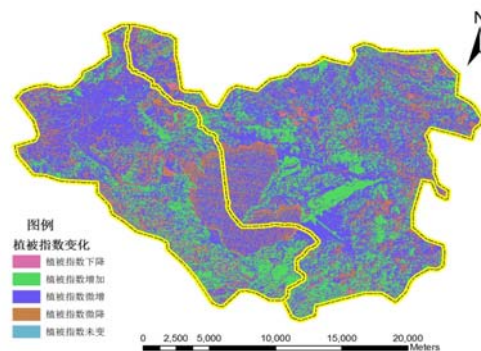
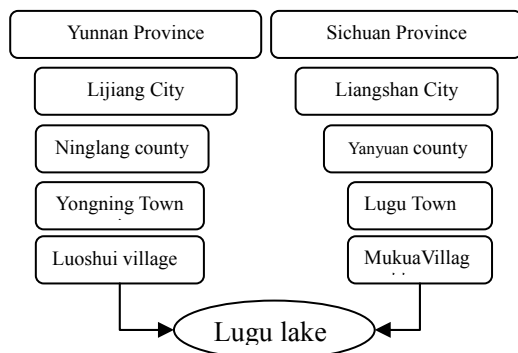


Fig.1 Ecosystem management of Lugu Lake at various levels Fig.2 The NDVI change of Lugu Lake on the boundary of two provinces

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## Minimum Construction of Water Ecological Landscape Elements in Shanghai EXPO, Houtan Park

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Houtan Park covers a total area of 14.2 ha in the south-west of the EXPO site in Pudong district, next to the Huangpu River. Houtan Park is a natural sediment area linked to and affected by the Huangpu River. The environment and landscape of the original site was seriously polluted. According to the EXPO master plan, the theory of water and landscape ecology were used as guidance and the hierarchical cluster analysis method and coalesced multidisciplinary and technology integration systems were used to ensure the health water ecosystem. Minimal landscaping in Houtan Park was achieved by maximising the water recycling capacity of the park with the smallest possible landscape design.

The waterfront landscape design included water bodies, water and land border definition, as well as identification of ecological landscape stereoscopic patterns. These design elements were used to restore the regenerative processes of the degraded landscape, propose integrative technology systems consisting of the protection of aquatic ecosystems, achieve ecological restoration, water purification, rainwater utilisation, flood protection and aquatic

landscape construction. Sequential ecosystem landscapes of "deep water - shallow water - waterfront - land" were formed and the function of aquatic landscapes were realised by constructing sequential waterfront plant landscapes with ornamental plants, selected for individual community characteristics and ecological function.

Polluted water was recycled and restored to a quality suitable for local conditions, and infrastructure for ecological restoration, ecological flood production and biological manipulation was improved. The living environment, ecological niche and the interrelationship of the aquatic organisms were considered. The effects of the intertidal ecotone were considered and the plant configuration in the vegetation buffer zone were improved. Native organisms were chosen to establish a steady, efficient and spontaneous connection with their environment, to accelerate water material flow, energy flow and information flow in the aquatic system. Thus allowing the reestablishment of the water recycling capacity of the system and improve water quality.

36,000 m<sup>3</sup> of water in Houtan Park was restored and the self-purification capacity of the water was reestablished through the construction of a sustainable water ecological purification system. Water purified through this system was improved from a class V - inferior class V standard of water flowing in Huangpu River to a National Surface Water class III - class II standard. The water improved in this system could provide 2,400 m<sup>3</sup> of ecological fresh water for EXPO. A long-term effective administrative system, biological dynamic monitoring model and a warning system were established to improve the stability of the aquatic system through a staged process defined as follows: "ecological evaluation stage - locality analysis stage - biochemical analysis stage - achievement feedback stage".

The minimal water environment restoration of Houtan Park was realised through the reasonable configuration of water ecological landscape elements and the establishment of a healthy ecological water purification system. The system was designed to ensure that the long-term, stable and efficient water self-purification and recycling processes could be achieved to realise the sustainability of Houtan Park aquatic ecosystems.

## **A Comparison Study of Lake Carbon Flux in Summer and Autumn at the Northern Grass-type Lake-Baiyangdian**

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The lake carbon cycle is an important part of regional carbon cycle research. Lake ecosystems are an important carbon sink and they absorb masses of carbon dioxide through photosynthesis through the transformation of carbon dioxide to organic carbon. Lake traits therefore include abundant carbon reserves and high carbon density. Lakes play a significant role in the carbon cycle, particularly because of their geographical location and high-end productivity. There is now a clear acceptance of the greenhouse effect, especially because of the qualitative and quantitative understanding of the primary ocean carbon cycle. However, little research has been done on the lake carbon cycle and associated carbon flux. There are many lakes in China, so it is crucial to study the lake carbon cycle. In this paper, the improved Static Chamber and Li8100 used to monitor silo Carbon Flux are introduced. Through



continuous monitoring of the northern Grass-type Lake-Baiyangdian in July, August and September 2010, the following conclusions were reached regarding lake Carbon Flux : the day-variation of Carbon Flux changed significantly and varied with time and temperature; the greatest Carbon Flux was consistently observed at the highest temperatures; the day-variation of Carbon Flux remained consistent over the three months of monitoring (except for outlier days), however, Carbon Flux decreased overall from July to September; and the day-variation of Carbon-Flux between swamp and non-swamp regions was similar, however, the Carbon Flux of swamp regions was found to be significant lower than of non-swamp regions.

## **Designing Water Quality and Wildlife Functions into Local U.S. Agricultural Landscapes**

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Water pollution and unacceptably low wildlife populations in U.S. agricultural regions has spurred efforts to restore water quality and wildlife functions into agricultural landscapes. These issues have emerged largely as a consequence of intensifying land use for a single ecosystem service – food crop production. Success will depend on our ability to improve both water quality and wildlife populations with minimum negative effect on crop production. A common guiding principle for attaining this goal is to restore riparian corridors to natural vegetation (FISRWG, 1998). While this general principle is suitable for broad scale assessment and planning, attainment of a multi-function goal requires more-detailed attention to varied local circumstances which can render general prescriptions prone to yielding uncertain results.

Specific characteristics of local water and wildlife issues will dictate how each local landscape must be designed (e.g., Bentrup, 2008; ELI, 2003). For wildlife, it must be determined which species are of particular concern. The results will lead to a cascade of specific habitat requirements that help to determine better locations, size, kind of vegetation, and management that will produce desired results. For water quality, the particular pollutants of concern must be identified, along with their sources and pathways of transport to waterways, in order to develop specific design criteria for mitigating these problems effectively and efficiently. Compromises in design may be needed to achieve both water and wildlife goals on the same site. Unique opportunities for synergy with adjacent crop fields may present themselves at local scales. While general principles are easy to apply and sufficient for large-scale assessments, their true impact will depend on how they are applied at local scale. Increasingly, more efficient designs and greater certainty of results are desired which will require quantitative tools and greater attention to details.

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## **Landscape Multi-functionality: Concepts and Design Challenges**

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The concept of multi-functionality is gaining attention within landscape ecology and it is often viewed as a prerequisite for sustainable land use. A conceptual framework is useful for clarifying what multi-functionality is, what its benefits are, and to identify the challenges of advancing its science and application. The Millennium Ecosystem Assessment (MEA, 2005) set forth an anthropocentric framework whereby ecological functions are manipulated to promote human benefits. From this perspective, landscape multi-functionality is viewed as a landscape that provides multiple ecosystem services such as producing food and materials, providing aesthetic qualities, and promoting social cohesion. Increasing demands of growing human populations are driving the need to attain more and greater benefits from local landscapes.

There are three general approaches to enhancing multi-functionality in a landscape: 1) attaining different functions from separate land units, 2) attaining different functions on the same land unit, but at different times, and 3) attaining different functions on the same land unit at the same time (Brandt and Vejre, 2004). While the first type has received the most attention by ecologists in recent years, there is growing need to consider ways for designing each land unit to enhance multiple ecosystem services, either simultaneously or successively over time. The challenges of enhancing landscape multi-functionality revolve around its greater complexity (de Groot et al., 2010). Multiple benefits and their related ecological functions are considered simultaneously. Greater success is attained by recognizing and capitalizing on ecological interactions and synergies and by identifying and minimizing conflicts and tradeoffs. Improved techniques are needed for assessing existing ecosystem services and their values as well as ecosystem capabilities for providing them. Scientific information is needed that quantitatively link manipulations of landscape structure to change in ecosystem services. Finally, systematic methods are required to effectively process large amounts of information and to distill it into a design for attaining multiple ecosystem services from each land unit.

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## **A Quantitative and Distance-decay Ecosystem Service Value Assessment of Land Use Change in the Pearl River Delta Region**

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The Pearl River Delta Region is one of the most urbanised areas in China, where dramatic land use change has resulted in significant effects on regional ecosystem structure, patterns and service. This paper presents a spatially explicit and quantitative ecosystem service assessing model. The change of ecosystem service value caused by land use change has also been evaluated for the period 1985 to 2005. Ecosystem service assessment indicators were established considering major human demands. A distance-decay function for ecosystem service assessment was then adopted considering human willingness to pay for services. The change in three types of ecosystem service values, including material service, ecological security maintenance and the service relating to landscape and culture was assessed. These were represented by indicators such food production, O<sub>2</sub> maintenance and leisure tourism and were assessed based on land use change data of the Pearl River Delta Region from 1985 to 2005. The result showed that regional ecosystem service value increased from 24.7 billion yuan in 1985 to 27.1 billion yuan in 2005, in which leisure tourism value contributed the fastest increasing rate. Moreover, the correlation between land use intensity and ecosystem service value (both non-distance-decay and distance-decay) was significant when assessed using Pearson factor analysis.

**Keywords:** Land use change, Ecosystem service value, Pearl River Delta Region; distance-decay function

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## **Numerical Simulation of Hydrology, Critical Fauna Highly Dependent on Hydrologic Conditions, and Human Induced Alterations to Hydrology and Species Population Density and Distribution**

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Many non-aquatic species of fauna have a strong dependency on hydrologic conditions for survival. These species are adapted to very specific hydrologic conditions that offers them advantages in shelter, breeding, or foraging, and specialization makes them very susceptible to alterations in the hydrologic conditions. Humans have altered the environment like no other species that has ever existed. Such activities as building roads, canals, levees, and reservoirs have a direct effect on hydrology. Secondary activities, such as changing the landscape for agriculture and urbanization, also have a pronounced effect on the hydrology. At another level, man's activities are thought to be producing potential changes to the overall and local climates. This too can have a pronounced effect on the local hydrology that these species depend upon. In order to better understand the hydrology, the effects of human influence on hydrology, and the species response to both, numerical simulation models are often employed. In this presentation, we will discuss several species that are highly dependent on specific hydrologic conditions for breeding and foraging, including: rosette spoonbill, wood stork, American alligator, striped newt, Flatwoods salamander, and indigo snake. In each case, the spatial-temporal patterns of the species is being affected or potentially affected by human activities via hydrology. Integrated numerical hydrologic models and biological models are being used to examine the link among hydrology, human influences, and the population of above mentioned species. We will focus on the hydrologic needs of each species, the hydrologic and biologic processes involved, issues related to this integrative modeling approach, modeling results, and management actions.

## **An Application of Gradient Analysis and the Markov - Cellular Automata Model in Predicting Landscape Change of Tien Lang Coastal District, Vietnam**

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Vietnamese coastal zones have favorable conditions for mangrove development. These include estuaries and inlets along a coastline of approximately 3,260 km in length, large river systems rich in alluvia and a tropical seasonal climate. However, many mangrove areas have been destroyed due to aquaculture practices during recent years. This has resulted in adverse effects on ecological services provided for both the local community and ecosystem function.

This study is therefore aimed at improving the understanding of landscape patterns and land use change, as well as natural and socio-economic factors controlling land use change in a specific area of the Vietnam coastal zone. The first task of the study was to integrate a gradient analysis with satellite image processing from the Doimoi (Renovation) period (1986) to the current day, in order to improve understanding of spatial pattern dynamics of the Tien Lang District, is a specific urbanised area in Vietnam. A model applying a stochastic modeling technique in remote sensing, geographical information systems (GIS), Markov chain analysis and cellular automata, was then used to simulate land cover change in the case study area over a specific period. The steps were as follows: (1) Pairs of land cover maps (1992 Spot-2 and 2008 Spot-5 images) were analysed using Markov Chain Analysis to present a transition probability matrix, a transition area matrix and a set of conditional probability images; (2) A contiguity filter was used to obtain a series of suitability maps already identified for each land cover class; (3) The concept of a CA filter and Markov Chain Analysis was combined to predict land cover change (until the year 2024) over the period specified in the Markov Chain Analysis. Validation was undertaken and showed that these methods improved simulations of future land cover/use. This study may be used as a reference for land use planning and decision making to move towards sustainable development.

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## **Patterns of Wet Nitrogen (N) Deposition in China and Its Contribution to N Supply in a Typical Forest**

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Increasing industrial and agricultural activity has led to rapid increases in anthropogenic reactive nitrogen emissions (especially  $\text{NH}_3$  and  $\text{NO}_x$ ) in China since the 1980s. Elevated reactive nitrogen emissions to the atmosphere have increased reactive nitrogen input to the earth's surface through wet and dry deposition. This has aroused concerns about the impacts of enhanced N deposition on the health and service of ecosystems in China. Atmospheric deposition represents an external 'new material' supply into forest ecosystems and makes a considerable contribution to the internal biogeochemical cycle of forest ecosystems. Analysing the temporal and spatial patterns of nitrogen deposition is of priority, in order to improve the assessment of environmental impacts from nitrogen deposition on a national scale. However, analysis of the patterns of nitrogen deposition and contributions to N supply in typical forest ecosystems in China is rare. A database of wet deposition observed from 1995 to 2009 was established to show the characteristics and patterns of wet nitrogen deposition in some typical forests in China, on a national scale. High rates of wet nitrogen deposition were observed in large areas, particularly in central and eastern China. Average rates of wet deposition for dissolved inorganic nitrogen (DIN),  $\text{NH}_4^+\text{-N}$  and  $\text{NO}_x\text{-N}$  were:  $17.36 \pm 10.53$ ,  $10.66 \pm 6.54$  and  $6.57 \pm 4.93$   $\text{kg N ha}^{-1}\text{yr}^{-1}$ . The average ratios of  $\text{NH}_4^+\text{-N}/\text{NO}_x\text{-N}$  in wet deposition were as high as  $1.96 \pm 1.27$   $\text{ha}^{-1}\text{yr}^{-1}$ . Average wet deposition for dissolved organic nitrogen (DON) was  $4.84 \pm 2.80$   $\text{kg N ha}^{-1}\text{yr}^{-1}$ , accounting for  $25.4 \pm 13.5$  % of the total dissolved nitrogen (TON) deposition. The N fluxes in litterfall was assumed to represent an important internal input from above ground. Measured data of litter production and N concentrations in litterfall were collected from published literatures to estimate the litterfall N fluxes in some typical forests in China. The comparison between N fluxes in atmospheric deposition and litterfall indicated that N deposition played an important role in the N supply and carbon sequestration in these forest ecosystems.

## **Changes in Landscape Patterns between 1990 and 2009 in Minqin Oasis, the Lower Reaches of the Shiyang River Basin**

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Changes in landscape patterns were reported for a 20 year period for the Minqin oasis, located in the lower reaches of the Shiyang River basin. 3S technology and landscape pattern analysis software (FRAGSTATS) were applied, based on Landsat 5 TM (1990) and Landsat 7 ETM+ (2009) remote sensing imagery. The ecological safety index at the patch level and landscape level was calculated, combining changes of various types of ecological carrying capacity. Results showed that: (1) Oasis patch number was increasing, and fragmentation and separating degree was ascending. This indicates that mutual conversion between patches was frequent and strong. (2) Landscape patterns included existing agricultural and residential areas overall, and various transformation occurred mainly in transitional areas between the oasis and desert. (3) The per capita ecological carrying capacity decreased from 1.809 gha in 1990 to 1.125gha in 2009. This demonstrated that the ecological carrying capacity decreased rapidly and the carrying capacity of different types of landscape varied significantly, in

relation to the influence that human activity exerted on landscape patches. (4) The threat of desertification and salinisation was increasing and the number of affected patches was also increasing, representing the vulnerability and instability of the ecological environment. Therefore, to strengthen the ecology of the regional landscape, construction and integrated defense governance are considered effective measures to reduce the acceleration of landscape pattern change.

## **Challenges and Opportunities of Spatial Integration of Environmental and Social Aspects in Urban Areas: A South African Case Study**

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Anthropogenic actions substantially influence the functioning of ecosystems and are felt nowhere more intensely than in urban environments. Unfortunately, a shortage of comprehensive ecological data limits the implementation of conservation-oriented policies in urban planning and management (Cilliers et al., 2004). However, decision makers progressively place pressure on scientists to provide instant answers to environmental problems. Researchers are therefore increasingly reliant on existing information to supplement detailed time consuming investigations. Several versions of conceptual models exist elaborating on the complex interactions and processes operating in urban ecosystems, each representing, incorporating and emphasizing different aspects of human impacts on ecosystems (e.g. Pickett et al., 1997; Alberti et al., 2003; Tzoulas et al., 2007). Application of well constructed frameworks can elucidate the underlying processes that drive urban land-use dynamics, aiding in answering pressing questions and assisting in better management of urban areas. Successfully linking social and natural systems in a practically applicable way may also convince decision makers to pay attention, thereby advancing towards sustainable solutions in urban environments.

The current study evaluates all urban ecological research conducted in Potchefstroom, South Africa, and its immediate surroundings during the past decade to identify possible gaps in the gained knowledge, in particular the scale dependent relationships between processes and observable patterns in biodiversity, land use and land cover. The focal level of interest is the landscape; however, the respective studies are temporally and spatially heterogenous. Specific scaling methods will therefore be investigated in an effort to relate the different hierarchical scales of observation to the scale of analysis (Wu & David, 2002). The main challenge will be to develop a suitable comprehensive framework with which to sensibly integrate existing ecological data that can serve as the basis for future detailed applications on multiple focal levels. Several factors inhibit the usefulness of existing data such as the data heterogeneity, and especially, the limited time frame of most of the completed studies, influencing the reliability of the research outcomes. A distinctive urban spatial organisational legacy, evident through specific population density distributions, allows research in a unique setting on the dynamics of urban environmental interactions in South Africa.

## **The Diversity of Geometrid Moths (Lepidoptera: Geometridae) in Different Habitats in an Agricultural Landscape, Bashing Plateau**

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Intensifying agricultural practices and land degradation are the main causes for a widespread decline in biodiversity. Habitat restoration through afforestation has been proposed as an important measure for biodiversity conservation. Natural conditions, including landform, climate and vegetation, vary over short distances in the Bashang region, which results in a high level of species diversity and turnover. It is one of the most vulnerable ecotones in northern China. In previous centuries, Bashang region has experienced profound degradation and has even been the source of ecological disasters such as dust storms in neighbouring regions, due to overgrazing and land reclamation. Therefore, many national and regional eco-restoration engineering projects, such as the construction of the Sanbei shelter forest system and the Beijing-Tianjin Sand Source Control Engineering project, have been launched since the 1980s to prevent land degradation in the region. In this study, geometrid moths were sampled through the use of light traps in both cultivated fields and reforested semi-natural land at three villages of different altitude. Geometrid moth sampling was undertaken to answer the following questions: 1) Do restored semi-natural habitats harbor significantly more diverse geometrid moths assemblages than intensively managed cultivated fields? 2) Does landscape heterogeneity induced by elevation change still impact on biodiversity in a human-dominated landscape?

The results showed that there were no significant differences in both Fisher's Alpha and Rarefied number of species of geometrid moth assemblages found in all sampled cultivated land and restored semi-natural habitat, or between farmland and restored semi-natural habitat, at each village. However, non-linear multidimensional scaling (NMDS) showed that the community structure of geometrid moths in both different habitats and different villages were significantly different. This indicated that landscape heterogeneity caused by elevation change significantly impacts on the structure of geometrid moths assemblages even in a human-dominated landscape. Both restored semi-habitats and cultivated fields provide essential habitats for geometrid moths assemblages, with the former serving as the source of moth species in farmlands and the latter providing additional food sources for adult moths. It was concluded that landscape mosaics with both restored semi-natural habitat and cultivated land, as well as varied topography, should be protected in the degraded human-dominated landscapes for a wider conservation range including both beta and gamma diversity. Long-term monitoring is also needed to complement the role of habitat restoration for the improvement of biodiversity in degraded human-dominated landscapes.



## **A Mensurative Experiment to Study the Effects of Landscape Heterogeneity on Biodiversity**

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Spatial heterogeneity of landscapes is a major factor for sustaining and restoring biodiversity, sometimes more important than the type of farming system in agricultural landscapes. However, landscape heterogeneity is often evaluated by calculating the proportion of habitats without accounting specifically for their spatial arrangement. It is crucial to separate the effect of habitat area from the effect of spatial organisation to determine if management efforts should focus on increasing the area of habitats, or on the design of particular habitat spatial patterns.

Semi-natural habitats were shown to play an essential role in maintaining biodiversity in agricultural landscapes. By providing a wide range of habitat types, agricultural lands can also enhance biodiversity and related ecosystem services. Diversity in cropping systems results in a heterogeneous mosaic of vegetation cover which might influence species that use crops during their life cycle, or disperse in the crop mosaic. The heterogeneity of crop mosaics has been poorly studied to our knowledge. Thus, the role of spatial arrangement of cropping systems for biodiversity remains unknown.

A mensurative experiment was designed in 2011 to analyse and separate the respective effects of the area and spatial organisation of semi-natural and cultivated habitats on plant and carabid beetle diversity. Spatial analyses of land cover were performed on a selected 20, 1 km<sup>2</sup>, landscapes distributed along a double gradient of habitat area and edge length, between semi-natural habitats and crops (spatial organisation) in Brittany, France. To evaluate gamma and beta diversity, carabid and plants surveys were performed using a stratified sampling design. In each landscape, two replicates of five habitat types (woodlot, hedgerow, permanent and temporary grassland, and wheat crop) were sampled using pitfall traps for carabid beetles and squared plots for plants. The percentage cover and spatial organisation of the different crop types were estimated to integrate the heterogeneity of the crop mosaic.

It was hypothesised that gamma diversity of carabid beetles and plants increase along both axes of the gradient. The area of semi-natural habitat, as well as edge length (which promotes exchanges between habitats), are expected to enhance carabid and plant gamma diversity. Beta diversity, which reflects differences between communities, is expected to increase with semi-natural habitat cover (appearance of less common species). However, interfaces are expected to reduce those differences and so, reduce beta diversity. Responses are likely to vary according to functional groups, in particular, “crop specialist” carabids and arable weeds.

## **Sustainable Design of Green Spaces – An Evaluation Tool**

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Aspects of sustainability are taken in consideration increasingly in urban design since Rio 1992. Reviewing the current literature of landscape design it is evident that aspects of sustainability are scarcely used here. The result of a random test of public buildings have achieved the result that the buildings are designed and constructed consequently following aspects of sustainability, while in the opposite in the design of green spaces sustainability does not matter in general.

First attempts to evaluate green spaces for sustainability were developed in Great Britain with the “Green Flag Award” (since 1996) and the United States with the “Sustainable Sites Initiative” (since 2005). But these systems are difficult and expensive in handling or do not concern all aspects of sustainability.

Against this background we are focusing on a simple evaluation tool, which is based on a set of indicators which enable a rapid evaluation of green spaces including all aspects of sustainability. The aim is to sensitize landscape architects for sustainable planning and to improve current green spaces. The indicators’ set is covering the following topics: design objective, material application, usability, welcome place, biodiversity, climate/water and energy efficiency. At this presentation we will discuss the set of indicators and present first results of its testing phase in public green spaces in Germany.

The evaluation tool might be used further for certification of green spaces and for financial incentives by the municipality to improve urban sustainable design.

## **Landscape Connectivity as Mitigation for Habitat Fragmentation (Case Study: Persian Leopard in Golestan National Park, Iran)**

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Habitat fragmentation and degradation in natural areas is a major threat to biodiversity conservation across the world. These trends considerably threaten the biological environment, particularly wildlife.

Most of the recent studies on natural ecosystems show that the presence of road infrastructure intensifies existing threats to wildlife, and causes habitat fragmentation, degradation and environmental pollution. Many ecologists believe that the use of corridors (underpasses or overpasses) as a means of promoting landscape connectivity is the most effective approach to preventing these threats and associated problems.

The purpose of this paper is to locate suitable routes for overpasses and underpasses in Golestan National Park to reduce wildlife road kill. The Park is the most important biosphere reserve in Iran. A highway crossing the Park is currently considered a threat to wildlife. The Persian leopard (*Panthera pardus saxicolor*) was chosen to exemplify the animals crossing the highway because of its high mortality rate. The Persian leopard is an endangered species, listed in the IUCN Red List.

This paper describes how to create a habitat suitability map and how this map can be used to identify least-cost pathways between isolated areas of habitat. A number of short and safe paths between terminals were determined through the use of least-cost path analysis.

**Keywords:** Least-cost path analysis, Corridor, Golestan National Park, Persian leopard

## **Spatial Patterns of Exotic Invasive Trees, Shrubs, and Palms in a Subtropical, Coastal urban forest: Implications for Ecosystem Services Provision**

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Urban exotic invasive trees, shrubs, and palms (EITSPs) can have significant impacts on adjacent subtropical natural areas, urban forest structure, and the subsequent provision of ecosystem services (Escobedo et al. 2011). Most EITSPs originate in urban landscapes, yet little is known about their distribution in subtropical cities, their site requirements, the social and ecological drivers such as hurricanes influencing that distribution, and other variables that might affect the spread of these species into adjacent natural areas (Thompson et al 2011; Zhao et al. 2010). We conducted spatial analyses of EITSPs and quantified key ecosystem services in metropolitan Miami-Dade County, Florida in the United States. Using data from 230, random 0.04 ha plots over a 1273 km<sup>2</sup> study area we measured urban forest structure, composition, and analyzed the spatial distribution of EITSPs (Zhao et al. 2010). The provision of key ecosystem services by EITSPs is also explored (Escobedo and Nowak 2009; Escobedo et al. 2010). We also examined the relationships between land tenures, soil physical and chemical properties and urban morphology variables with respect to EITSP distribution. Palms contributed to urban forest cover and most trees were located in residential areas, whereas structural characteristics and species diversity were statistically different than those in non-residential land tenures (Zhao et al. 2010). Urban forest structure differed spatially across the study area and 10% of all trees were exotic and invasive tree species. Results indicate that highly invasive trees, shrubs and palms do provide ecosystem services (Escobedo et al. 2010). Since urban forests contain a large proportion of EITSPs, we discuss a sustainable approach to management.

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### **Local Habitat, Landscape Structure and Pure Spatial Dependence in the Variation of Caterpillar Community Structure in Deciduous Tropical Mosaics, Mexico.**

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Tropical seasonally dry forests (TSDF) are threatened ecosystems worldwide. The Yucatan Peninsula (Mexico) harbours TSDF within a heterogeneous landscape matrix (i.e. primary forest, secondary forest, agriculture and urbanisation). Changes in landscape composition and configuration may affect species distribution and abundance. It may also potentially reduce species persistence and influence the composition of ecological communities. Lepidoptera communities are important ecological indicators, associated with ecosystem health and diversity. Lepidoptera larvae, in particular, are susceptible to changes in environmental conditions such as temperature, humidity and plant composition, and are typically affected by habitat disturbance and secondary succession. Thus, caterpillars are an ideal model to study the effect of habitat modification resulting from human disturbance.

Caterpillar assemblages were studied in the South of Yucatan state to examine the relative contribution of local habitat characteristics, class metrics describing the configuration and composition of the landscapes and pure spatial dependence on the variation in caterpillar community composition. Caterpillar assemblages were sampled in 216 forest-sites, ranging from 3 to 100 years in age, within eighteen 1 km<sup>2</sup> unit mosaics in an area of 22 x 16 km<sup>2</sup>. Local environmental predictor variables were measured *in situ* (i.e. plant richness, plant abundance and forest complexity). Altitude and soil nitrogen concentrations of these sites were also taken into consideration. A second set of site-predictor variables were analysed for each landscape, including class-based metrics, computed using a classified image (e.g. class area, contrast and edge complexity). A SPOT5 satellite image was used to obtain a land-cover thematic map showing slash and burn agriculture and rural settlements, in which four

vegetation classes were defined: VC1 (3-8 yr-old forest), VC2 (9-15 yr-old forest), VC3 (> 15 yr-old forest) and10 VC4 (> 15 yr-old forest on hills). The third set of predictor variables describe the spatial structure of the sample design and were obtained by PCNM eigenvectors. 5000 caterpillars were recorded and 340 species were identified, feeding on 170 host-plant species. Based on the Bray-Curtis resemblance matrices of species abundances, PERMANOVA tests indicated a significant contribution of the four vegetation classes to the variation in caterpillar assemblages, and pairwise tests were consistent with the successional gradient. Using distance based redundancy analysis (dbRDA) in the DSTLM sequential modeling routine (PRIMER), most of the total explained variation in caterpillars (21%) was accounted for by landscape configuration and composition (13%), to a lesser extent by local habitat variables (5%) and pure spatial dependence (2%), and explained least by categorical landscape units (1%). The explained variation in the Lepidoptera assemblages increased from 20% at the morpho-species level to 30% at the subfamily level, while the proportional contribution of variable types remained similar. These results support the importance of broader habitat conditions in the selection for oviposition sites for flying insects. Insects' mobility plasticity to switch between host-plants, even when their host-plant use is restricted to local habitat conditions, may contribute to this pattern. Identification at the subfamily level may save time and money in future tropical assessments.

## **The Stability of Altered Forest Ecosystems (SAFE) Project**

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Opportunities to conduct large-scale field experiments are rare, but provide a unique prospect to reveal the complex processes that operate within natural ecosystems. Here, we present the Stability of Altered Forest Ecosystems (SAFE) Project, a new forest fragmentation experiment located in the lowland tropical forests of Borneo (Sabah, Malaysia). SAFE represents an advance on existing experiments in that it: (1) allows discrimination of the effects of landscape-level forest cover from patch-level processes; (2) is designed to facilitate the unification of a wide range of data types collected on ecological patterns and processes that operate over a wide range of spatial scales; (3) has greater replication than existing experiments; (4) incorporates an experimental manipulation of riparian corridors; and (5) embeds the experimentally fragmented landscape within a wider gradient of land use intensity than existing projects. The SAFE Project combines research on biodiversity, ecosystem processes, soils, water and earth-atmosphere linkages, all conducted in an integrated manner to quantify the impacts of forest modification on ecological functioning and the provision of ecosystem services. The end goal of the project is to generate quantitative estimates of how to best design habitat mosaics in modified landscapes to retain the natural values of tropical forest.

# **Can Community Involvement and Participatory Mapping Enhance Assessment of Landscape Services? Case Study from Zanzibar, Tanzania**

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For practical implementation of research results in management and decision-making, integration of both cultural and ecological values of landscapes is essential. We present a case study from Zanzibar islands, Tanzania where local stakeholder knowledge of landscape related services is studied under land management challenges where tropical forests are being extensively used for subsistence purposes. Landscape service concept (derived from ecosystem services) is used as a theoretical framework to capture spatial knowledge from the local communities, and involve them, in the process of assessing the development of the multifunctional cultural landscape and forest resources under shortage.

The underlying assumption is that inhabitants of a certain area possess valuable knowledge of landscape services at local scale. Many of these services relate to direct uses of natural resources but as many are associated with immaterial values such as aesthetics and sacred places in the landscape. These uses and values are difficult to represent with expert knowledge and standardized spatial data sets, such as remote sensing data. Participatory mapping of landscape services, on the other hand, captures the socio-cultural value domain of these services. Mapping of landscape services with participatory GIS (PGIS) methods creates local knowledge which emerges from environmental experience and can be associated with geographical places and areas. Hence, it enables the place-based assessment of landscape services.

Our presentation is based on recently collected and analysed data on community stakeholder landscape services using a combination of semi-structured interview questions completed with participatory mapping on aerial photograph. The results show that different landscape services have variable geographical distribution and spatial clustering in the landscape. On the basis of these patterns, local landscape can be classified into different landscape service areas. These emerge from individual stakeholder perception of landscape but are organized into multiple characterisations of key services in geographical space.

The landscape level local knowledge can be used to address resource management challenges within the community land areas and to enhance sustainable solutions to resource allocation conflicts. Especially for practical management of multifunctional landscapes, the proposed method is useful when collaborative bottom-up landscape development is wanted and when the non-material values of land and resources are appreciated in planning and decision-making.

## Utilization and Management of Urban Nature in Buenos Aires, Argentina

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In this study we investigate opinions and attitudes of visitors and neighbors of 5 urban nature reserves located in the Buenos Aires metropolitan area and an area proposed for further urban nature management (Faggi et al 2011). The selected nature reserves have similar physiographic characteristic but differ in some environmental and socioeconomic features. We interviewed 600 people and gathered data about utilization and evaluation of the reserves, distance travelled and effort required to reach them, perception of nature, flora and fauna knowledge, and features from a landscape they preferred.

Effort required to reach the reserves varied from 20 minutes to 1 hour and the duration of visits varied from 20 minutes to more than 4 hours. Visitors had little flora (76%) and fauna (80%) knowledge, although they pointed out “nature” as the principle feature that they preferred from the landscape. Many interviewed agreed that it was necessary to improve infrastructure and information on nature. Results showed that personal data profile like gender, age and education level were the main explanatory variables (Priego et al 2010).

The study reflects a lack of ecological knowledge of biodiversity, a factor that is controversial with the mission of urban reserves (Breuste et al. 2008).

Water was one of the most preferred landscape features. Our findings showed that individual experiences based on cultural traits, such as familiarity with a place, explained the discrepancy between urban and suburban coastal residents, while surprise and induced water scarcity account for the differences between visitors to urban and suburban waterfronts.

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## **Managing Landscape through Culture and Spirituality: A Landscape Approach Experience along A Pilgrimage Route in Italy.**

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The paper looks at possible ways in which recovering ancient Christian routes of pilgrims could operate at a landscape scale to stimulate practices of managing territorial resources for local sustainable development, into the institutional frame of the European Cultural Routes Programme. It focuses on the Italian case study of the Laetana Pilgrimage Route (LPR), which crosses the highly valued natural landscape of the Marche-Umbria's Apennine Mountains. The LPR recovery project led by the University of Florence was presented to local administrators in February 2011.

The project applies an experimental method to build a *network* of ancient pilgrimage pathways in order to create a “thematic backbone” of a system of multidimensional *connection webs* (Gambino, 2009). This method shifts from a system where different point locations, lines and areas are considered as separate individual elements, to that where they are perceived as active components of bio-cultural systems involved in dynamic temporal processes, giving recognisable shapes to a landscape (Amadio, 2003). The project aims to create a “model” of landscape planning beginning with the understanding of the functional and symbolic elements of the pilgrimage, whose sacred dimension could support the conservation of biological diversity inside and outside protected areas (Mallarach, 2008).

An historical-based approach was first used to analyse the diachronic evolution of the LPR and adopt a *landscape approach*, which is also based on the physical experience of walking “into” a landscape (Careri, 2006). This approach was taken in order to understand how the complex system of meanings, including spiritual ones created by the pilgrimage phenomenon, has set up different landscapes from the natural environment and has created and connected self-organized bio-cultural systems whose value is also provided from the sacred dimension of places. Such an approach allows us to find a way to connect the needs of natural conservation of lands crossed by the LPR with those of sustainable local development. Moreover, linkages between man and nature, that is, man's need for social development and the need to conserve nature in order to ensure sustainability, are defined by the very dimension of the pilgrimage route, whose spirituality is expressed indeed by the “perceptive relationship” between pilgrims walking the route and the landscape in which “sacred symbols” (e.g. sanctuaries, icons ... nowadays part of cultural heritage) find their “connective texture” (Settis, 2002). Since *perception* is strictly connected to landscape, activating the cognitive process (Farina, 2006) that makes environment “familiar” to human beings, the work stresses the concept from an “on the move” perspective considering the voyager's dimension as an optimal point of view to understand the landscape discovering its *genius loci* as the Grand Tour's European travelers once did (Brilli, 2006).



## Ecological Diversity of National Nature Reserves in China

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Nature reserves play very important roles in ecological security including species protection, watershed protection and ecological diversity protection (Yue T.X., et al 2006; O'Neil RV, 1989; Ervin J, 2003). Analysis of the 304 national nature reserves in China, GIS spatial statistical data and related landscape diversity index models, shows that the total area of national nature reserves in China is 92.7 million ha, which equates to approximately 9.7% of China's terrestrial area. Between 1990 and 2005 the number of landscape patches increased from 26,306 to 26,804, patch intensity increased from 0.0582 to 0.0593 and the landscape apartness index increased from 0.9933 to 0.9943. The Shannon-Weiner index also increased from 2.4282 to 2.4610. In terms of ecosystem characteristics and attributes of its protected species, these national nature reserves can be divided into seven categories including; forest ecosystem, grassland ecosystem, wetland ecosystem, rare animals, rare plants, and geological and paleontological relic nature reserves. The spatial distribution and biodiversity of national nature reserves was assessed in the Northeast, North, Central South, Northwest and Southwest of China.

The results indicate that since the 1990s, the maintenance of biodiversity in China's nature reserve has become more efficient, and the ability to maintain typical natural ecosystems, rare wildlife populations and natural relics has improved in nature reserve areas, particularly in the 21st century. However, land degradation resulting from land cover change still exists (Quan J, Ouyang Z Y, et al., 2010). If the protection of nature reserves is to improve, much ecological restoration work and better management of nature reserve is required in the future.

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## **A Modified Model for the Energy Ecological Footprint Based on LUCC**

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The Ecological Footprint (EF) is a useful accounting tool that measures the area of land required to continuously supply resources and assimilate waste to satisfy human consumption. However, estimating the Energy Ecological Footprint (EEF) has been an important and highly disputed subject in EF analysis and has gained much attention from the scientific community and decision makers. Considering forests only, rather than many types of landscapes, will inevitably cause bias in the assessment of carbon sequestration and is a major source of criticism of EF analysis.

Integrating EEF with land use/cover change (LUCC) was thus undertaken to facilitate the assessment of impacts of land-use practices on human CO<sub>2</sub> emissions. In this study, LUCC was incorporated into a modified model through the addition of regional Net Primary Productivity (NPP), in order to improve EEF analysis. One modification priority was to consider landscapes other than forests that are available to absorb anthropogenic CO<sub>2</sub> emissions. Another was to redefine NPP as land productivity instead of as inherent regenerative capacity used by the conventional method. Using these modifications, EEF was for the first time calculated taking into account the linkages between energy consumption, CO<sub>2</sub> emissions and carbon sequestration. A new parameter was also put forward to measure the ecological impacts of LUCC. In order to predict the expected EEF under given LUCC scenarios, a dynamic simulation model was established that advanced EEF analysis from static to dynamic.

Using Jilin Province as a case study, the following results were obtained: (1) Between 1994 and 2008, the EEF per capita increased from 0.228 ha to 0.524 ha, to which grassland degradation made great contribution since 2003; (2) Between 2009 and 2023, under low, medium and high growth scenarios, the average annual EEF per capita is predicted to increase by 6.36%, 10.73% and 11.43%, respectively; and (3) With the exception of increasing energy consumption, LUCC was, is and always will be the main driving force of EEF. These results indicate that more effort should be made to protect grassland in western Jilin by increasing land capacity for carbon sequestration.

This work allowed a deeper understanding of the interaction between sustainable energy consumption and sustainable landscapes and also, a more meaningful assessment of energy consumption for sustainable development, to be obtained. It also showed that the modified model can be used to look for new opportunities (such as in land-use planning) to help reduce high CO<sub>2</sub> emissions.

## **A Habitat-oriented Approach to Detect and Prioritise Ecological Hotspots for Management by Ranking Ecological Risk Levels on the Chinese Yellow Sea Coast**

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Ecological Hotspot (EH) detection is a leading approach for biodiversity conservation. In this study two questions were considered: (1) How to detect EH using a habitat-oriented approach instead of a species-oriented approach; and (2) How to rank the ecological risks of EH and then create a corresponding management strategy. An ecological naturalness assessment is completed in three steps. The first step is to detect the EH using NDVI, the second is to determine the Euclidean Distance to the main sources of human impact and the third is to assess land use reclassification. The naturalness assessment result is mapped with a 0-4 stretched grades approach. The potential Hakanson ecological risk index of heavy metals were computed and interpolated using ARCGIS 9.2 to obtain the spatial distribution of the ecological risks. A raster calculation method was then used to obtain three logic computations to delineate the EH with low, medium, and high ecological risks, taking the median value of 2 as the EH identifying threshold. Only the area with naturalness values above 2 were considered as EH to be managed. The following results were obtained: (1) The naturalness assessment shows that there are three areas of high naturalness: the center of the National Red Crown Crane Natural Reserved lands (YNNR), the center of the Dafeng Milu Natural Reserved lands (DMNR) and the southern area around the Liang Duo River Gate; (2) The Hakanson RI index interpolations show that the areas of high ecological risk due to the presence of heavy metals were located mainly in the northern areas; and (3) The EH with low ecological risk were mainly found in areas of the YNNR, the DMNR and the most southern area. The EH with medium ecological risk were mainly distributed north of the EH with low ecological risk. The EH with high ecological risk were smaller in area than those of low and medium ecological risk. This is an effective habitat-oriented approach for detecting EH and classifying their ecological risk level, to determine the best spatial management strategy. It is strongly proposed that EH with low and medium ecological risks are prioritised for management.

**Keywords:** Ecological hotspots detection, NDVI, Land use, Human impacts, Heavy metals, Ecological risks, Management strategy

# Grouping the Spatial Diversity of Forest Characteristics for Carbon Sequestration Estimation - An Example of Camphor Trees in Taiwan

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The purpose of this study was to examine the characteristics of individual trees and stands to group them for accurate carbon sequestration estimation. In 2006, camphor tree (*Cinnamomun camphora*) biomass was estimated for 7722.66 ha of camphor tree plantation. Growth models and allometric equations were developed from the data of 81 stem analyses which included measurements of volume and component parts, including: leaves, branches, bole and coarse roots (> 2cm) for each analysis. From the 81 stem analyses the mean and upper and lower 1 deviations of DBH distribution of 27 plots in three age classes (<25 yrs, 25 yrs ~ 50 yrs, >50 yrs) were obtained. The parameters of the allometric equations were used to integrate extension factors for above-ground (including leaves, branches and bole) and underground (coarse roots) biomass with DBH. Tree height-DBH curves and volume equations were developed from the 27 plots. DBH, H, BA and V growth curves of the 81 stem-analysis data obtained from the 27 plots were determined using Schnute's growth model. The parameters for each plot were analysed spatially using a coordinate system. The results showed that growth trends could be determined for the central mountain range in the east and west of the study area, including; the Hopping River and Siouguluan River in east-Lanyang, east-Hualian and East-Taidoun; the Ta-an River and Zhuoshuixi River in the north-west, centre-west and south-west, to estimate biomass, carbon sequestration and carbon conservation more accurately.

**Keywords:** Spatial distribution, Allometric equation, Schnute's growth model, Camphor trees, *Cinnamomun camphora*, Biomass estimation

## Spatial Point Pattern Analysis of Forest Landscapes in Northeastern China

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Patterns and processes are core issues of landscape ecology research. With the development of geographic information system, remote sensing and computer technology, the study of landscape ecology has become more and more complex and has become more quantifiable and less descriptive (Ma et al., 2000; Chen et al., 2008). However, most studies currently use a series of landscape indices to analyse the temporal and spatial changes of landscape pattern on specific scales and studies on multi-scales are relatively few. Spatial point pattern analysis methods can analyse changes in spatial patterns on various scales and is widely used in population ecology. Spatial patterns of plant populations and species associations may be analysed using spatial maps showing individual distribution patterns (Su et al., 2010). These

may clearly reveal the relationships between various scales and the spatial patterns of plant populations, thus laying the foundations for the quantitative study of population patterns.

In order to understand the spatial patterns of forest landscapes and correlations between different forest landscape types, spatial point pattern analysis was undertaken. Ripley's K function was used to explore spatial patterns of forest landscapes using data obtained from forest maps sourced from the Huzhong forest bureau, the Wuying forest bureau and the Changbai mountain nature reserve. Results showed that coniferous forest landscapes were clumped at all scales. Other types of landscape were clumped at smaller scales, and more random at larger scales. No correlations were observed between coniferous forests and shrubs at a scale of 5000 m ~ 25,000 m, or at broad-leaved forests and meadows at a scale of 12,000 m ~ 24,000 m in the Huzhong forest. Significant negative correlations were observed between other landscape types. This distribution pattern of forest landscapes in Northeast China has significant implications for ecological restoration and reforestation in these forest areas. On smaller scales, vegetation recovery should undertaken using centralised planting methods. While random planting patterns, depending on the type of site conditions, should be applied for large scale reforestation. This research is a new attempt to use spatial point pattern methods to analyse spatial patterns of forest landscapes at different scales. Spatial point pattern analysis could be widely used in the study of landscape ecology.

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### **Recreation Suitability Mapping: A Spatially Explicit Methodology for Determining Recreation Potential at the Local Level**

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Tourism, particularly ecotourism, is increasing worldwide, and will continue to increase as global economies improve and leisure time increases. Walking, sightseeing, picnicking, swimming, fishing, bicycling and bird watching are some of the most popular recreational activities. Although some of these activities can be accomplished near home, most involve

expenditure for travel, accommodations, meals and guides. They can play an important role in ecotourism and thus to the development of local and rural economies.

On the other hand, all these activities are closely linked to natural resource use, particularly in forests. The literature on suitability assessment shows several examples of methodological approaches based on the relationship between landscape attributes or characteristics, and forest uses such as wildlife and forestry. However recreational aspects of forest are less easily defined in terms of landscape characteristics and have not been incorporated into GIS-based approaches with the same degree of success compared to forestry and wildlife.

The purpose of this work is to present an approach for recreation suitability analysis at the landscape level, integrating a multi-criteria framework in a GIS system. The first step involved semi-structured interviews with local planners and stakeholders, providing information about preferential users and common recreational activities. During the consultation process a set of five factors were identified as relevant for recreation assessment: forest recreational suitability; landscape vulnerability; landscape quality; locations of interest for tourism and accessibility. In the second step a set of direct or proxy attributes with a spatially explicit dimension were developed using different spatial modeling approaches, in order to produce quantitative maps for each factor. The results for all five factors were standardised and combined using a weighted linear sum to produce a global landscape recreation suitability map. Weights were determined by expert judgment. The methodology was developed for the study area of the municipality of Cantanhede, which occupies an area of 395 km<sup>2</sup> and is located in central Portugal.

The output of the methodology was a recreation suitability map portraying the spatial extent of recreation suitability of the landscape. In addition, each recreation variable is also expressed in a quantitative spatial map that can be easily used for other land use planning purposes. Actual landscape management is discussed from view of recreation potential.

## **A Spatial Multi-criteria Framework for Designing Greenways in Rural Landscapes: A Case Study of Cantanhede Municipality, Portugal**

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Rural landscapes in Europe have experienced dramatic changes in the last decades and multi-functionality is regarded as a way to address social and ecological concerns such as farm abandonment and biodiversity loss, or to reach ecological and social objectives such as sustaining rural communities, or responding to the increasing demands for the provision of

environmental protection, amenity, cultural value and other recreational opportunities.

Local planners, policy makers and citizens frequently advocate the development of greenways to improve the environmental quality of their communities. In fact, greenways are widely recognised as a successfully planning strategy to foster conservation of natural and cultural landscape values and to provide opportunities for recreation and for pedestrian and cycling networks. At the local level and in a rural landscape greenway planning should take advantage of the local context. Connection between environmentally sensitive areas, wildlife habitats and other natural areas is essential in order to ensure the ecological functioning of the landscape. Community connections between local destinations such as public recreation lands, historical and other cultural interest locations and village centers, are also important and can ensure a better quality of life for inhabitants and increase rural tourism. Thus greenway planning and design methods must ensure the conservation of natural resources and satisfaction of social and cultural needs at the same time, without generating future social and environmental problems. Once greenway planning involves public participation, methods should also be transparent and replicable in order to be discussed with several stakeholders. In this work we present a spatial methodological framework in a GIS system that combines multi-criteria decision analysis, collaborative planning and network analysis to design greenways. The proposed methodology is structured in the following phases: (1) Focus group discussions with local stakeholders in order to frame the scope of the study, to develop a broad understanding of the greenway, its main objectives, the people who will use it and the range of ecological and cultural elements that should be addressed; 2) Detailed inventory and mapping of the ecological and cultural sites that should be protected and maintained to form the fundamental ecological structure; (3) Generation of an ecological and cultural corridor connecting the relevant points of the ecological structure that runs within the study area, by performing a pathway analysis based on the suitability maps for conservation and recreation; (4) Development of a pedestrian and cycling network using the GIS network analysis capacity to create a network of paths and cycling roads in order to connect and distribute people along the ecological network. (5) Discussion with stakeholders to establish the final proposal. The methodology was applied to a rural landscape located in central Portugal with an area of 395 km<sup>2</sup>. The final proposal is presented and discussed. Results confirmed the concept of an ecological structure as a powerful tool for landscape planning for conservation and greenway design.

## **Transformation in Central Europe as a Multiple Challenge for Mutual Interactions of Landscape Ecology and Spatial Development Practice**

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The paper is focused on Central European landscape transformations as a reflection of the convergence of ecological, economic and social aspects in overall societal transformation towards democratic, civic society in a market-oriented knowledge based economy. The role of

interactions between landscape ecology and existing integrative systems of landscape development management in these transformations is assessed (Finka, Zigray, 2009).

An important question in this area of research is to what extent landscape ecology, with its special position in ecological, economic and social sciences, dealing with landscape as a cultural phenomenon is prepared to offer coherent theoretical and methodological analyses for practical solutions facing current landscape development problems. This question refers not only to the availability of relevant knowledge and reflective mechanisms, but also the ability (methodological, instrumental, and institutional) to transfer results of landscape ecology research to landscape development management.

Time and space are two inseparable and complementary dimensions of landscape development. One of most important tasks is to reflect in the interaction mechanisms between landscape ecology and landscape development management in a time-spatial context (Kozova et al., 2010). The functioning of landscape development processes is intertwined with the social, political and economic organisation of society. This implies that cooperation between social and natural sciences and practice is required between descriptive and prospective disciplines. Only the interaction between them reflecting temporal and spatial continuity and uniqueness can safeguard deeper knowledge of varied natural and socio-economic circumstances of landscape transformation, appropriate transfer of the knowledge and its efficient exploitation for necessary managerial interventions.

Central European experience from the last two decades demonstrates the possibility of new concepts, approaches and more effective mechanisms of implementation of results obtained from landscape ecology for landscape transformation management. This will be useful for the decision makers and stakeholders as well as prevent bottlenecks for their implementation (Zigray, 2006).

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## **A Simulation System for Estimating Wildfire Risk for the Continental U.S.**

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This simulation research was conducted in order to develop a large-fire risk assessment system for the contiguous land area of the United States. The modeling system was applied to each of 134 Fire Planning Units (FPUs) to estimate burn probabilities and fire size distributions. To obtain stable estimates of these quantities, fire ignition and growth was simulated for 10,000 to 50,000 “years” of artificial weather. The fire growth simulations,



when run repeatedly with different weather and ignition locations, produce burn probabilities and fire behavior distributions at each landscape location (e.g. number of times a “cell” burns at a given intensity divided by the total years). Fire suppression effects were represented by a statistical model that yields a probability of fire containment based on independent predictors of fire growth rates and fuel type. The simulated burn probabilities were comparable to observed patterns across the U.S. over the range of four orders of magnitude, generally falling within a factor of 3 or 4 of historical estimates. Close agreement between simulated and historical fire size distributions suggest that fire sizes are determined by the joint distributions of spatial opportunities for fire growth (dependent on fuels and ignition location) and the temporal opportunities produced by conducive weather sequences. The research demonstrates a practical approach to using fire simulations at very broad scales for purposes of operational planning and perhaps ecological research.

### **Linkages between Landuse Change and Land Degradation of a Nature Protected Area, Batang Merao Watershed, Sumatra**

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Problems in watershed management are becoming more complex because the rate of land degradation is tending to increase. An increasing population in an area of limited land resources results in land shortage, a factor that leads to unsustainable landuse practices. These conditions often have an impact on land use and result in complex environmental problems. During the last few decades, land degradation has had multiple and complex impacts on the global environment through a range of direct and indirect processes affecting a wide array of ecosystem functions and services (UNEP., 2006). Land degradation in watersheds has been as a serious and critical environmental threat in many countries (Wei et al., 2010) and a widespread problem in developing countries (Ananda and Herart., 2003). The existence of Batang Merao watershed is important for sustainability of the nature protected area, Kerinci Seblat National Park.

The objective of this study was to quantify land degradation and population pressure and analyse linkages between landuse change, land degradation and population pressure on Batang Merao watershed. Prediction of land degradation is limited to soil erosion using the universal soil loss equation (USLE) method (Wishmeier and Smith., 1978) and land use change is determined by changes in area cover. To undertake this research, landsat data from 2000, 2005 and 2010 were used to analyse land use change and assess land degradation over the last 10 years in this area. Overall analysis was undertaken using remote sensing (RS) and geographic information system (GIS) tools. Analysis of priorities for managing land degradation was undertaken using the rank sum method and scale normalisation. The expected outputs of this research is quantification of landuse change and trends, land degradation levels and gaining an understanding of the linkages between landuse change and land degradation.

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## Urban Green Infrastructure Planning and Design as a Part of Sustainable Development - Challenges and Crucial Factors

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For a successful sustainable development of urban areas there is a need to incorporate ecological knowledge in the urban planning and design process. This holds for planning and design in general, but especially concerning the development of urban green infrastructure. Therefore, knowledge about management of the planning and design process is crucial.

Several theories have been presented concerning the urban planning and design process (*survey-analysis planning, rational planning, incrementalistic planning, strategic planning, communicative planning*). However, a problem with all these theories is that they are not only founded on scientific studies and practical feed-back. They are also to some extent *normative* in that they also put forward ideas of how planning *ought to* be carried out, according to the opinion of the author(s) of the theories.

A planning theory which is not normative and can describe any planning process is the theory of *stakeholder-driven planning* (Faludi, 1987). Stakeholders can be authorities, officials, private companies, NGOs, scientists, members of the general public, and so on. The approach of this theory is that the stakeholders take positions. They decide whether or not to be actors in the process. The process is best described as ever ongoing negotiations between the stakeholders. A stakeholder can act within the planning authorities' official procedure, or outside it. The planning process can be initiated, operated and also obstructed by any stakeholder. The planning process directed by laws and other regulations is a formal framework, but the process as such can be operated outside this framework, with only the formal decisions following it. The actors try to manage the process to fulfil their own interests.

This is formally acceptable as long as they keep within laws and regulations. Survey-analysis, rationality and strategy can be parts of the process, but do not need to be so (Nilsson & Florgård, 2009). The most important conclusion for landscape ecologists and other scientists is that when they enter the planning and design process they become actors among other actors, and have to adapt to that position in their information and argumentation.

Actors look for information which consolidate their positions, and omit other information. This affects the presentation of scientific results and conclusions. To become an integrated part of the planning process results and conclusions must be presented in a manner which makes them understandable and useful for the actors. The information must be adapted to the stages in the planning and design process. In early stages it must be concise and simple, but in late stages detailed.

Adaptation of the development to the natural conditions of the area is an important part of sustainable urban development. Especially in detailed planning and design it has been found that aim description, nature surveys, development plans and other drafted regulations are not enough. Adaptation is often missed during the process due to impact of technical, economic and other considerations. For a successful adaptation to nature three factors need to be fulfilled: i) a planning and design team determined to the aim to adapt to nature, ii) the presence of a determined and committed person at a central position in the team, and iii) a well functioning information system (Florgård, 2010).

## **A Netways Transportation System to Restore Nature, and Improve Mobility, Fuel, Emissions, Water, Food, and Recreation**

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Roads with vehicles slice the land into pieces, yet tie it together for us. For centuries spreading roads have progressively degraded nature, and now for 15 years road ecology has emerged with useful principles. Its solutions for at least 11 major transportation-and-environment problems are beginning to spread widely. Nevertheless, worldwide road construction and traffic growth far exceed the rate of implementing solutions. Therefore the next level of road ecology problem-solving should begin. A transportation system is outlined to reverse the degradation trajectory, so that natural processes are widely restored across the land. As added benefits, (1) safe and efficient mobility is enhanced, (2) renewable energy replaces fossil fuel use, (3) greenhouse gas emissions are eliminated, (4) water quantity/quality is improved, and (5) market-gardening food production and (6) trail-system recreational opportunity near communities are noticeably increased. In brief, netways are raised or sunken transport guideways, with electrical power embedded in the paved surface to move compact lightweight “pods” or capsules. These vehicle-like objects (personal, public, and freight types) are moved using inductive coupling and automated controls. Netways may be about 8.5 m wide (slightly wider than a football goal), with wind, solar, geo, hydro and other energy sources at intervals powering the

system. Some pods contain small batteries charged en route, and can be driven on roads at ground level. The automated control system can move pods centimeters-or-far apart, distribute weight, and smoothly adjust speed and entering/exiting at small service centers. No driving, no crashes or wildlife roadkills, no fossil fuel use or CO<sub>2</sub> emission, very quiet, travel and arrive rested. The strip of land under or over netways is used productively for solar panels, wind turbines, market gardening, trails, and other societal benefits. The netway system is initially targeted to non-urban areas with the most important nature, especially large green natural emeralds, major water and wildlife corridors, and the vicinity of water bodies, where the most damaging roads (e.g., with  $\geq 3000$  vehicles/day and  $\geq 80$  km/hr posted safe speed limit) are replaced. In essence, replacing such ground-level roads and traffic with the netway system removes concentrated strips of environmental degradation, and re-knits our land together for unimpeded flows of streams, rivers, wildlife, hikers, cyclists and local residents. The netways ahead spectacularly provide a sustainable future for both nature and us.

## **Landscape Modulates Transfer and Effects of Metallic Trace Elements in Small Mammals**

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Concepts for and development of a new field in ecotoxicology named “landscape ecotoxicology” have been proposed since the 90s (Cairns & Nlederlehner, 1996). Until now, little research has developed in this emergent field of science. Understanding the effect of the spatial arrangement of habitats and interacting communities on transfer and effect processes is critical for exposure and risk assessments. The bioaccumulation and the effects of trace metals (TMs: Cd Pb and Zn) in small mammals was studied in a 40 km<sup>2</sup> smelter-impacted area where soils are heavily polluted (Fritsch et al., 2010), focusing on the potential influence of landscape on transfer and impacts. Animals were trapped during autumn in woody habitats (hedgerows, woods, etc) in four landscape types, each along a soil pollution gradient. Concentrations of TMs were measured in soils in areas where animals were captured. Bioaccumulation was investigated in both herbivorous/granivorous and insectivorous species (bank vole *Myodes glareolus* and greater white-toothed shrew *Crocidura russula*,  $n = 406$ ), and exhibited an increase with soil pollution. Results showed that TM levels in animals and their variations along the pollution gradient were modulated by landscape (Fritsch et al., *Accepted*). Such an influence of landscape was species- and metal-specific. These results strongly suggest that availability in soil does not fully determine transfer in food webs. This leads to the hypothesis that ecological characteristics, such as food web structure and the way by which organisms exploit their environment (spatial and foraging behaviour), are both dependent on landscape features and mainly explains TM transfer in food webs. The influence of metal pollution on small mammal communities was studied in consideration of assemblage structure (abundance, richness, evenness), and using Pb concentration in soil as a proxy for environmental pollution. The responses to soil pollution were landscape-specific for abundance and richness, while evenness varied with soil pollution only, showing a constant decrease. Effects of pollution on small mammal assemblages were found and it was assumed

that assemblage structure could vary because of the disappearance of species sensitive to metals and/or of the dominance of species not sensitive to habitat quality (opportunistic generalist species). This study clearly shows that landscape modulates the exposure of organisms to soil pollutants and their responses. This is an argument for the further development of landscape ecotoxicology and multi-scale approaches, which would allow better insights in the understanding of transfers and effects of pollutants in ecosystems.

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## N<sub>2</sub>O Emissions in a Hilly Red Soil Landscape

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Nitrous oxide (N<sub>2</sub>O) is one of the potent greenhouse gases, and accurate estimations of N<sub>2</sub>O emissions from fertilised arable lands is vital for the national greenhouse gas inventory and the development of emission mitigation strategies. It is well known that acidic soils are characterised with low pH and high N<sub>2</sub>O production and emissions due to chemo-denitrification, compared with other cropped soils. Given the intensification of agriculture in subtropical China, N<sub>2</sub>O emissions from tea field and paddy field were continuously observed using the static closed chamber method under three different gradients in a hilly red soil landscape: a tea field in the upper plateau (UPT), a valley area (VT) and a paddy field (PF) at the bottom of a hill. All three sites were located on a slope containing acidic red soils. Measurements have been recorded since January 2010 and N<sub>2</sub>O soil emissions have been recorded for 15 months so far. The results show that fertilization moderately increased N<sub>2</sub>O emissions in the tea field and paddy field soil, but there were still obvious differences between the three sites. Compared with UPT and PF, the VT site showed higher N<sub>2</sub>O emissions, much greater than in PF, over the whole observation period. UPT emitted slightly more N<sub>2</sub>O than PD. This may imply that there are different N<sub>2</sub>O emissions as a result of different land management in the hilly red soil landscape. Many environmental variables may play important roles in controlling N<sub>2</sub>O emissions, such as topography, temperature and rainfall. It was observed that low fluxes responded well to cold seasons and high fluxes to continuous rainy seasons. In addition, the increasing rates of N<sub>2</sub>O concentration in chambers varied between treatments and land uses. Further N<sub>2</sub>O flux observation are intended and further study of combined temporal and spatial variability of N<sub>2</sub>O emissions to investigate emission characteristics in the hilly red soil landscape will be undertaken.

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## Assessment of Forest and Agricultural Land-management Practices in Land-use Management for Climate Change Mitigation

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Forests and agricultural land are considered to be highly important for the provision of manifold ecosystem services, for supporting local and global climate regulation and for making essential contributions to the mitigation of climate change impacts (de Groot et al., 2010; Rounsevell and Reay, 2009). A still open question is how to improve the consideration of forest and agricultural management practices in environmental impact assessment processes and in a climate change sensitive regional development planning (Füerst et al., 2010). Land management practices are highly variable and difficult to classify in a way that allows for generalization. In consequence, valuable information on the real potential of land management practices to contribute to a healthy and well functioning environment is often lost (Power 2010, Verburg et al. 2009, Dale and Polasky 2007). In this talk, we present a case study based approach, how to integrate forest and agricultural management practices in a land cover classification that allows for evaluating scenarios of changing management practices with regard to their impact on a set of ecosystem services and on the regional preparedness for climate change effects. The classification criteria applied in agriculture and forestry were different due to differences in the management philosophies. Finally, a quantity of 22 classes in forestry and around 30 classes in agriculture were derived. The case study is carried out in Saxony, Germany in the context of developing a regional climate change adaptation and mitigation strategy ([www.regklam.de](http://www.regklam.de)). Land cover changes are rather not possible in the model region. By means of an application case from regional development planning, we demonstrate that a more differentiated look at the impact of management practices instead land cover changes provides valuable information on realistic regional potentials and limits to react to Climate Change and to evaluate trade-offs for the provision of ecosystem services.

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## **Conservation of Coastal Pine Forests Based on Adjacent Landscape Structures**

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Coastal forests, which are located between the sea and human settlement, are one of the representative cultural landscapes in East Asia because they are multifunctional and are closely related to the daily life of residents in the area. However, the functions of coastal pine forests have been changing since the 1960s. Fujihara et al. (2011) described the historical change of the relationship between coastal forests and nearby residents, and proposed methods of conservation and management for the coastal forests as a cultural landscape. Coastal forests are mainly composed of Japanese black pine (*Pinus thunbergii* Parl.) trees. Since the 1970s, many large pine trees died of pine wilt disease and bare ground was exposed after the removal of these dead trees. Planting events were frequent, but selective cuttings for density control have not been conducted. Coastal sand vegetation is an important remnant of natural vegetation. However, beaches are also places of recreation that utilise the natural environment. It is important for artificial land use and natural vegetation maintenance to coexist. Landscapes on various scales affect the structure and function of coastal pine forests. In this study ecosystem services and mass dieback of pine trees by pine wilt disease were analysed based on adjacent landscape structures.

The main study sites were three coastal pine forests (Keinomatsubara, Fukiagehama and Ohama park) located on Awaji Island, Hyogo Prefecture, western Japan. Ecosystem services of coastal pine forests were related to landscape structures behind the pine forests and the direction of pine forests. Many dead pine trees were distributed in the northern part of Keinomatsubara. Secondary pine forests were located within 1.6 km of the northern part of Keinomatsubara. Distribution of broad-leaved trees and forest floor vegetation in the pine forests were affected by adjacent landscapes.

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## **Landscape Ecological Approaches for Understanding the Effects of Design and Location of Sacred Places on Local Biodiversity of Urban and Suburban Areas**

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The characteristics of forests and green spaces in an urban or suburban area depend on the historical diversity of the area. It is important to understand the process of historical transition of culture in such areas. These spaces are fragmented in urbanized areas and have decreased as a result of land-use management. It is necessary to not only preserve the uniqueness of an area that has been shaped by its history and culture but also to consider the long-term use of an urban space from the perspective of developing a wider landscape.

In this study the effects of location and design of sacred places, such as shrines in urban or suburban areas, on the biodiversity of forests and green spaces in these areas were examined by two approaches.

In the first approach, the distribution morphology of small open/green spaces in an urban area was examined. In the second approach, the locations of shrines, temples, parks, and satoyama were analysed using GIS. It was found that shrines and parks tend to be dispersed and temples tend to be concentrated in certain areas. 68% of shrines have been built on slopes. To investigate the geographical features and their relationship with ecological resources, a continuous green space was generated by forming a buffer between the spaces of forests that include shrines and the surrounding green space. This analysis showed that the main buildings located on downward slopes show either a high (19.4% of cases) or low one (38.9% of cases) green preservation function. It was conjectured that this difference derives from the relationship between the entrance path and the steep inclination. The main building of a Shinto shrine, however, demonstrated an excellent green preservation function when located on a steep upward or downward slope (11.8% of cases).

Most forests and green spaces are fragmented and reduced by uniform spatial development. As a result, natural spaces that serve as a breeding ground for diverse wildlife are greatly reduced in urban areas. Moreover, the decline of green spaces in cities results in environmental deterioration such as the degradation of flora and fauna, heat island effect, heavy rains, and, most importantly, loss of culture and history, the basis of which cities are developed.

The green spaces of shrines contribute largely to burden sharing as they are located on transformed steep land or transformed open land, which are otherwise difficult to inhabit. Although the relationship between green spaces and geography was investigated using



continuous green spaces with shrines and forests as reference points, it may not always be consistent with that observed for geographically varying slopes and it was found that the former can be used as a standard evaluation method for any region.

## **Sacred Groves in a Japanese Satoyama Cultural Landscape: A Scenario for Conservation**

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Sacred groves are small-scale woods that are detached from larger forests and are found in the precincts of Shinto shrines and other places of Shinto worship all over Japan. Vegetation in sacred groves has been protected for centuries as a subject of worship and can therefore often provide vital hints on the original vegetation and relationships between nature and humans in a region.

Sacred groves play an important role as habitats for wildlife and as hotspots for the preservation of biodiversity within Japan's Satoyama cultural landscapes. They are also thought to serve as crucial corridors that can serve as a link between the vegetation of larger forests in surrounding areas. Moreover, they provide green space within rural and/or suburban areas that is freely accessible to citizens and popular with local children. Finally, they are home to traditional Shinto ceremonies and festivals, and are highly valued as cultural property.

Today, the preservation of sacred groves faces various difficulties. For example, it is often difficult to contain the impact of management and development in adjacent areas. Some plant species also cannot maintain isolated communities within woods on a very small scale.

In this research, the current state of vegetation was identified and relationships between local people with differently sized sacred groves within a Japanese Satoyama cultural landscape on the west coast of Lake Biwa was investigated. The findings were analysed and discussed from a landscape ecology perspective and suggestions were made for strategies to conserve Japan's sacred groves for the future.

## **Five Principles for Ecological Landscape Design**

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The conservation of biodiversity in human-altered landscapes is becoming increasingly important in the face of the ever-expanding human presence on the planet. Local government planning agencies, with limited knowledge of wildlife biology and few resources to carry out research need simple, practical guidelines for biodiversity conservation. We propose five steps for terrestrial ecological landscape design that are not species- or habitat-based, are supported by current science, and are directly applicable to on-the-ground planning. Our five steps for ecological landscape design, in the order in which they should be carried out, are: 1) assess the availability of land cover data, and decide which land cover types constitute natural land cover; 2) assess the constraints (economic, social and otherwise) on land use planning that exist for the landscape in question; 3) maximize the amount and diversity of natural land cover; 4) minimize human disturbance in non-natural land cover; and 5) aggregate high-intensity human land uses. We illustrate the application of these principles using an example landscape in Ottawa, Ontario, which, together with Gatineau, Quebec, is the fourth largest metropolitan area in Canada and is projected to experience a 31% increase in population over the next 20 years. We compare the outcome of the application of our five principles with that produced by following the traditional patch-corridor-matrix guidelines suggested by the Ontario government. Our five principles of ecological landscape design for biodiversity conservation are superior to traditional patch-corridor-matrix guidelines in that they are hierarchical, prescriptive, and do not require detailed ecological information to be implemented.

## **Urban Change Detection Using Multi-temporal Remotely Sensed Imagery (Case Study: Ziarat Basin, North East of Iran)**

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Urban expansion is an important issue in the field of global environmental change and sustainable development. This study seeks to detect urban change by integrating multi-

temporal remotely sensed data over a period of 19 years in the Ziarat Basin of Golestan province in northeastern Iran. Change detection is the process of identifying differences in an object or phenomenon by observing it at different times. In this study this process was performed using Landsat TM images from 1988 and 1998, and IRS satellite images Liss III from 2007. The images were studied in terms of geometric and radiometric properties and then classified in six categories using a maximum likelihood classifier algorithm. Changes in urban areas were then investigated post-classification using a Cross Tabulation method. The results showed that in the 19 year study period, urban areas increased five times with an annual growth rate of almost 20%. Most areas changed from range and agricultural land into residential areas. Landscape change data can be used to update maps and to estimate the rates of changes in certain localities. The availability of this information can help managers to make more informed decisions on urban expansion, conservation and sustainable landuse.

**Keywords:** Landuse change detection, Urban expansion, Satellite data, Ziarat Basin, Iran

## **Evaluation of the Loss of Ecosystem Services of a River in Relation to Flood Control in Tabasco, Mexico**

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The state of Tabasco is located in the lower section of the Grijalva-Usumacinta watershed, the largest in the region and also an area with one of the highest rainfall patterns. Plains are the main landscape systems and maintain a complex hydrology and different kind of wetlands and tropical forests. These areas cover 91,345 km<sup>2</sup> and represents 4.7% of Mexican territory. Basins in Tabasco have a population of 4,919,793 inhabitants corresponding to 5% of the Mexican population. One third of all run-off in the country is drained here. Five of the biggest dams in the country are used for electricity generation and were constructed upstream area of the Grijalva River. Yearly floods are natural in this region, however, there has been an increase in their magnitude, extension and duration in recent times. During the last four years Tabasco has experienced the worst floods on record that had put at risk an important amount and placed a large proportion of population at risk. The damage resulting from these floods have had large economic, social, and environmental consequences (Gama et al., 2010). According to information recorded by the Mexican Secretary of Environment and Natural Resources, floods constitute the most important type of disaster in Southern Mexico and are expected to increase as a result of climate change. Although it is impossible to eliminate floods, it is possible to minimise their effects. The objective of this research was to evaluate the vulnerability and ecosystem services loss in the Tabasco region. Aerial photos and historical data were reviewed to evaluate changes in hydrology, ecosystems and land use and their possible causes using GIS. An analysis of vulnerability to floods due to the physical condition of the area and the relationship with increases in extreme precipitations events was done to configure a vulnerability map. Results show that Tabasco has undergone important land cover changes due mainly to agricultural and cattle raising activities. Important actions related to oil

extraction are also affecting natural landscapes. The hydrology of the area has changed drastically since pre-hispanic times. These changes and fragmentation of local streams affect natural floods and increases the vulnerability of the territory. Each time there was a change or further fragmentation of basin hydrodynamics, as well as construction of hydraulic infrastructure, a drastic increase in the vulnerability of the localities was observed over the last century. The hydrodynamics of the basin has been severely altered due to infrastructure growth and urbanisation. Changes in precipitation patterns are more frequent according to data and an increase on precipitation is expected due to climate change. 3,001 million dollars was the estimated costs associated with the damages of the 2007 flood and of this amount 152 million dollars were costs associated with direct damage of ecosystems. Ecosystems conserve water resources by storing excess runoff and discharging ground water to surface water, and most of this capability has been lost due to changes in soil use. Ecosystem services related to wetlands and monitoring stations, studies related to vulnerability and also adaptation strategies are required to minimise flood risk to populations in the future.

## **A Knowledge Approach to the Multiple Dimensions of Landscape: the Case Study of Pompeii**

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In coping with environmental decay that threatens social balance, population security and health, it is evident that the quality of the landscape can be used to reaffirm social identity, increasing psycho-physical well-being and improve the sustainability of economic development. The study of landscape must take into consideration the multiple dimensions which have organised a place with time and the ways in which the presence of humans has framed an environmental identity closely linked to the geological, morphological, hydrological, agricultural, biological, ecological, historical cultural peculiarity and to the relationships between them and the presence of man. Referring to such a complex situation we must manage a fair knowledge approach, including the premise of safeguarding and enhancing the environment. The paper will show a theoretical and methodological study regarding cultural landscapes, also making reference to legal innovations introduced by the European Convention of the Landscape and by the Italian Urbani Codes.

In line with the considerations expressed above, research conducted in the Pompeii area will be presented. The project *POMPEI, Knowledge Factory* (Know-how Lab) is subdivided into strategic targets defined from many analyses which have resulted from the important innovative Benecon scarl tools (Centre of Excellence about Cultural Heritage, Ecology, Economy) used to measure and assess architecture, land and the Nets. This research aims to add knowledge to the archeological excavations of the Ancient City of Pompeii, in a unifying project aimed at a sustainable development and based on the potential cultural heritage of the area. Its potential is considered raw material (this is the reason for the Know-how Lab), through which gains in knowledge produce a higher quality of life, safeguards of cultural heritage and landscape, and provides services for tourism.

Projecting targets include the the identification, restoration and the recycling of large buildings which have been abandoned or not fairly used and empty urban areas (greenhouses, *hortus*, gardens) in order to provide a new identity to city outskirts, making them more attractive. The introduction of renewable energy sources, to improve the quality of the relationship between environment, life and work and the restoration of facades and perspectives, are expected to provide a more balanced context to urban areas. This strategy aims to promote the sustainable development through the safeguarding and evaluation of existing natural and cultural resource, in order to improve regional environmental quality and support economic growth resulting from the sustainable development of tourist, productive and cultural activities.

In this context the restoration of green areas will be shown, as it is considered one of the most important topics in the recovery of local areas. A recent census shows that there are 1,318 greenhouses in local areas totalling 97 ha. Next to many of them there are empty urban areas which may be restored and re-zoned as *hortus* and gardens, according to the tradition of the Roman *domus*, which is wonderfully represented in archeological buildings in these areas. The hypothesis of this study focuses on the creation of urban *hortus* and artistic greenhouses, for both production and display in addition to the re-zoning of solar greenhouses to produce energy through photovoltaic panels.

## **Simulating Ecological Risk resulting from Urban Expansion in the Liao River Watershed, China**

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The influenced of rapid socio-economic development and population growth on urbanisation is an inevitable process in today's world, especially in China since it was opened up to the world in 1978 (Che and Shang, 2004). Land use/cover has been changed significantly due to urban expansion, often resulting in serious ecological issues at the watershed scale (Bendor, 2009). It is necessary to understand the ecological risk due to urban expansion at the watershed scale. Taking the Liao River watershed as the study area, this paper captures the historical urban expansion in the watershed from 1990 to 2005 using the land use/cover maps interpreted from Landsat TM data. A dynamic spatial prediction model, Urban Expansion Dynamic (UED), is then used to predict future urban expansion in the watershed until 2020. The development of an ecological risk assessment model based on the landscape pattern indices was undertaken to reflect the spatial disturbance of urban expansion in the watershed. Lastly, the ecological risk in the Liao River watershed between 1990 to 2020 was simulated to understand the spatial disturbance processes of urban expansion in the Liao river watershed. The results will be useful for ensuring ecological protection and sustainable environmental management at the watershed scale.

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## **Roles of Cultural Forests on the Conservation of Species Diversity in Southern China**

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Cultural forests are those preserved and managed by local communities through traditional culture or religious belief, and have certain social and ecological functions. Compared with non-cultural forests, cultural forests face different types of human disturbance leading to different biodiversity responses. This study investigated alpha and beta diversity within tree layer, shrub layer and herb layer in three types of cultural forests in five villages of South China. The aim was to compare differences in community structure, species composition and biodiversity between cultural forests and non-cultural forests and to see the role of cultural forests in biodiversity conservation. A total of 355 species belonging to 85 families and 181 genera were found in cultural forests within a sample area of  $4 \times 10^4 \text{ m}^2$ . This included two first-grade nationally protected species and six second-grade nationally protected species. In non-cultural forests, 300 species belonging to 82 families and 167 genera were found, which included three second-grade nationally protected species. It was found that: (1) Cultural forests have more plant genera, families and species, species density are relatively lower and the DBH is relatively larger, especially in cultural forests in which cemeteries are located. The dominant species in the tree layer were indigenous species with broad leaves, including *Castanopsis carlesii*, *Castanopsis sclerophylla*, *Tsuga longibracteata*, *Cinnamomum camphora*. In non-cultural forests, the dominant species were easily introduced and cultivated coniferous species, including *Cunninghamia lanceolata*, *Pinus massoniana*, *Phyllostachys heterocyclus cv. Pubescens*. In the shrub layer, the species and composition were similar, however the cultural forests were found to have more species. The species composition in the herb layer was complex, depending on human disturbance; (2) Alpha diversity was calculated using species richness, Simpson index, Shannon-winner index and the Pielou evenness index. In the tree layer, the diversity of cultural forest was significantly higher than in non-cultural forests, with the exception of cemetery cultural forests which showed no significant difference. In the shrub layer, the diversity of cultural forests was higher and some of the indices showed a significant difference. The only exception was the Simpson index, which was lower in cemetery forests. In the herb layer, the indices in Xibei village and the Simpson index in Fenshui village were lower. The other indices were higher, some of which showed a significant difference; (3) The contribution to regional species diversity increased from 42.9% to 81.0%. The cultural forest played an important role in tree conservation; (4) Beta diversity was calculated using a similarity index and the largest similarity was found in the shrub layer. The tree layer and herb layer, however, had relatively less common species, but common species made up more than half of the number of species in non-cultural forests. Cultural forests maintain a certain area of natural forests and are important for conserving local species and biodiversity within the regional species pool. It is

recommended that a conservation network is formed for better protection and restoration of biodiversity in rural areas of South China.

**Keywords:** Cultural forest, Community structure, Species composition, Diversity

## **Landscape Units and Queqchí Landscape Perception, the *Honey of the Land Use Planning Cookie* in the Lachua Ecoregion, Guatemala**

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The Lachua Ecoregion is composed of the Laguna Lachuá National Park and its influence zone, an area delineated by the Chixoy and Icbolay Rivers. The influence zone was proposed for management of the Park in a landscape context, in order to avoid isolation. There are 23 rural villages present in the region, predominantly of the Queqchi ethnicity. Social factors are main forces of land use change in the region (Reid et al., 2000; Vanacker et al., 2003). In this study physic-geographical landscape units are compared with landscape units recognised by people from villages in the zone of influence. Landscape units were defined through vertical delineation of terrain and geology. Each legend unit includes vertical delineation, geology, altitude, climate, land use and soil type. Queqchi perception was evaluated through workshops in which participants identified landscape units within their villages. Three workshops were carried out in order to obtain information from villages located in the northern area of the Ecoregion and Spanish-Queqchi translation was employed for better communication as not all participants spoke Spanish. Four physical-geographical landscape units were defined in the study area. The Queqchi participants identified landscape units based on topographic and soil characteristics related to agriculture and other land uses. Religious beliefs were associated with some landscape units. During workshops, concepts of landscape planning were presented to attendants, who decided that the translation for landscape in the Queqchi language was *ruchich'och*, referring to everything covering the Earth. Currently, external forces exist pushing to change forests into livestock and oil palm monocultures. Land use planning based on landscape units is a key system for maintaining natural processes and productivity over time. Queqchi perception of the landscape reveals the way that people interact with their environment in the region. Both interpretations of the landscape should be taken into account when planning is undertaken. As a villager stated in a workshop “you and us, working together are the honey that sticks the cookie”.

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## Can Habitat Monitoring Schemes Capture Ecosystem Services?

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In recent times, the political focus on biodiversity (IPBES, CBD Aichi targets 2020) extends to ecosystem services (EU targets 2020). Monitoring schemes currently in place within Europe tackle many different system levels and topics, from EU-wide general land cover mapping to taxonomically oriented species monitoring. From a monitoring perspective several levels of biodiversity must be considered: landscape, habitat, life forms, species and genes. Most of the monitoring biodiversity schemes focus on the habitats and species levels. Although the habitat level is possibly the most suitable for ecosystem services monitoring, it is yet unclear how well these habitat monitoring schemes can provide valuable information on ecosystem services and what additional information could be needed to monitor them efficiently.

Among the various notions embedded in the concept of ecosystem services, a difference is acknowledged between the provisioning of services and the actual uptake of services. Biodiversity monitoring schemes generally provide records of the environmental and biological context, hence they record the potential of provisioning of services, but barely record any information on the uptake or use of services.

We compared 7 monitoring systems addressing three levels of biodiversity (landscape, habitat and species) for their potential to monitor ecosystem services and we discuss what steps could be taken to extend biodiversity monitoring schemes to ecosystem services monitoring. For the seven monitoring schemes, either on-going or experimental (CORINE, LUCAS, EBONE, BioBio, NILS and Pan-European Birds and Butterfly monitoring), field instructions and nomenclature were analysed on parameters that could potentially contribute to the computation of ecosystem service indicators. The schemes were subsequently ranked for providing proxies for the specific services and were then compared based on their score per service category. The monitoring systems aimed at habitat level (i.e. NILS, EBONE, BioBio) appeared to be the most effective in providing proxies for the provisioning of ecosystem services.

What is required to improve capacity of the monitoring schemes in capturing ecosystem services? Certain services and indicators are currently not monitored in any schemes, e.g. soil, marine and freshwater services. Some services may be monitored by only the environmental setting (biomass production, air purification), whereas for others the actual uptake of the service by people is a more important factor, e.g. recreation. Changes in sampling density and sampled parameters can result in a data improvement from indirect to direct indicator.

Conclusion: Of the here reviewed monitoring schemes, habitat monitoring schemes provide the best potential for capturing ecosystem services. However, additional efforts will be required to sufficiently monitor ecosystem services.

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## **Economic Assessment of Natural Resources of Lake Arpi and its Watershed Basin**

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The careless use of wetlands has caused many environment problems (The World General Assembly of Steady Development, 2002). These problems are of global importance. To help solve these problems, the 1971 Convention on Wetlands of International Importance, especially for Waterfowl Habitat (Ramsar Convention) was signed with the aim of ensuring conservation and wise use of wetlands and wetland resources.

Wetland loss has also occurred in Armenia due to historical communist policies allowing the extensive use of natural resources. Recognising the true values of wetlands, on 6<sup>th</sup> July, 1993, less than 2 years after independence from the former USSR, Armenia became a Contracting Party to the Convention on Wetlands. Two wetlands were selected for the List of Wetlands of International Importance (Ramsar List): Lake Sevan basin (150,000 ha) and Lake Arpi and surrounding marshes (3,139 ha). Both Armenian Ramsar sites are heavily threatened by human activities (Adamian Martin S et al. 1999). One way of supporting protection of wetlands is through economic assessment of areas.

The economic assessment of environmental function is difficult due to the lack of appropriate markets, therefore, it is very difficult to present their real value (Gluhova et al. 2003). Nevertheless an estimated assessment of the environment allow natural resources to be competitive economically (Lukjanikov e al. 2002). At present, rational use of natural resources of Lake Arpi and its basin is valued annually at approximately 290 million drams (\$760 000 USD).

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## Vegetation density patterns affecting the spatial variability of soil macrofauna biomass

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There is an increasing awareness that feedback between aboveground and belowground biota is a major ecological driver in terrestrial ecosystems. The study of spatial patterns of soil biota and factors by which they are governed is a key research area for understanding the structure and function of soil biodiversity and its relationship with above ground processes. This study was conducted to analyse the effect of vegetation density on spatial patterns of soil macrofauna biomass in the riparian forest landscape of the Karkhe River, southwestern Iran. Macrofauna (invertebrates visible at the naked eye) was sampled last winter by hand sorting 150 (50 cm × 50 cm × 25 cm) soil monoliths along parallel transects (perpendicular to the river). The sampling procedure was hierarchical and maximum distance between samples was 0.5 km. Samples were taken at 250 m, 100 m, 50 m and 20 m apart at different sampling locations. All soil macrofauna were identified to the family level. Macrofauna biomass was measured in each sample. At each transect point vegetation density (%) was also recorded (20 m × 20 m plots). The biggest problem in the measurement of vegetation density was finding appropriate sampling procedures that accounted for spatial variability with appropriate spatial resolution. Remote sensing applications and using NDVI was chosen to help define the spatial variability of vegetation density. NDVI was measured using an Indian Remote Sensing Satellite (IRS P<sub>6</sub>) and Linear Imaging Self Scanner (LISS III). NDVI was then correlated with vegetation density at each sampling point. Soil macrofauna biomass and NDVI data were analysed using geostatistics (variogram) in order to describe and quantify the spatial continuity. Both variograms were spherical and revealed the presence of spatial autocorrelation. The range of influence was 1728 m for biomass and 1977 m for NDVI. The soil macrofauna biomass was found to have a moderate spatial dependence (Nugget/Sill: 62%) but NDVI had a strong spatial dependence (Nugget/Sill: 19%). Soil macrofauna biomass significantly correlated with NDVI ( $r=0.4$ ,  $p \leq 0.01$ ). The similarity observed between both spatial patterns (range and model) may signify that macrofauna biomass spatial distribution is dependant on vegetation density in this area. It was concluded that spatial pattern of vegetation density affect macrofauna variability. This information could be used to evaluate landscape conditions and to aid in decision-making for ecosystem management.

**Keywords:** Spatial pattern, Soil macrofauna, geostatistics, NDVI

## **Agricultural Intensification and Landscape Homogenization Still Determine Large-scale Distribution of Farmland Birds in Brittany (NW France)**

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Agricultural intensification and its associated landscape homogenization have caused a major decline in biodiversity. In Brittany (NW France) the landscape is dominated by agriculture and strongly influenced by intensive farming devoted to dairy cows, pigs and poultry. Widespread crops are rotational grassland, maize and cereal, while vegetable crops are mainly cultivated in the western coast. This study aims at determining how agricultural landscapes and practices correlate with large-scale distribution of farmland birds in Brittany. Data were gathered from the breeding bird atlas of the region (2004-2008, 10x10 km), a remote sensing land use map (2004-2007, 250x250 m) and the French Agricultural Census (2000-2001, municipality level). Fifty-three species were studied in 224 10x10 km grid squares (>50% of agricultural covers). Constrained redundancy analysis (RDA) was performed with and without controlling for spatial patterns since large-scale factors influencing agricultural landscapes (e.g. climate, geology) can be masking determinants of species distributions at this scale. A likely spatial linear trend was considered by means of the central UTM coordinates of the grid squares. Alternatively, indicator species analysis and comparisons of species richness and diversity were computed after clustering landscapes according to significant RDA predictors.

Farmland birds were firstly structured along an agricultural intensification gradient, annual working units were opposed to forests, and secondly by the type of agricultural specialization, cereal crops were opposed to grasslands, ( $R^2_{\text{adjusted}}=11.2\%$ ,  $p<0.0001$ ). After accounting for large-scale spatial patterns influencing agricultural landscapes, the gradient of agricultural specialization was not more evident and the new RDA was less explicative ( $R^2_{\text{adjusted}}=6.7\%$ ,  $p<0.0001$ ). Only a few species seemed to respond to these gradients, being more related to agricultural landscapes with semi-natural covers than to those dominated by maize. Two groups of agricultural landscapes discriminating those with semi-natural covers (45% of the sample) against those dominated by agricultural covers revealed 9 farmland birds as possible indicators (IndVal values  $<0.26$ ,  $p<0.05$ ), but neither species richness nor diversity significantly varied according to these groups of landscapes. Excluding two possible indicator species that had extremely limited or boundless ranges, two of the remaining indicator species were more related to landscapes dominated by agricultural covers. These results are discussed bearing in mind that some species may have biogeographical constraints because Brittany is a small peninsula at the NW corner of France. Overall, results showed that at this scale agricultural landscapes in Brittany seemed to harbour quite uniform communities of farmland birds, although some species were still detected as being potentially jeopardized by agricultural intensification and landscape homogenization. Following this methodology, further research will focus on analyzing other taxa, biological data and finer spatial scales.

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## How Landscape Changes Regulate *Echinococcus multilocularis* Transmission

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Biological mechanisms known to affect space-time dynamics of infectious diseases may be impacted by ecosystem change and the last 50 years have seen the greatest changes in ecosystem structure and function in human history (Patz and Confalonieri 2005). Alveolar echinococcosis (AE) is a disease lethal to humans caused by a cestode parasite, *Echinococcus multilocularis*. The parasite is transmitted through a life-cycle including small mammal intermediate hosts (rodents and lagomorphs) and carnivore definitive hosts (foxes and domestic dogs). Over the last 15 years it appears that the parasite has spread its geographic range in the red fox populations of western and eastern Europe and large foci of AE have been discovered in Western China at the Eastern border of the Tibetan plateau. Transmission systems have been studied in eastern France and Western China combining quantified analysis of landscape changes, small mammal communities and AE prevalence in humans and foxes (Giraudoux et al. 2003, Giraudoux et al. 2006, Pleydell et al. 2008). Evidence has been provided that at the regional scale, landscape can affect human disease distribution through interaction with small mammal communities and their population dynamics. Regional models have been proposed where satellite imagery was used to describe landscapes and evaluate transmission risk. Here we review those studies and discuss their results with perspectives for studies of pathogenic organism transmission grounded on a systems approach and landscape ecology concepts.

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## **How to Make Knowledge Effective? Issues on Languages and Methods in Landscape Policy Making from the Italian Experience**

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The European Landscape Convention (CoE, 2000), signed in Florence in 2000, constitutes a turning-point in Landscape policy making and in urban planning in Europe, whose innovation has not yet been entirely acknowledged in practices. The innovative conceptual interpretation of landscape as the relationship between man and nature introduces subjective and objective issues. Moreover, it entails a problem-oriented approach towards planning, as well as a systemic and multi-level governance, where languages for reading and communication of the landscape play a pivotal role.

The present contribution discusses the process of knowledge building in landscape planning and management. The process of elaboration of public policies is at stake.

Landscape knowledge frameworks are composed of expert knowledge and of applied knowledge. Two different fields exist, one where applied knowledge forms itself (landscape as complex system), and another where choice takes form (work pattern of the policy maker) (Calafati, 2004). Separation of these two semantic fields constitutes a structural problem of rational policy formulation. Furthermore, the applied knowledge is elaborated through a global process of learning where policy makers, stakeholders, communities and expertise have to take part. It therefore becomes of fundamental importance that the procedure with which they acquire knowledge and contents of decisions should be adequately constructed, paying attention to and including the contributions of all the parties involved. In the landscape field, this assumption raises issues and questions in terms of languages and methods, according to the principles of European Landscape Convention (CoE, 2000).

The paper discusses how landscape knowledge frameworks influence and affect decision making, taking into consideration the Italian experience. On one hand, the process of knowledge building deals with the rising awareness and liability between actors, communities and policy makers. On the other hand, the systematisation of data frames gives place to a fruitful environment for multi-disciplinary and multi-level decision-making. Some Italian experiences are analyzed, providing evidence for conflicts and inertia of legal frames and regulation, with respect to landscape dynamics and quality objectives, as well as the effectiveness of methodological approaches in languages, scales and procedures.

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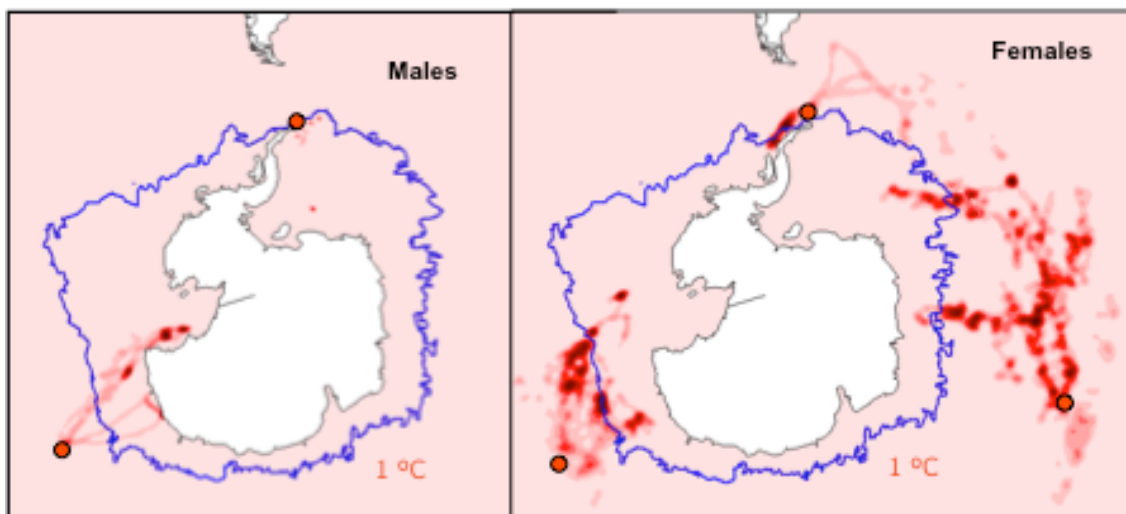
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# Sexual Segregation in Elephant Seals at a Global Scale and Potential Effect of Climate Change

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Elephant seals are among the most sexually dimorphic and polygynous species of all mammals, and show segregation between males and females in foraging grounds. We test the following hypotheses on the origin of sexual segregation: different energetic requirements, different reproductive requirements and different thermal requirements. We also analyse the predictions of the thermal requirement hypothesis in the context of the expected global climate change. We used website and bibliographic sources to obtain information on elephant seal distribution and environmental predictors at a global scale, Kernel models to represent foraging trips and MaxEnt distribution models to predict the present and future suitability of ocean regions. Male and female elephant seals showed differences in their habitat distribution. Females were distributed in warmer waters than males and males used shallower waters than females. Males also showed a trend towards more productive waters, however, this result was not statistically significant. In a global warming scenario, elephant seal distribution will move to high latitudes, and more overlap between females and males will occur in Antarctic waters. These results support the thermal requirement hypothesis: due to their relatively small body size, females are metabolically constrained and have a thermal limit in water temperature, while males can use the coldest waters of the polar regions due to their large size and thick blubber layer. More interactions between sexes and between members of different colonies are expected in foraging grounds in a simple scenario of global warming. The Figure represents results from colonies (red circles) located near the Antarctic, as an example. While most female populations are located in temperatures higher than 1°C, males forage in waters with temperature less than 1°C, most of the time.



## **Jaguar Habitat and its Connectivity in Yucatan Peninsula, Mexico**

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Continental scale assessments have been made to identify areas for conservation, connectivity, and monitoring for carnivores with large distribution range such as the jaguar. Within continental conservation schemes, however, it is important to recognize regional dynamics to provide spatially-explicit information at a scale relevant for decision-making and to incorporate differences in habitat availability for female and for male jaguars. The Yucatan peninsula of Mexico is believed to maintain one of the most important jaguar populations in the northern part of the range. We developed three potential suitable habitat models at the regional scale within Yucatan to compare predictions between sex-based (male or female) and non sex-based models. First, information from jaguar surveys was related to environmental and land-use/land-cover variables pertinent for habitat selection using MaxEnt to classify habitat patches along a gradient of suitability. Then, a cost path analysis was conducted to measure structural connectivity and identify potential corridors between suitable habitat patches using GIS. Models showed that highly suitable areas were scarce. Unsuitable areas around human settlements and roads resulted in fragmentation and limitations for the permeability of the landscape. There was considerable variation between the models, with the non sex-based model predicting only 52,700 ha (0.42%) as unsuitable, while female-only model showed 1,232,300 ha (9.78%) as unsuitable and male-only model showed 1,569,900 ha (12.47%) as unsuitable. We identified 10 potential priority areas for jaguar subpopulations based on the patches consistently predicted as highly suitable by all the models. Of those, only four were found partially within the limits of protected areas. Therefore in order to maintain connectivity, areas outside reserve become critical not just to act as corridors but also to provide potential habitat. Nevertheless, on productive land there is also greater risk of human-jaguar conflicts, underlining the importance of supporting land management strategies compatible with conservation. Ultimately, our research will help identify suitable areas for future jaguar surveys and inform management strategies at the regional scale.

## **Urbanization Processes and Landscape Changes of an Oasis City in Arid Areas — A Case Study of Jiayuguan, China**

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Landscape spatial patterns is a key research field in landscape ecology. Landscape patterns and their change are affected by both natural and human factors. Oasis cities are sensitive and

complex areas affected by their local environment and human populations in arid areas of China. Urbanisation results in the change of components including population, culture, industry, transport/construction and its aggregation. Jiayuguan is one of the typical historical and new-established industrial cities, located in Gobi Desert in the arid area in Northwest China. It is famous for its fragile environment, vulnerability and the intensely dependent relationship between human and environment. Based on remote sensing images from 1978 to 2009, social statistical data and RS/GIS techniques, this paper analyses the processes of urbanisation and landscape change in Jiayuguan. This research was undertaken to reveal the role of urbanisation in landscape pattern change in a the typical desert oasis city and to provide a scientific basis for understanding urbanization, landscape change and sustainable development of oasis cities in arid area of China.

The results indicated: (1) Urbanisation processes in Jiayuguan is apparent and has increased gradually. The population in urban areas increased from 69.95% in 1978 to 90.33% in 2009. The urban economy of the city also increased and industry dominated as the main contributor to the national economy (73.54%). Urban areas increased rapidly and the expansion index was 5.56%. (2) Unused land is the main land type and matrix of the local landscape. The change in temporal landscape patterns in Jiayuguan between 1978 and 2009 varied between landscape types. The area of arable land, forest land, water bodies and construction land increased by 47.78%, 150.93%, 41.81% and 177.79%, respectively. However, the area of grassland and unused land declined by 14.35% and 7.49%, respectively. The fragmentation of arable land, forest land and construction land decreased and unused land increased, however, grassland and water bodies both fluctuated during this period. (3) The Shannon's Diversity Index (SHDI) rose from 0.59 to 0.75, the Shannon's Evenness Index (SHEI) rose from 0.33 to 0.43 and the Largest Patch Index (LPI) decreased from 72.91 to 64.50. The differences between different periods decreased and the dominance of unused land reduced. The whole landscape of Jiayuguan city was strongly affected by human activity and total diversity and heterogeneity increased overall. (4) Landscape Shape Index (LSI) and division (DIVISION) both increased and the Perimeter-Area Fractal Dimension (PAFRAC) reduced. Landscape shape became more regular, matrix components reduced and control of landscape patterns decreased. (5) The increase in urbanisation led to greater interaction between urbanisation and landscape change and more impact on local natural system due to human activity in the oasis city. Macro-control and administrative supervision of local government and research on proposed urbanisation processes, including scientific planning and control of urbanisation processes, should be strengthened in the future to ensure sustainable development of Jiayuguan city.

**Keywords:** Arid area, Urbanization, Landscape pattern change, Oasis city, Jiayuguan

## **Perception, Knowledge and Communication of the Geomorphological and Cultural Landscape**

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The evaluation and improvement of environmental sustainability of a territory has to include the acknowledgement of the value of the site and its landscape. In any landscape recognisable elements include, the natural, physical, man-made, historical and cultural elements that in their integration, form the heritage of an area.

A surface model is an articulation of the topography resulting from morphogenetic processes that produce specific landscapes. These processes are driven by the geological and geomorphological features of the substrate and influence the topography, the urban cities and the history human settlements in those landscapes.

Geological history intersects with human history, which is enriched by the cultural values of the landscape that derive from the environment in which it develops and evolves. Even art is influenced by the environment: for example, artistic productions of Giotto or Perugino (in Umbria, Italy) reflects the 15th century landscape, fossil elephant bones found in the former mine of Pietrafitta describe a lake of two million years ago and the famous poet Dante Alighieri used natural topographical features for the description of the historical and psychological settings in his 14<sup>th</sup> century Divine Comedy.

These cultural findings define the emotional landscape of people living within it or visiting it. It is cultural development that by means of topography, tells the geological history of the site and the memory of the earth. As well as particular topographical and morphological processes, peoples and cities have altered and have been influenced by natural processes and the shape of the landscape.

The scenic fascination with Orvieto (the Tuff City) in Umbria (Italy) and its spectacular landscape derive from the morphological processes that have isolated the *mesa* from the Alfina *plateau* (Bolsena volcanic apparatus, in Lazio-Italy). The peculiar topography is the result of phenomena acting on volcanic rocks superimposed on clay: erosion processes have carved this unique landscape that attracts scholars and tourists. Due to erosion dismantling and shaping its topography, the landscape has become a unique natural site.

Cities built on an alluvial fan are generally perched on topset beds of marine or lacustrine paleodelta and tell a history of landscapes that existed in the past. Their perception and communication adds value to the territory.

The winery landscape is one of the last cultural backgrounds investigated from a scientific point of view in this paper. To know and communicate the *reasons* why wines belong to a certain region means not only describing the wine and its organoleptic characteristics, but also tracing the paleogeographic evolution of the territory that has conditioned the wine's *terroir*.

The geological history of sites is a heritage offering very important cultural content in terms of scientific dissemination, touristic activity and, last but not least, economic impact. To understand and convey the cultural contents of a place which also contains valuable resources, is an opportunity that must be developed and shared globally.

The landscape is also characterised by a strong biodiversity often influenced by *geodiversity* induced by the spatial diversity of rocks, the morphology of mountainsides, petrographic and mineralogical characteristics and by the color of substrate. Lithological, hydrological and morphology differences, and their density and distribution produce patterns are key to understanding diversity in geological sites.

Geodiversity therefore is an important variable for the evaluation and protection of territorial values and is also expressed through the topographical evidence of geosites/geomorphosites.

From the above discussion, a transversality of earth sciences clearly emerges. Geology/geomorphology, allows a relationship between the natural environment, forms and processes with artists, urban and cultural traditions and ethnographical traditions in a cultural synergy of scientific and didactic interests.

Cultural transversality is a scientific, cultural and economic opportunity and should not be underestimated nor ignored. Academic research of this field achieves goals and results that can play a great role in scientific communication. This can allow the comparison with other subjects and/or cultural items with different backgrounds. Through a multidisciplinary and integrated vision the sometimes unexpected values of the places may also allow be perceived, captured and communicated.

## **Validity of Landscape Function Assessment Methods – A Scientific Basis for Environmental Planning?**

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In the emerging field of environmental planning less attention is paid to the question, whether single or several methodical approaches, used within assessment procedures, could be invalid and therefore provide decision makers with unrealistic or misleading information (Gruehn 2010). Even if we assume that single invalid information would not change practical recommendations derived from complex multi-criteria sustainability assessments because of their pretended robustness, the question, whether and to which extent valid information is used within environmental planning tools could turn out to aim at a neuralgic point. A prerequisite for the discussion on the potentials to improve implementation of sustainability objectives in decision making or planning processes is the provision of assessment tools with valid data and methods. If we neglect scientific requirements and criteria, such as validity, landscape function assessment tools will face not only problems of acceptance within planning or decision making processes, but also juridical problems (Gruehn 2004).

Within this paper the need for validation techniques in the field of landscape function assessment will be discussed from a scientific, a legal, and a practical point of view. Different methodological approaches for the application of validity tests under varying conditions and contexts are described. The chapter will include an outline of numerous examples, which illustrate the broad field validity tests can be applied for, and which consequences can be derived from validity tests, especially in the field of EIA and SEA. Finally, the paper gives a perspective on potential further research topics.

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## **How to Assess the Ecosystem Service Biodiversity?**

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In view of the growing anthropogenic load on the ecosystem, as expressed in such phenomena as the dangerous loss of biological diversity or energy and climate problems, it is becoming ever more urgent to control the various and increasing claims upon limited resources, and to ensure sustainable land use. Numerous ecosystem services, such as the beneficial effects of biological diversity, have been very little investigated to date. In particular, there is a lack of quantitative systemic understanding, i.e. comprehensive knowledge of process interconnections.

Nowadays the habitat service has been identified as a separate category to highlight the importance of ecosystems to provide habitat for migratory species and gene-pool “protectors” (TEEB 2009). For reasonable statements, the individual services must be adequately specified. Moreover, reference to indicators which describe these are needed. In this respect, there are still considerable deficits in the literature.

The ascertainment of ecosystem or landscape services always involves an assessment step, i.e. scientific cognitions (factual level) is transformed into social categories (value level). The decisive factor is the combination of the various causal areas in the relationship between society and nature, e.g. in the form of economic valuation.

Assessment is the decisive step in interpreting a given (objective) factual context so as to permit decision-making and action. Several assessment levels can be distinguished, depending on contents or complexity: technical assessment/s (the mono-sectoral approach); comparison (political interest trade-off) with other use claims or policy areas (multi-sectoral approach) as a basis for decision-making; and ultimately, concrete action. Only once the assessment of given conditions of ecosystems and landscapes has been carried out using predefined standards, targets (models) and/or demands for action, will the substantial criteria for an assessment in the strict sense be fulfilled.

Based on a model framework for the processing of ecosystem/landscape services we will present a procedure for analyzing and assessing of ecosystem services for conservation/provision of biodiversity. The algorithm will be explained theoretically and on the basis of a practical example.

## **Landscape Management Strategies Based on Monetary Valuation**

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Sustainable used landscapes maintain hardly measurable goods for the benefit and for the future viability of man. Their unimpaired ecosystems are able to provide a multitude of services for human welfare. Frequently, the majority of these goods are public or common, thus not restrictable for private use. However, open access undermines the foundation of marked mechanisms basing on supply and demand. But those goods and services are by no means worthless just as they are unlimited available. On the contrary, the more people can use them, the greater their cumulative value is for society. The preservation of natural free services should matter public and private interest, but the opposite is still true. Civil society acts like within a prisoners' dilemma optimizing private profits at the expense of social benefits according the common market mechanisms. In order to overcome these challenge, we calculate reference values for the hardly marketable goods and services as well as for the efforts to protect natural ecosystems called management of the countryside. It is shown that the loss of intact ecosystems is much more costly than their maintenance.

The topic should be elaborated regarding landscape management at the example of Saxony (Germany). We discuss and illustrate the method of calculation and the comparison of resulting costs. The term landscape management is understood as the total of measures due to the protection, care and developing of near-natural habitats for plant and animal species as well as the maintenance and restructure in case of damages concerning the natural balance or regarding the scenery. A principal task is the preservation of landscape and bio-diversity. The calculation of management costs comprises firstly the determination of care-dependent objects (biotopes, structure elements, and species), secondly an allocation of necessary measures, and thirdly an estimation of the depending costs per year and object. The total financial requirement is composed of costs for maintaining, developing, and investing measures per biotope resp. habitat type as well as special expenditure for species conservation. The presentation explains the methodical framework step by step. The balance of landscape management reveals from the comparison between needs and real expenditures. The differences between need for action and true funding set starting points for future strategy as well as for the formulation of new measures and management objectives.

## **Biological Indices of Natural and Semi-Natural Forest Patches in Urban Guangzhou, China**

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Study of biological indices such as vegetation and soil is significant for urban natural and

semi-natural forest patches, which have relatively high ecosystem services. According to remote sensing interpretation and field survey, there are 94 natural and semi-natural forest patches (>1ha) in urban Guangzhou, with a total patch area of 8496.6 ha, which is 11.91% of the total area of the study region. The amount, area and NDVI of patches increases with distance from the urban center. Vegetation coverage is also related to the area of patches. When the area of patches were less than 30 ha, the areas where  $NDVI \geq 0.6$  accounted for only 13.3%. When the areas of patches were between 30 and 50 ha, as well as more than 50 ha, the areas where  $NDVI \geq 0.6$  were 30.9% and 47.3%, respectively.

Most of the natural and semi-natural forest patches in urban Guangzhou are at the early and middle stages of vegetation succession. However, a small percentage, in the form of Fengshui Woodlands, are at the late stage of vegetation succession. The species diversity, biomass, CWD storage and total organic carbon (TOC) of vegetation tend to increase from early to late stages of succession. In surveyed plots, the Shannon-Wiener Index of the arbor layer varied from 0.3861 to 3.0901, the biomass varied from 69.61 t/ ha to 371.34 t/ ha, CWD storage ranged from 0.22 t/ha to 13.37 t/ha and TOC varied from 33.30 g/kg to 64.11 g/kg. The contents of water soluble organic carbon (WSOC), microbial biomass carbon (MOC), easily oxidized carbon (EOC) and particulate organic carbon (POC), which are relative unstable and easily oxidised and decomposed, were 0.039~0.232 g/kg, 0.16~0.61 g/kg, 6.73~13.54 g/kg and 12.11~24.48 g/kg, respectively. TOC and labile organic carbon (including WSOC, MOC, EOC and POC) of the natural and semi-natural forest patches were significantly higher than those of the urban artificial green land. The species diversity was affected by different habitat factors such as the spatial distance among forest patches as well as the distance between habitats and urban center. The species diversity increased as the distance between sample-plot and urban center increased.

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**Keywords:** Natural and Semi-Natural forest patches, Biological indices, Species diversity, Biomass, Soil Organic Carbon, Urban Guangzhou

## **Direct and Indirect Causal Relations between Frugivorous Birds and Plant Communities in Fragments of the Brazilian Atlantic Forests**

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Causal relations among productivity and composition of forest remnants and bird communities are typically known because the abundance of dispersers is spatially correlated with abundance of fruits. However, this causal relationship may also be affected in

fragmented landscapes due to spatial and functional parameters. Changes in the landscape may directly lead to a decrease of species through changes in the availability of resources and in the intensity of interspecific interactions. To analyze this causal relationship we used path analysis which may identify the causal correlations. We tested the importance of direct and indirect effects of landscape (patch size and forest cover) on rates of plant species richness and productivity and the abundance and richness of frugivorous birds in seven fragments and three continuous forests during two seasons. The models are still inconsistent, however with significant trends of routes. Patch size has direct effect on the richness of birds and productivity of fruits. However the richness of fruits affects indirectly the bird species. The primacy of effects suggests that birds are most affected by the direct effects of the structure and configuration of the landscape and just indirectly through the availability of fruits, which highlights the habitat conditions in fragmented forests.

## **Landscape Function Research Applied in Environmental Planning and Policy Making**

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The functionality of landscape is shaped by humans to obtain goods and services that are beneficial for society. Examples of these landscape functions are food production, recreation, flood protection, and habitat provision (Verburg et al., 2009; de Groot et al., 2006). To comply with the increasing demand for land, landscape (multi-)functionality is increasingly used in environmental development policies and plans (Renting et al., 2009). It is therefore important to quantify and map landscape functions and to recognise relations between landscape functions and their environment. Because numerous different landscape functions exist, there is not one single method to identify and map these landscape functions (Gulickx et al., in prep), which makes their assessment complex and difficult. Next to scientific research, environmental policy makers and planners develop maps to establish the spatial consequences of their policies. Both disciplines use their own methodologies, whilst they can enhance each other's methods to achieve improved results.

This research developed three landscape function maps for two case study areas in the Netherlands. For each map a different methodology was used, one based on environmental policy, one on environmental research, and one on a combination of the two (Figure 1). Interactive interviews were conducted with the governing coalition, including engineers, local decision makers, and the water board to agree on terminology and objectives. The methods were compared and consolidated throughout three workshops. The authors generated a 'combined landscape function' map using the combined methodology, which were compared with the 'policy landscape function' and 'scientific landscape function' maps for both case studies. The results and methodologies were discussed in a feedback workshop and useful recommendations were specified to enhance collaboration between environmental policy makers and planner, and environmental scientists. This research shows that close collaboration between scientific environmental research and environmental policy making and

planning can lead to an improved product.

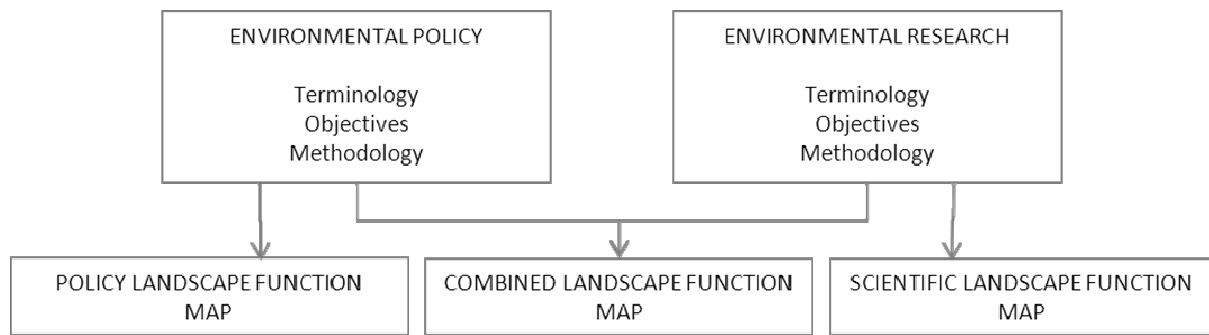


Figure 1. Methodological framework

## Analysing and Mapping Landscape Functions: A New Challenge in Land Change Research

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Ongoing changes of land have unintended consequences for the atmosphere, human health, and biodiversity. These consequences can be detrimental, therefore, a better understanding of land change processes are required. Analysis beyond studying land cover and land use change by including land functions and the provision of goods and services in land change research is becoming increasingly more apparent. Landscape function (LF) is defined as the capacity of the landscape to provide goods and services that directly or indirectly satisfy human needs. A particular methodological challenge is to analyse and map these LFs, considering the diversity of LF-types combined with a lack of ready-to-use methods. The objective, therefore, is to investigate methods to identify, map, and analyse LFs.

We defined 25 potential LFs for region ‘De Peel’ in the Netherlands (192 km<sup>2</sup>). Based on method requirements, LFs were classified from those that can be directly obtained from land use maps (e.g. residential and forest habitat) to those that require additional information from data bases or field observations (e.g. aesthetic beauty and hobby farming). To investigate methods of LFs thoroughly, we focused on four LFs (entailing diverse method requirements): land-based animal husbandry, forest recreation, aesthetic beauty for walkers, and wetland habitat. For 400 data points, LFs were identified at a radius of 10m, 100m, and 200m to ascertain the effective scale for the four LFs. Additionally, spatial characteristics (e.g. elevation, soil, road-type) were either observed in the field or obtained from GIS data. Correlations between LFs and spatial characteristics were calculated at the corresponding effective scale. From these correlations suitable determinants for each LF were ascertained

and extrapolated to a LF map.

Results indicate that fundamentally different methods are necessary to identify and map LFs. The correlations between the LFs and spatial characteristics provided several suitable determinants to map the LFs, although the accuracy of some maps need to be further improved. Overall, the provided methodology can be used for all LF-types and provides a fundamental set-up to attain the necessary information to analyse and map landscape functions. However, the lack of data remains a crucial limitation and a great challenge we need to take up. Although the assessment of LFs is still difficult, our approach improves our ability to analyse and map LFs, and hence, provides us better insight in the human-environmental system.

**Keywords:** Landscape function, Goods and services, Land cover, Land use, Land change, Methodology, Mapping, GIS

## **A Geographical Cellular Automata-Based Study on Land Use Change**

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Land use and coverage change have always been popular issue of globe change research at home and abroad. The characteristics of land use change and its spatial distribution both indicate the stability and sustainability of a regional ecological environment. Geographical cellular automata as a land use dynamic model of probing spatial-temporal evolution patterns, is able to predict future land use conditions by simulating changes in land use. Taking Minqin oasis as the study area and on the basis of the variation of land use in 2000 and 2005, this paper focuses on the prediction land use structure in 2010 through the use of a geographical cellular automata model. The results show that the land use structure modeled for 2000 approximated the real structure. This calculation and prediction model method is characterised by simpleness, accuracy and speediness, however, it is necessary to improve the prediction accuracy of land use of geographical cellular automata.

**Keywords:** Geographical cellular automata, Spatial distribution, Land use

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## Tumen River downstream Wetland Ecosystem Health Assessment

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Detailed wetland ecosystem health research is currently undertaken at home and abroad. On this basis, a wetland ecological health evaluation system for downstream Tumen River was established. In this system the health, sub-health, general sickness, disease and use of a five standard pressure - state - response (PSR) model was assessed in combination with wetland characteristics of Tumen River downstream. A wetland ecosystem health evaluation index system was provided from this assessment for Tumen River downstream regions.

The system layer was divided into three items and eight factors layer, giving a total of 30 indicators and provides quantitative standards for each indicator. A more comprehensive indicator system to cover the physical, chemical, biological, landscape, socio-economic and human health broad categories index was also investigated.

The weight of each index was calculated through the Analytic Hierarchy Process (AHP) and three fuzzy comprehensive evaluation methods were then used to calculate the final result. The results showed that the health status of the Tumen River downstream wetland ecosystem is that of Sub-health. While the overall health index was calculated to be 0.5878, the pressure, state and the response indicators were found to be 0.5292, 0.05116 and 0.6866, respectively. The matrices of membership degrees was S=16.83%, 25.37%, 16.76%, 16.97% and 24.07%.

The factors resulting in the poor Tumen River downstream wetland ecological health status were considered to be poor water supplementation resulting in serious water pollution and eutrophication, and man-made factors which have lead to wetland degradation, fragmentation and productivity reduction.

These factors have eventually led to the health decline of the wetland ecosystem in downstream Tumen River. Wetlands are suffering from certain threats to their health and analysis to determine reasons for these threats has allowed countermeasures for wetland ecosystem health protection, recovery and sustainable development to be put forward.

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## A Basic Experiment in Wetland Restoration using a Seed-bank in Shiga Prefecture in Japan

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After World War II, Lake Biwa, in Shiga Prefecture, Japan, and many swamps and *naikos* (lagoon in this lake area) were reclaimed as agricultural land resulting in the loss of many aquatic plant habitats. However, in recent years, the importance of swamps and lagoons has been established as places of water purification and biological habitats. As a result, the restoration of reclaimed land has returned swamps and lagoons to their original condition in Japan. Sufficient discussion has not been undertaken, however, regarding the method of vegetation restoration in the wetland recovery process. The purpose of this research is to examine the possibility of using buried seeds in vegetation restoration.

In this study, soil samples were collected from the most southern littoral part of the *naiko* (*Shonakanoko*) in the middle east side of Lake Biwa, which was reclaimed in the 1946 and is now utilised as a paddy field. The surface cultivated soil layer (0~20cm depth) was first removed and collected followed by four more layers of soil: 1st, 20~45cm; 2nd, 50~70cm; 3rd, 80~100cm; and 4th, 110~130cm depth. Each layer was spread over a shallow pool (4.8 m×1.8 m=8.6 m<sup>2</sup>) in March 2009. Three soil cores were also collected from each layer using a cylinder (10 cm in diameter, 20 cm in height). The soil spread depth was almost 5 cm and the water level was maintained at a depth of 20 cm. Seedlings germination was recorded from April it began and continued until September.

The germinations of 1,623 individuals (23 species) in four spread pools was recorded with a mean density of 47 seedlings m<sup>-2</sup> (28~89 ind./ m<sup>2</sup>), including three submerged species and four rare species. The germination number in the 1st layer was the highest, and more significant in comparison with other layers. The seed-size of species germinated in the first layer was generally less than 0.5 mm (70%). Although the rare species *Najas japonica* nakai, germinated in all layers, it germinated the most in the 4th and deepest layers. Using a hand sorting method, the number of seeds in the soil cores were counted. From this method seeds from two rare species (*Najas foveolata* A. Br. & *Potamogeton* sp.) were found in the deeper layers (2nd & 3rd layers). Judging from the conditions of these seeds, it is conceivable that the germination capacity of these species are high. In deep boring core samples from other reclaimed areas, seeds of *Potamogeton* spp. have also been found in a deeper layer (4.70 m~4.75 m depth).

The study presented two restoration methods; the short term recovery method by using the soil of shallow layers and a method that places emphasis on the recovery of rare species from deeper layers of soil.

## **The Impact of Plants on River Morphology**

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The changing location and form of floodplain rivers provides a dynamic mosaic of aquatic and riparian habitats across the river channel and surrounding floodplain. During the 20<sup>th</sup> century, research on this theme developed from a consideration of the dependency of river and floodplain styles on river flow and sediment transport regimes, to an increasing focus on the plant communities that characterise particular fluvial landforms, and areas of specific inundation frequency and/or groundwater availability. In the first decade of the 21st century, an increasing body of research has started to reveal the many ways in which plants can contribute to the building, reinforcement and turnover of fluvial landforms. This paper will consider the importance of these historical trends for our understanding of the functioning of relatively unimpacted river-floodplain systems and the ways that we can incorporate such understanding into attempts at river rehabilitation and restoration.

## **Designing Farmland for Multifunctionality – A Case Study from South Sweden**

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Agriculture provides the production of food and fibre, but also a wide range of landscape values such as biodiversity, cultural heritage, recreation and amenity values. The importance of multifunctional agriculture for society has often been stressed and has become a major goal for European agricultural policy. Improvement of multifunctionality of farmland is thus often requested in various policy documents asking for an enhancement of landscape values as biodiversity and recreation. However, the interrelationship between these different landscape values has been comparatively little studied in the context of farmland development towards an increased multifunctionality.

In this case study we explored the relationship between the different landscape values biodiversity, cultural heritage, recreation and amenity values under the task to improve multifunctionality of a farm in South Sweden. In our methodology we combined methods originating from both the natural sciences and the design traditions of landscape architecture, the later being more often applied in urban settings and less often in an agricultural context. The aim was to create a spatially explicit farm plan where multifunctionality is improved through the integration of the studied landscape values. This was done by

- surveying and analysing each studied landscape value (biodiversity, cultural heritage, recreation, visual aspects)

- preparing one plan for each landscape value with suggestions for development
- an integration process with the overall goal of integrating as many of the suggestions made as possible without negatively affecting the others
- designing an integrated farm plan including an analysis of trade-offs in the integration process

The farmer was interviewed at the beginning of the process and the plans were discussed with him afterwards. The results demonstrated that it was not always easy to integrate the considered landscape values in practice. From the case study, we developed some general relationships – synergies and conflicts - between biodiversity, cultural heritage, recreation and visual aspects that can occur when improving multifunctionality on farmland. Finally, we discuss how the design approach of landscape architects can contribute to developing multifunctional farm plans and how the design process results in farm-specific solutions.

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## **Analyzing Landscape Multifunctionality: A Contribution to Efficient Landscape Management and Solving Scaling Problems?**

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Landscape management has to deal with the tasks of (i) applying a given budget for implementation in a way which creates the most benefits and (ii) solving problems which stem from discrepancies in the distribution of cost and benefits of land use changes across different levels of spatial analysis and decision-making. Assessments of land use multifunctionality have so far primarily contributed to the first task (e.g. Wiggering et al 2008). However, little empirical evidence is presently available concerning general synergies between certain landscape functions and respective management measures (Rueter 2008). Another unresolved question is whether multifunctional measures can contribute to addressing scale-related governance problems.

This paper assesses the multifunctionality of different landscape functions and related management measures and calculates degrees of synergy between them. The biosphere reserve “Elbe Floodplain”, Germany, serves as a case study. Data comes from an existing landscape plan, and considered landscape functions include climate protection, biodiversity, soil, and water.

The assessment results in four findings: First, expected land use changes – in this case primarily the conversion of grasslands to fields – could result in a considerable rise of GHG emissions and a loss in biodiversity. Second, the multifunctionality analysis shows considerable spatial overlaps between areas suitable for enabling or supporting GHG storing and sinking, protecting soil and water, and safeguarding biodiversity. Measures which serve all three functions overlap on about 10 percent of the climate protection priority areas.

Third, the choice between multifunctional measures should be based on the most specific demands: Measures for safeguarding or improving biodiversity are usually more specific with regard to management and location than measures for climate protection and soil and water conservation. Fourth, multifunctional management including soil and water protection measures can also contribute to some degree to the governance of scale related problems. In some cases, climate protection or biodiversity measures coincide with EU's Cross Compliance (CC) or good agricultural practice (AGP) and this comes as an added value when CC or AGP management requirements are fulfilled. In the case of CC and AGP both cost and benefit should occur on local scale.

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## **Reducing the Emission of Green-house Gases in Farm Management: Assessment of an Ecosystem Service and Generating Revenue by Climate Protection**

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Agricultural land use is a major source of greenhouse gases. In Germany CO<sub>2</sub> emissions from farm land originate mainly from ploughing up of grassland (especially on peat soil). N<sub>2</sub>O emissions are caused primarily by intensive fertilizing. At present both the assessment of the emission risk as well as control mechanisms are unsatisfactory. Farmers are not remunerated adequately for climate protection ecosystem services. In order to safeguard greenhouse gas storages and sinks and to prevent emissions, strategies have to start at farm scale, where the emissions or respective ecosystem services are produced.

A methodology has been developed for estimating CO<sub>2</sub> and N<sub>2</sub>O emissions on the basis of soil and land use data (Saathoff, Haaren 2011) and an approach by Neufeldt (2006, unpublished) for the calculation of organic carbon stocks in soil. For the assessment of N<sub>2</sub>O emissions farm data about crop rotation and fertilizer input is necessary (method by R. Dechow, A. Freibauer, vTI Braunschweig). The assessment method was programmed in the open source farm management system MANUELA. The results represent the precondition for a targeted strategy of land use related climate protection. Control or remuneration mechanisms can be concentrated on sites with the highest (potential) emissions.

The remuneration of respective ecosystem services could be realised by agri-environmental programs, by including land use into emission trade or by generating revenue on commercial markets. The latter option seems to be an innovative and timely way to compensate in parts for deficits in governmental control mechanisms. Some German eco-food producing companies are planning to support environmental farm services provided by their suppliers.

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## **Modeling Green-blue Ecosystem Service Potentials in Growing and Shrinking Cities**

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Ecosystem functions and services provided by urban areas, particularly their open, green spaces and waters, are by far underestimated (Boland & Hunhammar, 1999). In urban areas, biodiversity and ecosystems contribute to a range of ecosystem services of importance for human well-being (TEEB study; URBIS initiative). These services are generated in a diverse set of habitats such as parks, cemeteries, allotments, vacant lots, streams, lakes, gardens and yards, campus areas, golf courses, bridges, brownfields and landfills.

In terms of individual ecosystem services urban vegetation may significantly reduce air pollution and noise (Boland & Hunhammar, 1999). Urban parks, lakes, rivers, coastal areas, vegetation, green roofs and green walls may significantly reduce the urban heat island effect, especially during heat waves (Kottmeier et al., 2007). An increase in the canopy cover may decrease ambient temperature by about 3 Kelvin which makes trees of high interest in climate change adaptation strategies to serve as cooling spots (Schwarz et al., 2011). Urban green spaces also provide direct health benefits, e.g. presence of street trees has been found to be associated with a significantly lower prevalence of early childhood asthma (Lovasi et al., 2008), accessibility to green-blue spaces can be linked to reduced mortality (Mitchell & Popham, 2007) and improved perception of overall health.

Urban planning could use green and blue spaces more frequently in terms of developing adaptive and resilient cities as it does at the moment. The most crucial reason why science has not met the threshold for policy impact/change concerning ecosystem services is, according to Cox and Searle (2009), the lack of information, standards, and verification as well as

insufficient involvement of local stakeholders, particularly in urban areas. Among cities, those that are shrinking bear great potentials to deliver ecosystem services and maintain/improve quality of life as they hold large brownfields in their inner parts (Haase, 2008).

Set against this background, the paper will discuss concepts and assessment of green-blue ecosystem service potentials in both growing and shrinking cities using modelling techniques.

## **A Synthetic Approach to Modeling Riparian Landscape Change during Urbanization: Exemplified by Suzhou Case**

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Many Chinese cities are enduring rapid urbanization, which involve fundamental conflicts between maximum production of urban environments and maximum protection of natural environments especially in the fringe belt. A simple, intuitionistic and effective approach to demonstrate the landscape change and make scenario analysis for different scheme is essential for the landscape management.

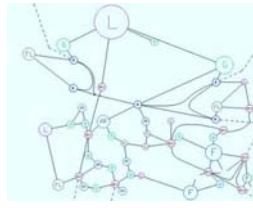
The authors synthesize two ecological concept to form an integrated method, which derives from the *Landscape Graphs* (Margot D. Cantwell and Richard.T.T. Forman,1993) , and the *Componential Model of Ecosystem* (Eugene. Odum, 1971) . *Landscape Graphs* adopts a topological method to comparing land mosaics based on the spatial configurations of and interactions between landscape elements. E. Odum promoted the use of *Bioenergetics* to evaluate what kind of ecosystems one has and how to rank their value for planning. With easy categorization of an ecosystem by P/R ratio, it is easily converted urban ecosystem into a simple compartmental model.

Landscape graph can provide the spatial pattern while componential model can indicate the attribute of ecosystems and direction of entropy flow; they can be embedded perfectly in GIS application for more complicated analysis. With the framework, the authors develop a simple and effective methodology to model landscape change with easily accessible land cover data such as Google earth image and historical map. Exemplified in Suzhou riparian zone, this approach can detect ecological network configuration (Edward A Cook, 2002), hotspot area and disturbance easily. After all, its features to illustrate the trajectory of landscape change and compare scenarios directly and vividly, will not only provide insights into the balance of protection and development, but also contribute to make constructive and feasible policies in urban context.

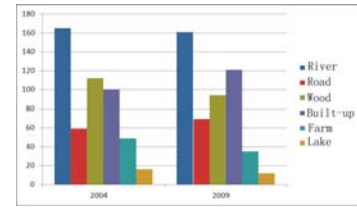
**Keywords:** Landscape graphs, Bioenergetics, Ecological history modeling; riparian; GIS



Land cover Image



Landscape Graphs analysis



Nodes Change from 2004-2009

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## Greenhouse Gas Fluxes in an Open Air Humidity Manipulation Experiment

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Air moisture is one of the main factors that causes the greenhouse effect. Air consists of roughly 2% water, which may be responsible for 2/3 of the greenhouse effect. IPCC (2007) predictions show that humidity will increase due to climate change in high latitudes such as northern Europe. If humidity increases because of climate change, it is necessary to know its influence on greenhouse gas emissions in order to predict the ecosystem's reaction to climate change.

In 2006, a Free-Air Humidity Manipulation (FAHM) facility was established to investigate the effect of increased air humidity on the performance and canopy function of two tree species - silver birch (*Betula pendula* Roth.) and hybrid aspen (*Populus tremula* L. × *P. tremuloides* Michx.). The FAHM system is situated in Järvelja in southeastern Estonia (58°24'N, 27°29'E, altitude 40-48 m), on Endogenic Mollic Planosol of former arable land. The system enables relative air humidity to be increased to 18 units (%) over the ambient level during mist fumigation, depending on the wind speed inside the experimental stand (Kupper et al., 2011). In addition to humidification plots, decreased humidity and control plots were established.

We measured CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O emission from the FAHM system using closed chamber and gas-chromatograph techniques since July 2009. Measurement has been carried out once a month in three humidification (h), one decreased humidity (d), and five control (c) plots. In each plot, 5 replicate chambers have been used, and water depth in piezometers, as well as soil temperature, soil moisture and vegetation parameters have been measured.



The vegetation period from 2009 had a great deal of precipitation, but the next summer was very dry. The results varied from one year to another. The dry summer made it easier to perceive the humidification effect, whereas during the moist summer, a drying effect appeared. The CO<sub>2</sub> flux decreased when air moisture differed from the control. Soil acted as a sink to methane. More CH<sub>4</sub> was captured in the soil with decreased humidity, whereas increased humidity made soils a weaker sink. Emission of N<sub>2</sub>O did not have a significant relationship to humidity, but one could observe a clear trend that the period with increased humidity had a greater N<sub>2</sub>O flux. Expectedly, CO<sub>2</sub> and CH<sub>4</sub> flux demonstrated a strong positive correlation with soil temperature.

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## The Importance of Yatsu Landscapes to Conservation of Biodiversity in Urban Fringes

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This research focuses on the 'yatsu' landscape of the southern Kanto Region, in central Japan. Yatsu is a local term for narrow valleys that cut complicated branching patterns into the surrounding uplands (Fujihara *et. al*, 2005). This agricultural landscape consists of narrow, branching valleys where rice is cultivated in irrigated paddies, and surrounding slopes and uplands devoted to a variety of landscape types, such as dry vegetable field, orchard, bamboo grove and coppice woodland. These valleys form the representative geological feature over much of the southern Kanto Region, central Japan. In the traditional land use pattern the bottom of the yatsu valleys are planted in irrigated rice paddies. Upstream, however, the valleys grow even narrower as they branch, and near their source are only wide enough for a few very small paddies. These paddies are inefficient in terms of agricultural production, and are frequently abandoned. The area around the head of a yatsu valley, however, often supports a rich mosaic of wetland and forest habitats, including natural water seeps, dirt irrigation ponds and canals, small marshes, and various forests growing along the valley slope. In recent years, these areas have been recognized as vital cultural assets and important biodiversity reserves, especially in rapidly suburbanizing countryside regions.

Azeta Yatsu is a typical yatsu valley landscape located in western Sakura City, Chiba Prefecture, in the eastern suburbs of Tokyo. Parts of the valley and surrounding uplands have

been purchased by the city, and the land is now designated as a municipal park. Conservation and restoration work in the park, targeting both marshland habitat and traditionally maintained rice paddies, is being implemented under cooperative participation of the local administration, NPOs and citizens. Abandonment of rice paddies in the Azeta Valley began in the 1970s, but from 1992 a local NPO leased and continued to maintain some paddies. In 2000 this area was converted into a biotope (bio-reserve). In addition, a comprehensive management and restoration program, funded as a Strategic Habitat Restoration Program by the Chiba Nature Restoration Fund, has been implemented since the city acquired the land in 2006. This program, cooperatively managed under the active participation of various stake-holders, includes restoration and management of marsh and paddy habitat, monitoring of the local flora and fauna, and various information dissemination and exchange forums. Under this management program, native aquatic plant species have revived from seeds that had remained viable in the mud. In addition, populations of several species of amphibian, including the Japanese brown frog (*Rana japonica*), listed as A-rank (most vulnerable) in the prefecture RDB, have increased dramatically. The grey-faced buzzard-eagle (*Butastur indicus*), raptors which had previously disappeared from the area, have returned.

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## Monitoring of Landscape Changes in Eastern Asia Using Terra/MODIS Data

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In East Asia, geographic conditions have created a diverse natural environment. In addition, the influence of human activities also shows a long history. As a result, the region is rich in terms of diverse landscapes. On the other hand, in recent years modernization and accompanying changes in lifestyles are drastically impacting these traditional landscape patterns, including forest landscapes. Repeated human impact has been changing old-growth forests to secondary woodlands, pasturelands, farmland and even urban areas. The purpose of this research was to elucidate the potential climax vegetation and the present vegetation for East Asia. Terra/MODIS data, although available only in relatively low spatial resolutions of 250 m, and 500 m, can be acquired every day, and is thus suitable for understanding seasonal variations. In addition, the data is available over a wide area, and can thus be used to identify and monitor general landscape patterns and changes at the level of East Asia. This research employed MODIS data covering eastern Asia, for the years 2001 through 2010, acquired by Tokyo University of Information Sciences. MODIS data was utilized to classify LU/LC, and

the results of this classification were compared to the potential vegetation as predicted by the Warmth Index (WI), altitude and topography. The authors (Hara et al, 2010) have developed a system, called the Landscape Transformation Sere (LTS), for tracking changes in LU/LC patterns and vegetation as caused by human activities. Based on these comparisons, areas that had changed from the predicted category were identified, allowing for construction of a tentative three stage LTS model for describing landscape change at the regional level.

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## **Does the Brazilian Forest Legislation Contribute to the Biological Conservation of the Atlantic Forest? A Case Study**

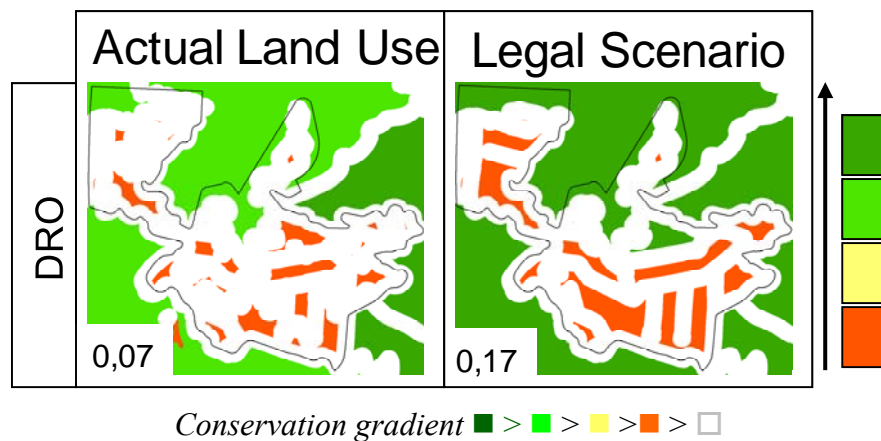
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The importance of the forest legal protection is related to its efficiency in maintaining fragments and forest resources submitted to the human interventions. In this way, the purpose of this work was to evaluate the forest conservation potential for a residence property development containing isolated buildings situated in the Atlantic Forest - São Paulo (BR). It was compared the legal scenario with the actual land use map applying landscape metrics in ArcGis®. The landscape was evaluated based on metric values of the resources availability - DRO (Hardt, 2010), permeability - P (Metzger and Décamps, 1997) and forest fragmentation: edge density – ED; edge segment density - ESD (Zeng and Ben Wu, 2005). The results showed that the forest cover increases and the ED and ESD values decrease on the legal scenario analysis. However, the legislation does not impede the existence of access roads and its negative effects on the shape and size of the habitat. As a consequence of these effects, there are just low environmental gains in terms of DRO (Figure 1). This way, it was concluded that the increase in amount of habitat and the reduction in the fragmentation prescribed by environmental legislation not always represented an increase in landscape quality and could not have the same contribution to biological conservation, mainly due to influence of the access roads, their disposition and edge effect on the forest fragments.



**Figure 1.** Spatial representation of the landscape metric values about the resource availability optimized of the Ermida residence property development – São Paulo (BR).

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## How Verticalization of Cities Affects Bird Distribution and Behaviour: A Case Study of Magpies in the Urban Area of Beijing, China

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Verticalization of urban landscapes caused by urbanization and urban redevelopment of downtown areas is rapidly increasing in the East Asian countries. Birds have wings, but tall buildings will cause birds to flyover and will block the bird's view. To evaluate the influence of tall buildings on the distribution of urban birds, we studied the habitat preferences of Black-billed Magpie (*Pica pica*) in the urban area of Beijing, China. The magpie is a Corvidae bird and breeds widely in urban and suburban areas of Asia and Europe (Birkhead 1991). Recent urbanization with tree plantation programs in France led to an increase in the probability of magpie occupancy (François et al. 2008), but do recent urbanization and urban redevelopment with tall buildings in the East Asian cities also affect positively on the magpie occupancy? We surveyed the distribution of magpie nests, and observed the magpie's breeding behaviour in two different urban areas in Beijing.

A pair of magpies protects their own breeding territory around their nest, especially the tops of trees of "their" territory. Therefore, we measured the area of 1) trees, 2) buildings taller

than the nest tree, 3) trees which could be seen from the nest, at three different radii (100m, 150m and 200m) from their nest and randomly selected trees for further sampling.

A vegetation map was created from an ALOS AVNIR2 satellite image, and trees were classified based on the NDVI value. The 10m resolution of digital surface model (DSM) of this area was created from a stereo pair of ALOS PRISM satellite images by RESTEC. The digital elevation model (DEM) was created from the DSM. The digital height model (DHM) was created from the difference between DSM and DEM. We classified trees and buildings using these two maps. The spatial resolution of these maps was 10m x 10m, and the vertical resolution of DSM was 1m.

We surveyed the distribution of magpie nests in March, 2008, and found 189 (including old nests) in the study area. Thirty-three nests were categorized as “active” in that year. We randomly selected 60 trees (more than 50m apart from the active nests) for comparison with the nest trees. This comparison showed that there were significant differences, magpies preferred areas with many trees and short buildings near their nest.

We observed breeding behaviour of magpies at two different habitats in May, 2008. One was a highly verticalized city with tall buildings, and the other an old down town with low-rise houses. The home range area (Minimum Convex Polygon) of a pair of Magpies in the highly verticalized city (4.05 ha) was larger than that in the old down town (1.50 ha). The area of green cover in their home range in the highly verticalized city (0.69 ha) was also larger than that in the old down town (0.47 ha), but magpies in the highly verticalized city did not use every part of green space such as street trees behind a tall building in their home range. Observations of breeding behaviour at two different habitats in Beijing showed that magpies can breed in highly urbanized areas, but pairs of breeding magpies must have several good perch points where they can watch many trees in their territory.

## **Landscape Pattern Analyses using Remote Sensed Data of Cameron Highland, Malaysia**

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A large part of the mountain steep land in Peninsular Malaysia is covered by forests. Cameron Highland is a mountainous region with a climate favourable to the cultivation of tea, sub-tropical vegetable and flowers. However rapid economic growth and land use practices has altered the environment landscape of the area. This study was carried out to examine the rate of loss and pattern of fragmentation of the tropical mountain forests in Cameron Highlands. Temporal remotely sensed data (SPOT-5 images) from 2000, 2005 and 2010 were used in a GIS to calculate landscape indices. Results showed increases in the class area (15,384 ha to 15,691 ha), number of patches (499 to 545) and patch density (1.8 to 2.0

patches/100 ha). The largest patch index increase (34% to 40%) was associated with the decrease in the area of mean patch (30 ha to 28 ha). The observed landscape trends indicate slight increase of forest loss and fragmentation, particularly during the years 2005-2010 periods. Approximately 2 % of the forest cover in Cameron Highland had been lost in 10 years, and a proportion of the remaining forests had been degraded as a result of agricultural practices. Combining landscape ecology and remote sensing has the potential to provide a significant way in assessing the dynamic of highland landscapes. It is suggested that conservation efforts should be focused on the management of the natural system and the management of the external influences particularly restoration and sustainable forest exploitation in the highland.

**Keywords:** Cameron Highland, Land cover change, Landscape pattern, Remote sensing

## **Climate Change Impacts on Water Resources and Possible Adaptation Measures Considering Landscape Characteristics and Water Management**

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When discussing climate change, impacts on water resources are among the main concerns. Many recent investigations highlighted the challenges that result from shifts in precipitation patterns and snow regime, changes in seasonal water availability and water quality, rise of sea level, and increase in the frequency and/or intensity of floods and droughts, all coupled with the rise in mean surface temperature. Most studies come to the result that also a moderate climate change will have severe impacts on water resources and hydrological processes in most regions of the world, and what is needed are strategies for sustainable water management under climate change integrating all water users including ecology and considering the specific climate and landscape characteristics.

Climate is the most important driver for the water resources in a certain region, but the regional manifestation of hydrological processes is the result of the landscape structure and the local water management. The regional and landscape scale is also the scale where political decisions and technical measures to adapt to climate change take place. Thus, feedbacks to vegetation, soil and water regulation including agriculture are crucial when discussing local and regional adaptation measures.

The study will present possible climate change impacts on hydrology and water resources in selected regions in Europe, Africa and Asia including quantification of climate impact uncertainty. Possible adaptation measures, allocated in communication with local experts and stakeholders, are discussed. The results were generated applying a model system integrating climate, hydrology, and landscape pattern including soil and vegetation.

## **A Research Concept for Finding the Climate Optimized Land-use**

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*Climate optimized land-use* is defined here as a sustainability strategy for a given geographical area with two objectives: (1) The adaption to current and future climate change, (2) the mitigation of climate change. Optimization means the choice of such adaption strategies which minimize an assumed negative climate change impact on land-use, typically on agriculture, and simultaneously minimize the related negative contribution to global warming. The latter causes might be physical ones due to land surface effects (albedo, heat- and moisture fluxes), or changes in the greenhouse budget by land conversion, reforestation or planting. In view of the global climate change discussion and the international negotiations on climate change mitigation policies, any nation is urged to contribute to the overall objective of preventing further global warming. This implies at least to monitor its national greenhouse gas emissions and to develop measures to reduce them. Land-use and related GHG emissions amount to 20- 30% of all GHG sources and represent thus a non-ignorable climate forcing. How can those adaption strategies be chosen, which minimize climate forcing? The necessary research strategy is outlined in this contribution. It concentrates on two or more selected geographical regions for which the following R&D has to be done:

1. Global climate simulations for a given set of IPCC scenarios and downscaled to the selected regions
2. Determining the relevant climate impact on land-use (soil, precipitation, erosion, irrigation, agriculture, flooding etc.)
3. Developing adaptive land-use scenarios (e.g. reforestation, urban green spaces, new irrigation technologies, change of crops etc.)
4. Determining the respective GHG emissions, respectively climate forcing (eg by albedo changes)
5. Selecting the optimized land-use
6. Application to other areas and upscaling of the GHG budgets on a national level

Results of such a research will be a comprehensive analysis of the past and future impact of climate change on land use in the respective test areas in terms of efficiency and risk or vulnerability. The land-use scenarios enfold the set of suitable options to the national governments in response to climate change, and, they also will quantify the net climate forcing effect of those options. Thus they allow each society and nation to find its own optimized way between adaption to and mitigation of global warming.

## Simulating wildfires under climate-change scenarios

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Forecasting future patterns of ecosystem disturbances, especially wildfires, is critical for assessing, mitigating, and adapting to the potential impacts of climate change. The primary drivers of wildfire patterns are the interactions between climate, weather, and landscape patterns with fire ignition patterns and behavior. Our goal was to understand how patterns of wildfire occurrence might change under a range of climate change scenarios in the United States. Past research has indicated that wildfire ignitions are a function of weather and fuel moisture conditions, and land-use to some extent. Following ignition, wildfire behavior is largely driven by weather conditions, but wildfire spread is constrained by the arrangement of fuels on the landscape. Using these assertions, we developed a simulation model that predicted daily wildfire ignitions based on fuel moisture levels and landscape characteristics (vegetation type, level of urbanization, etc.). Ignitions were allowed to spread and interact with fuels and topography using the minimum-travel-time fire spread algorithm. We applied this model to ecoregions in the western U.S. and simulated wildfire disturbances for 2001-2100 using a suite of downscaled climate-change data for the a1b, a2, and b1 storylines from the Intergovernmental Panel on Climate Change 4<sup>th</sup> Assessment Report. These climate data generally predict warmer and drier conditions in the West. Consequently, our simulation results showed significant increases in the number of ignitions and area burned per year across the West under all three scenarios. We will discuss our modeling framework, results, and the potential impacts of increased ignitions and area burned.

## Modeling the Hydrological Impacts of "grain for green" Policy in the Loess Plateau of Northern China

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Soil erosion control is essential for maintaining terrestrial ecosystem services and ensuring regional economic vitality. During the past decade, China has implemented a large scale "Grain for Green" program to return hilly cropland to forest and grassland in the loess plateau of northern China, one of the most serious soil erosion regions in the world. But how is the program affecting the ecohydrological processes of the region? This collaborative research adapts the Distributed Large Basin Runoff Model (DLBRM) to the Yanhe Watershed to assess



the hydrological impacts of the "Grain for Green" program. The DLBRM divides the Yanhe Watershed into over 7,000 1- km<sup>2</sup> grid cells. Each cell of the watershed is composed of moisture storages of the upper soil zone (USZ), lower soil zone (LSZ), groundwater zone (GZ), and surface. Multiple databases of DEM, land cover, climate, soil, hydrology, and hydrography are collected and processed to derive the input variables for each of the over 7,000 grid cells. The model simulates the spatial and temporal distribution of watershed hydrological processes and routes cumulative surface and subsurface flows downstream. The DLBRM is first calibrated against the observed streamflow data and then used to simulate the hydrology of the Yanhe Watershed prior to (2000) and after the implementation of the "Grain for Green" program (2008), respectively. Preliminary simulation results show that the "Grain for Green" program has produced significant effects on the hydrology of the Yanhe Watershed. Such results, once verified with field data, may be applicable to similar watersheds.

**Keywords:** Soil Erosion, Ecosystem Services, Distributed Large Basin Runoff Model (DLBRM), The Loess Plateau of northern China

## **Simulation of the Spatial Stress due to Urban Expansion on the Wetlands in Beijing, China using a GIS-based Assessment Model**

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China has been on the track of rapid urbanization in the recent decades. Wetland ecosystem is often spatially stressed during urbanization because many wetlands have been converted into other types of land use as a result of urban expansion (Bendor, 2009). Accurately assessing the spatial stress on wetlands due to urban expansion and finding an effective means to protect them during urbanization has therefore become a serious issue that needs to be addressed in China.

Based on the existing Urban Expansion Dynamic (UED) model (He et al., 2008), this paper develops a geographic information system (GIS)-based model that can be used to assess the current and potential spatial stress on a regional wetland ecosystem due to urban expansion. Synthetically utilizing the simulation capability of the UED model and the spatial analysis power of a GIS, this new model takes into account the present disturbance by ongoing urban expansion, the potential disturbance by future urban expansion, the accessibility via the transportation network, and the neighborhood stability. The model is used in particular to simulate the spatial stress on the major wetlands in Beijing from 1991 to 2004. The simulation results are found to be consistent with the actual remote sensing observations: a relatively high spatial stress normally leads to an eventual conversion into urban use. With the future urban lands predicted by the UED model, this model is used to further assess the potential spatial stress of urban expansion on the major wetlands in Beijing by 2015. Moreover, the spatially stressed wetland fringe areas in Beijing are identified based on the total spatial stress combining the current and the potential. These areas are found to be mainly distributed in downtown Beijing and the plains areas that have relatively easy accessibility via the

transportation network. Effective measures should be taken to protect such areas from being further disturbed in order to achieve the goal of a more effective conservation of the wetland ecosystems in Beijing.

**Keywords:** Urban expansion, Wetland, Spatial stress, Beijing, China

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## Analyzing the Scale Effect between Forest Landscape Pattern and Environmental Factors in Tianbaoyan Nature Reserve

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Analyzing on the relationship between environmental elements and landscape pattern contributed to the revelation of the changing mechanism of landscape pattern. Based on T-M image, topographic map and the second class investigation and by means of 3S technology, the relationships between forest landscape pattern and environment were analyzed quantitatively by using CCA (Canonical Correspondence Analysis) in Tianbaoyan National Natural Reserve. The results showed that the total Eigen value of ordination axes increased with the downscaling which were 3.137, 3.349, 3.484, 4.660 and 4.848 respectively. However, both the cumulative percentage variance of landscape-environment relation and landscape-environment correlation coefficients first increased and then decreased with reaching the maximum values at scale3 and scale2 respectively. The landscape presented latitude variation (the correlation coefficients between latitude and first axis were -0.2019~-0.3789) and vertical distribution regularity (the correlation coefficients between elevation and first axis were -0.3218~-0.4760), which were more obvious. The latitudinal gradient distribution regularity was as follows: bamboo grove, deciduous broad leaved forest, mixed broadleaf-conifer forest, farmland, evergreen broadleaf forest, mountaintop elfin forest, evergreen coniferous forest, sphagnum moss, shrub-meadow. Bamboo grove and farmland distributed at the low elevation comparing with sphagnum moss, shrub-meadow and mountaintop elfin forest at the high elevation. The relationship between landscape and environment had scale effect. The environmental elements had different impacts on landscape pattern in different scales.

## **Are Limited Numbers of Plots with Fixed Locations Reliable in Predicting Forest Landscape Change under Climate Warming?**

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A fundamental but unanswered question is whether field observations from limited numbers of plots with fixed locations are reliable in predicting vegetation changes at broader spatial scales. Extrapolating plot data to broader spatial scales depends largely on environmental heterogeneity.

We studied this question in Changbai Mountains Natural Reserve in northeastern China by examining three scenarios of environmental heterogeneity. Scenario 1 (S1) represented local scale and assumed that the observation of the monitoring plot only represented the land type unit the plot resided. Scenario 2 (S2) represented class scale and assumed that the observation of the monitoring plot represented the land type units with the same aspect class in the same elevation zone the plot resided. Scenario 3 (S3) represented the zonal scale and assumed that the observation of monitoring plot represented all land type units in the same elevation zone. S1, S2, and S3 correspond to the highest, intermediate and the lowest level of environmental heterogeneity, respectively.

Plot-level observation was represented by species establishment probability derived from an ecosystem process model that used the plot observational data (e.g., weather, soil, vegetation, etc.) as input. Response variables at broader spatial scales included species total area and spatial pattern (measured by mean patch size) for short (0~50 years), medium (50~100 years) and long (100~200 years) terms. These response variables were derived from a landscape model. We statistically examined whether these response variables differ among the three scenarios.

Our results indicate that for species whose total areas change (increase or decrease) mainly occur within the same elevation zone as the experimental plots reside, individual plots can capture the changes for the entire elevation zone. By contrast, for species that span many elevation zones or migrate from one elevation zone to another under warming climate, plot-level observations are not reliable in predicting broader spatial scale change for all periods. The most complicated situation is that for some species plot-level observations are reliable in predicting species total area for some periods but not reliable for other periods. Our results also suggest that species spatial patterns do not always coincide with those found for total area.

## Resources, Value and Agricultural Heritage Characteristics of Ancient Tea Plant in Middle and Lower Reaches of Lancang River

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Up to now, Yunnan province has the biggest ancient tea tree garden in the world, which is widely dispersed in Puer, Lincang, Xishuangbanna and Baoshan, those are in middle and lower reaches of Lancang River. These places have a long history of tea plantation and are rich in the ancient tea plant resources. There are the world's largest and longest years old ancient tea garden and a lot of ancient wild tea trees there, including wild type, cultural type and transitive type tea plant. Ancient tea plant does not only have ecological value but also has economic value and cultural value. The ancient tea garden ecosystem is a typical example for the integration of conservation and utilization of natural resources. It is good at biological diversity and tea germplasm resources conservation. There is no fertilizer and pesticide input during the plantation, so it is environmental. Ancient tea trees and the wild colony is the source of tea. The main biochemical components content of tea polyphenols, catechin, amino acids, caffeine in ancient tea tree fresh leaf is higher than those of tableland tea fresh leaf, which means ancient tea has a better quality and it is organic. This results in higher price for ancient tea. And the famous ancient tea trees and ancient tea gardens combined with local tremendous tea culture are excellent resources for ecological tourism development. All those can promote local sustainable economic development and increase local farmers' income. The ancient wild tea trees, transitive type tea trees and cultivate tea trees are evidences for Yunnan is the origin place of tea and tea cultivation. Different minorities in middle and lower reaches of Lancang have developed different tea culture, including the way tea is made and consumed, the way the people interact with tea, and the aesthetics surrounding tea drinking. But over the past fifty years, the area of ancient tea plant is decreasing due to population growth, irrational picking, over-exploitation. So we need to take a series of measures to implement the scientific conservation and rational utilization. This paper analyzed the ecological, economical and cultural value of ancient tea plant in middle and lower reaches of Lancang River based on survey and documentary and put forward that the ancient tea plant in Lancang River Basin has characteristics of Agricultural Heritage can be regarded as one. We can apply dynamic conservation ideas to protect ancient tea plant agricultural heritage protection.

**Keywords:** Middle and Lower Reaches of Lancang River, Ancient Tea Plant, Multi-Value, Agricultural Heritage

## Green Space Ecological Network Construction and Evaluation for Nanchang Urban Area

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Based on a present greenbelt map created from a SPOT satellite image from the year 2005, a map of planned greenbelt systems from 2003, we used landscape spatial pattern analysis and a series of landscape pattern metrics on a GIS platform and FRAGSTATS 3.3 software to assess the present situation and the planned greenbelt system for Nanchang urban area. Based on these analyses, and considered the actual situation of the Gan river through the Nanchang urban area, “one river two banks, north and south twin cities” scenario of ecological network was proposed. Some indices that reflected corridor characteristics, such as corridor length and corridor density, were also calculated for the scenario. Using network indices such as  $\alpha$ ,  $\beta$ ,  $\gamma$  indices, cost ratio and corridor metrics to analyses the ecological network. Decreases in patch density from 2.10 number/km<sup>2</sup> to 1.37 number/km<sup>2</sup> and Euclidean nearest neighbor distance from 46.18m to 40.13m, and increase in mean patch size from 47.63 hm<sup>2</sup> to 50.32 hm<sup>2</sup> and connectivity index from 2.33 to 2.99, indicated that the ecological network could improve landscape fragmentation and connectivity greatly, as compared with the planned green space system for Nanchang urban area. The results showed that the planning ecological network scenario would improve the degree of landscape fragmentation, increase the shape complexity of greenbelt patches and increase the landscape connectivity. The results indicated that the ecological network could improve the quality of the urban ecological environment, and using the methods of landscape pattern analysis and network structure analysis made the ecological network organized and rational.

**Keywords:** Green space, Ecological network, Landscape pattern analysis, Network structure analysis, Nanchang urban area

## Nutrient Budget and Land Use Relationships for the Lake Okeechobee Watershed, Florida

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Eutrophication of Lake Okeechobee in southern Florida has been a great concern for decades.

Previous studies in the Lake Okeechobee Watershed (LOW) indicate that net phosphorus (P) import was primarily in the form of pasture fertilizers and dairy feeds, whereas total P export was primarily in the form of milk, cows, and crops. This study provides insights as to how recent best management practices (BMPs) and strategies implemented in the watershed have affected P loading to Lake Okeechobee. Phosphorus import, export, and net import coefficients in terms of  $\text{kg P ha}^{-1} \text{ yr}^{-1}$  were determined for 26 different land use categories in the watershed based on landowner surveys, consultation with experts, and literature data. The net P coefficient for each land use was applied to the appropriate land use area with a Geographic Information System (GIS) to obtain a basin-wide P budget. The runoff P was estimated with the Watershed Assessment Model (WAM). The P loads to the lake were measured at discharge structures from each basin. On-site P storage and wetland assimilation values were estimated using a mass balance approach for each basin. Overall, compared to the previous analyses conducted prior to 2004, there was a 25% decrease in net P imports and a 29% decrease in onsite storage (the sum of P imports plus rainfall P and minus runoff P). It should be noted that the differences in the net P coefficients relative to previous P budgets may be partially the result of better available information. The net P imports for improved pasture increased by 15%. This is primarily due to the land application of residuals, which were not included in previous P budgets. By contrast, P import for citrus production increased. This is due primarily to changed coefficients in the Lake Istokpoga and Upper Kissimmee regions where citrus was previously calculated as a net exporter of P. Basin P loads to the lake were related to the nutrient budget, basin characteristics, and soil properties. Important budget factors include net P imports, wetland P assimilation capacity and upland P storage capacity, and off-site P loads in runoff water. Basin characteristics such as land use, wetland area and percentage, and stream length affect wetland P assimilation capacity and runoff P loads, and subsequently influence P loads to the lake. These findings emphasize the need to continue implementing BMPs for reducing the P import to the watershed and the loading to the lake.

**Keywords:** Phosphorus budget, Nutrient Management, Lake Okeechobee Watershed, P runoff, P import and export

## **Perception and Attitudes of Local Communities towards Wild Elephant-related Problem and Conservation in Xishuangbanna, Southwestern China**

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Wild elephant-related problem, a kind of human-elephant conflict (HEC), influenced the daily life of local communities and embarrassed the conservation of wild elephants. The perceptions and attitudes of local communities who inhabited the frontiers between human production and wild elephant movement are important to the mitigation of HEC and conservation of wild elephants. Xishuangbanna National Nature Reserve lies in Xishuangbanna Dai Autonomous Prefecture, which lies in southern Yunnan Province of China and to the northwest of Laos and northeast of Myanmar. The reserve is composed of five

separated sub-reserves. There are 260 villages and over 51 545 inhabitants living in or close to the reserve. Meanwhile, HEC happened in the reserve and its surrounding areas in the past decades. During July 2009 to February 2010, the Participatory Rural Appraisal (PRA) was applied to the investigation of 423 interviewees from 22 villages where wild elephant-related problems happened annually and HEC became crisis recently. The results indicated that 66.5% of interviewees were willing to support, participate, and assist at least the conservation of wild elephants; 33.5% of interviewees opposed to or cared less for the conservation, because their livelihood even lives were endangered by wild elephants. The local communities believed that the shortage of food was the key factor causing elephant-related problem but denied the fact that they occupied habitats used by elephants previously and did not want to make any concession. To methods of HEC mitigation, they thought the most important methods were to separate wild elephants from humans with some artificial blocks and to expel wild elephants by visual, auditory or olfactory fright. 43.0% interviewees considered planting food resource was an effective way to reduce crop loss, but 35.7% interviewees thought it just worked well in a short period of time. Only 4.4% interviewees considered land shortage problem. To the question, elephants and humans, who will be the host of the lands where the serious HEC happened, 69.6% interviewees thought the best way was to move elephants away or cut down elephant population. Only 16.0% interviewees considered to move out humans. Bivariate correlation analysis and multinomial linear regression indicated education level, gender, perception of human-elephant relation, methods to manage elephant-related problems and beneficiary were the key factors influencing their perceptions and attitudes towards the mitigation of HEC and conservation of wild elephants. Therefore, it is necessary to balance profits and cost for the mitigation of HEC and conservation of wild elephants. And analysis of diverse characters among local communities is important to make correct decision for nature conservation.

## **Estimating Loss of Semi-natural Grasslands in Denmark due to Shrub Encroachment from 1965-2010 Based on Visual Interpretation of Aerial Images**

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Shrub encroachment, here defined as the increase in density, cover and biomass of indigenous woody or shrubby plants (Van Auken, 2009), has been frequently reported from many parts of the world (e.g. Briggs et al., 2005; Maestre et al., 2009; Van Auken, 2009). In a European context, one of the main reasons for shrub encroachment is abandonment, defined as the complete withdrawal of agricultural management (Keenleyside & Tucker, 2010). In Denmark, abandonment is also a well-known problem and a threat to the remaining grassland habitats which are fragmented and under pressure (Ejrnæs, R., et. al., 2011). Of the total land area of Denmark, agricultural land makes up approximately 60 %, and less than 10 % represents grassland habitats (here covering wet and dry grassland, coastal meadows, heathland and bogs) (Levin & Normander, 2008). Cultivation and intensification have been the primary causes for the decrease of semi-natural grassland in Denmark, but this has probably changed during the last two or three decades, and shrub encroachment is now considered to be the most severe

threat (Ejrnæs, R., et al., 2011; Larsen & Vikstrøm, 1995). However, knowledge about the extent of shrub encroachment and the dynamics over time is limited.

The aim of this study is to estimate the loss of semi-natural grasslands due to shrub encroachment during the period from 1965-2010. The study is conducted in the western part of Jutland, in Denmark, within the borders of a former county which constitutes 4.854 km<sup>2</sup> or 11 % of the total area of Denmark. A dataset containing digitised meadow and bog habitats delineated from older topographical maps (from the beginning of the 20<sup>th</sup> century) is utilised as input data. By use of ancillary data (including land parcel information from the Single Payment Scheme), areas with crops, settlements, roads, etc. are discarded leaving only existing grasslands or former/abandoned grasslands left which are not subsidised by EU and hence under management prescribed by CAP regulations.

Subsequently, stratified systematic sampling is used to select quadrats from a grid which are afterwards analysed. Mapping is carried out based on visual interpretation of georeferenced aerial images. The images applied cover the following years: 1965, 1987 and 2010. An interpretation key has been developed consisting of a few general landcover/landuse classes and each quadrat is classified according to this.

Based on preliminary studies the final results are expected to show a substantial loss of semi-natural grassland due to shrub encroachment with no decreasing trend during the time period investigated. This indicates on one side the need for future monitoring of abandonment processes and their impacts, and on the other side the need for evaluating existing management and protection efforts.

As abandonment processes in Europe are believed to continue in the future (Keenleyside & Tucker, 2010; Stoate et al., 2009), with an estimated farmland abandonment of 3-4 % of total land area by 2030, which would amount to 126.000-168.000 km<sup>2</sup> (Keenleyside and Tucker, 2010), studies on the impacts of abandonment in a historical perspective are important in order to understand and mitigate abandonment processes in Europe.

## **Impact Assessment for Climate Optimised Policy Making in Land Use**

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Policy making can reinforce adaptation to climate change, reduce negative externalities of land use, and target land management towards provision of ecosystem services. Policies come across as regulations, financial incentives or education measures and they act at different governance levels from international down to the regional and local level. They considerably affect decision making of farmers, land managers and planners. Land use policies counteract or reinforce external driving forces such as climate change, global economic developments, demography, consumption patterns. Because of the interaction and non-linear feedback loops



with socio-economic and geophysical processes of the land use systems, policies are difficult to design, and their impacts are difficult to anticipate. Impacts do also have a spatial dimension and vary from region to region. Climate change is a particularly complex issue, the design of climate change adaptation policies is therefore particularly challenging.

The policy making community articulates an emerging demand for scientific support and research based evidence in support of the policy process. Consequently, providing this evidence in a useful and timely manner is an emerging challenge for researchers. Ex-ante impact assessment of policy making provides the legal basis to fuel scientific evidence into the policy process. For researchers, impact assessment is a means to structure the analysis of human-environment interactions. For policy makers, impact assessment is a means to better target policy decisions towards sustainable development. The integration of both requires a mutual understanding of the respective objectives and operational restrictions within the scientific and policy-making domains.

This paper provides insight into the jurisdictional process of policy impact assessment and how research based methods and tools can best feed into this process. An analytical framework for land use impact assessment is provided (Helming et al., 2011). It makes use of the concept of landscape multifunctionality as an integrating entity between socioeconomic and bio-geophysical features of the land use system (Helming and Perez-Soba, 2011). Application examples are provided for the case of land use policy scenarios in Europe and China. Regarding the improvement of policy relevancy of land use impact assessment tools, three aspects are outlined: the involvement of decision makers early on in the design of the impact assessment study; the integration of quantitative analysis with participatory valuation methods; and the robustness and transparency of the analytical methods.

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## **Linking Context with ‘openLandscapes‘ – The Knowledge Collection for Landscape Science**

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Landscape Science represents at the least a meta-discipline of several domains of knowledge. With independent theories and methods this realm of science is conducting research that is characterized by a broad interdisciplinarity. In addition the complexity of research in landscape science continuously grows due to a constant increase of integrative approaches on

analysing landscape related processes, especially in managed landscapes.

The research within landscape science is an emerging field linking geo- and bio-disciplines with those in land use and rural development. Conducting research in such a complex and new scientific realm needs orientation, communication and central places for elaborated standards and knowledge chunks. In addition the community needs continuous and easy access to information on current research activities. Having such an access would be new and helpful for an effective research, especially if contexts of information are provided.

Due to a multitude of information supply in the internet and its diversity in structures a definite accessibility of desired information often is hampered. Even in the future, search engines will only cover parts of the total pool of a research domain. A solution could be an internet based knowledge collection that is focused on the landscape aspects and fulfils the demands of landscape researchers to access the context of specific information.

‘openLandscapes’ is an open access portal that has been developed to facilitate a special entrance to contextualized knowledge for researchers and students. It includes a growing amount of information about research projects, publications, presentations, experts, institutions and networks. An ‘openLandscapes’-wiki is included to discuss terms within the specific scientific context. This wiki consists of a ‘glossary wiki’ and an ‘essay wiki’. The poster will show the structure of the platform and examples of these wikis and their linked context, e.g. projects, terms, definitions, papers, experts and institutions. An important long-term goal is to publish and contextualize also data from observations, experiments and long term simulations to enhance information exchange and collaborative scientific work.

**Keywords:** Information system in landscape research, Glossary wiki, Essay wiki, Research data

## **Integrative Landscape Policies on Climate Change Adaption and Mitigation in two Countries; the UK and Sweden**

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The European Science Foundation policy briefing; Landscape in a changing world (2010), argues that in order to face the major challenges facing our society, integrative approaches are needed between human, social, natural and physical sciences. Climate changes, as well as measures to adapt to and mitigate climate changes, is expected to result in landscape changes affecting the natural environment, wildlife, landscape character, land use and cultural values over the world. Also social and economic conditions which are related to the landscape, health, housing, transport, waste management, food production and social justice will be affected by more extreme climate conditions, as well as the means for adaption and mitigation to these changes. Adapting to climate change in the landscape is hence not just about solving technical or ecological problems, but also involves ethical, cultural and social issues. Indirect effects of climate change on landscape will depend on political and economic responses at the

global arena. For dealing with these complex issues in landscape planning, clear and integrative landscape policies has to be developed in the near future. In the UK, for example, the concept of landscape is increasingly being used as an integrative concept, closely related to the sustainability concept, which embrace nature as well as cultural values as expressed in the European Landscape Convention (2000). In Sweden, the landscape concept has not yet been much applied in this holistic sense, and there is less reference to landscape in policy guidelines.

This paper reviews and analyses the current discourse in landscape planning and policy documents in Sweden and the UK, with focus on how landscape is being used as an integrative concept in strategies for adaption and mitigation for climate changes. A special attention is paid to how landscape ecological functions and values are integrated with other issues such as social values, historical and cultural values. Also currently wide-spread concepts such as 'ecosystem services' and 'green infrastructure' are scrutinized in the review and discussed in relation to the landscape context.

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## **Integrated Framework for the Assessment of Landscape Services in Central European Transnational Ecological Networks**

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European cultural landscapes are characterised by a high level of anthropogenic fragmentation which is known as a major reason for the loss of biodiversity in industrialised countries (Jones-Walters, 2007; Kleijn et al., 2009). As a first step to enhance the connectivity of landscapes, the status quo and trends of ecological valuable landscapes have to be evaluated. Therefore, the project TransEcoNet aimed at assessing the actual functionality of Central European transnational ecological networks as the capacity to provide goods and services to society. The investigation area covers more than 2000 km<sup>2</sup> in the cross-border region of Austria and Hungary. Within this project we developed an integrated framework for mapping and assessing landscape services based on spatial information as well as field data. This framework encompasses five steps: (1) selecting the investigation area by a stratified random sampling, (2) linking landscape services to land-use/cover based on expert knowledge and/or geo-data, (3) field mapping of valuable attributes and impacts on the service provider unit (landscape element/biotope), (4) refining landscape services by empirical data and spatial indicators and (5) extrapolating the results to a wider investigation area using spatial information. On the basis of the proposed assessment framework we mapped and quantified five landscape service groups:

regulation, habitat, production, information and carrier (mainly adapted from de Groot, 2006) within the investigation area. The final landscape service maps provide regional stakeholders with valuable information on the functionality of transnational ecological networks and can therefore be used as a decision tool in landscape planning processes. Making landscape services spatially explicit and combining empirical data with spatial information presents an innovative approach to landscape research in the field of visualising and quantifying landscape services.

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## The Effects of Forest Age in the Surrounding Landscape on Spider Communities in Eucalyptus Plantations in the Northern Negev, Israel

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Plantation forests are an important part of the forest estate in many countries. This applies particularly to Israel where foresters planted almost 100 000 ha of former open land with often non-native tree species. Thereby, *Eucalyptus camaldulensis* is one of the most common tree species used as forest stands and groves. The oldest patches were planted almost 80 years ago and the species is still used into the present. Due to the different ages of the plantations, animal assemblages may vary strongly between planted forest patches. Thereby, older patches may serve as source habitats for adjacent younger forests. Arthropods are a vital component of these forests, functioning as decomposers and pollinators, herbivores, predators and prey. Spiders are often used in biodiversity assessment and are amongst the most abundant predacious arthropods in these arid and semi-arid environments. The conducted study aimed to examine spider diversity in *Eucalyptus camaldulensis* plantations of different ages and their

relation to other forest patches in the surrounding landscape. Thereby, we hypothesized that spider diversity and abundance increases 1. with the age of the plantation 2. with the age of the adjacent forest patch due to immigration 3. with the mean age and amount of forest in the surrounding landscape. To investigate these hypotheses, we performed a GIS-based pre-selection of study sites that kept study site age and age of forest patches in the surrounding landscape as independent as possible. Thereby, 19 sites were selected varying in planting age from 1963 to 1999 and age of adjacent forest patches between 1952 and 1995. Spiders were sampled using pitfalls, beating tray sampling and cardboard hides to assure the highest sampled diversity.

## **Urban Green Infrastructure: Ecosystems Services to Build Resilience to face Climate Change Challenges – a Case Study in Rio de Janeiro**

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Natural landscapes have been transformed by the intensive urbanization process, where monofunctional impervious gray environments are predominant in most cities across the planet. The ecological processes and functions were altered and native ecosystems were eradicated with significant increase of: air, water and soil pollution; GHG (green house gases) emissions; private cars dependency; material (including food and water) and energy consumption coming from distant supplier sources; storm surges, floods and landslides susceptibility among others. On the other hand the quality of life is in decline, impacting on population's health, sociability (Newman et al., 2009; Beatley, 2011) and the loss biophilia (Wilson, 2006; Beatley, 2011). Cities face uncertain environmental, social and cultural challenges caused by global climate change. This paper argues that planning and designing urban green infrastructures may be a way to mitigate negative impacts and adapt existing areas, with the restoration of natural processes and flows. The aim is to build urban sustainability and resilience, e.g. inner strength to prevent and minimize damages and losses through its ecosystems services. The case study in Rio de Janeiro presents a multi-scale proposal plan, that addresses abiotic, biotic and cultural goals, such as: water bodies; stormwater drainage and filtration; floods and landslides; local climate; support native biodiversity habitats, interactions and flows; provide human-nature experiences; increase population socialization, health and well-being; supply local food production, among others (Ahern, 2007; Herzog, 2009). It is based on landscape and urban ecology principles of structure, function and change, whereby connectivity is key (Forman, 1995; Ahern, 2007). Green infrastructure is an adaptive, multidisciplinary, "learn-by-doing" process (Ahern, 2007), where biologic, hydrologic, circulatory, social and metabolic systems interact to achieve multi-functional benefits (Herzog, 2009).

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## Identifying Indicators for Monitoring Farmland Biodiversity

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Farmland biodiversity is an important component of Europe's biodiversity. More than half the continent is occupied by agricultural lands. They host specific habitats and species, which – in addition to their conservation values they provide – perform vital ecological functions. Indicators are needed to enable the monitoring of biodiversity at the farm level for the purpose of assessing the impacts of farming practices and of agricultural policies. Our research aims at identifying farmland biodiversity indicators which are scientifically sound, operational and relevant for stakeholders.

We screened the literature for farmland biodiversity indicators and, in an iterative process with stakeholders, we identified 28 candidate indicators for genetic, species and habitat diversity. Those selected biodiversity indicators, as well as 14 management indicators that are known to relate to biodiversity, were assessed in 12 case study regions across Europe. Each case study region represents a typical production system (i.e. specialist field crops, horticulture and permanent crops; specialist grazing with cattle and other livestock types; mixed crop and livestock farming). In each region, 8 – 20 farms were randomly selected, mostly within the two groups of organic and non-organic farms, to obtain a gradient of farming intensity. Indicators were measured applying standardized sampling procedures and farm interviews. Sampling effort was recorded in order to assess the cost of indicator

measurement.

For each case study region, biodiversity indicators are presently being evaluated in conjunction with management indicators. Surrogate indicators will be proposed when possible and indicators will be prioritized taking into account their validity, practicality, cost and priority for stakeholders. Based on preliminary results, the presentation will focus on the specific challenges of farm level monitoring, addressing issues of sampling design within the farms and up-scaling from plot to farm to region.

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## **A Multi-scale Analysis of the Typical Steppe Landscape Desertification on the Hunshandake Sandland Border, China**

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Desertification of the Eurasian steppe biome brings serious problems to the natural environment, socio-economy and people's lives on both local and global scales. In the present study, we focused on the grassland/sandland boundary in geographical land-use patterns, distributed in the Typical Steppe zone (*Stipa krylovii*/*Leymus chinensis*-dominant steppe zone) in the semi-arid area of Inner Mongolia, China, and assessed landscape structure and fragility through a multi-scale analysis. The study area (30.0km×22.5km) was Canggen Dalai in Zhenglan Banner (42°32'13"N, 116°14'27"E; ca. 1350m a.s.l.), located on the south-east border of the Hunshandake Sandland. Investigations during the 2008-2010 period consisted of (1) a scene analysis on land-cover using Landsat TM images taken in August of 2000 and 2007, with ground truth accompanied in 2010, (2) a vegetation/habitat-mapping (landform measurement, phytosociological survey at 60 quadrats and chemical analyses of surface-soil at 35 sites) along a 1.4km transect across a typical upper tributary and (3) a sociological census of eight pastoral families.

The results are summarized as follows: (1) from the local-scale viewpoint, eight types of land-cover were classified, included three categories of grasslands (rich, medium and poor coverage classes, respectively), bare-land and salinized lakes, (2) three categories of grasslands and bare-land were distributed in an intricate mosaic, although a striped-pattern in a NW-SE direction was clear, according to gently undulating hilly landform and strong seasonal winds, (3) comparing the situations of each land-cover type between 2000 and 2007, grasslands and bare-land almost equivalently occupied 89.4% and 7.1% of the study area, respectively, but 14.5% of the medium coverage class grassland (32.72 km<sup>2</sup>) degraded into poor coverage class grassland, (4) from the micro-scale viewpoint, nine types of plant

communities were distinguished by TWINSPAN, and the ecological characteristics of each vegetation type (e.g., indicator species, their life-histories, community architecture and distributional patterns) were examined with relation to landform, soil conditions, grazing by livestock and land-cover types obtained by the scene analysis, and (5) a sociological census demonstrated a scenario of the drastic desertification of the landscape since the 1990's, paralleled by the change of land-use policies and local people's life-styles. Finally, in order to restore this indigenous steppe and to be blessed with sustainable ecosystem services, we emphasized the importance of the catenary structure of landscape and the traditional wisdom and skills on pasture management.

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## **Grassland Arthropod Community along Urban-rural Landscape Gradient in Japan**

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In Japan, paddy landscape includes grassland networks on the banks between aquatic fields and those along irrigation channels. Such grasslands caused rich biological diversity compared to large monoculture of terrestrial crops in North America and Europe. We conducted the community survey in various types of grasslands left in dry riverbeds, parks and margins of agricultural lands along gradients from urban to rural landscapes. It is highly likely that the two factors, local vegetation (plant species, grass height, etc.) and large scale landscape (urban, agricultural, forested, etc.), have significant effects on arthropod communities of grasslands. Our research objectives are (1) to classify arthropod communities in various grasslands from urban to rural landscapes in Japan, and (2) to determine the importance of vegetation properties and landscape types on species composition of arthropod communities.

Three, 5 km × 5 km plots were established along urban to rural areas in Kanagawa prefecture, Japan. Within each region plot, 9 grasslands were selected as research sites. In each research site, arthropods were collected by sweeping along a 2 m × 15 m transect in summer and autumn of 2010. All arthropod individuals were identified at least to the order level, and food types (carnivore, herbivore, omnivore or detritivore) as well as their body size (small, middle and large) were determined. Based on the combination of food type and body length, we created a new variable, "functional group", which consists of 12 categories. In order to examine land use characteristics, proportion of agricultural land, urbanized area and forest area, and distance to roads and wetlands were calculated. Vegetation properties were plant composition and vertical canopy structure (height and complexity of grass canopy). The relationships among land use characteristics, vegetation properties, and abundance of arthropods in each functional group were analyzed using stepwise forward regression analysis. Additional analysis was made for abundance of each arthropods taxon.



According to the regression analyses, abundance of small to large size herbivore increased as distance to roads decreased, and as proportion of agricultural lands increased. The similar relationships were found also for abundance of small to middle size carnivore and detritivore. This type of grasslands is usually managed with frequent mowing. Large size carnivores and middle size omnivores were significantly abundant in sites with large forests, short distance to roads, and vegetation covered by *Phragmites australis*, *Setaria viridis* and *Cayratia japonica*. This type of grasslands is usually managed with infrequent mowing and is not disturbed. Small size omnivores were abundant in sites with urbanized area, long distance to the roads, and vegetation covered by *Sorghum halepense*, *Lespedeza juncea* and *Imperata cylindrical*. This type of grasslands is infrequently mowed and is often disturbed. In conclusion, grassland arthropod communities from urban to rural landscapes are highly affected by land use characteristics and plant composition because these two factors are highly related to management on grasslands by humans and level of disturbance in surrounding areas.

## **Changing Biocultural Diversity of Sacred Landscapes in Southwestern Korea**

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A biocultural diversity in Asia have been historically consistent with the concept of *Feng-shui* (*pungsu* in Korean word). *Feng-shui* is a combination of the terms *feng* (wind), which here refers to green zones (mountains), and *shui* (water), which connotes lakes and rivers. In way of *Feng-shui*, water quality and the characteristics of aquatic ecosystems and biota, are formed in accordance with the attributes of forests and valleys. As such, the concept of *Feng-shui* is not one that whose scope is limited to the simple traditional land use, but rather one that is consistent with a notion of biocultural diversity especially in land use in Korean attitude (Hong et al., 2007a, 2011).

Korean has long been known as a nation in which the basic notion of *Chisanchisu*, which essentially means that the people's happiness can be secured through the virtuous management of mountains and water sources, has prevailed. The concept of *feng-shui* has also undergone a gradual deterioration as well. Korean has traditionally been referred to as *Geumsu gangsan*, which loosely translates to the land surrounded by breathtaking lakes and mountains that almost look as if they had been embroidered on silk cloth (Hong et al., 2007b). However, it is difficult to find such beautiful ecological landscape factors anywhere these days except for several sacred places. Sustainable landscape and its beauty can only be maximized when the mountains and water sources can naturally connect to one another.

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## **Management Strategy for Sustainable Islands in Shinan Dadohae Biosphere Reserve**

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The Republic of Korea has more than 3,400 large and small islands. Around 60% of these islands are located in the Southwestern Jeollanam-do Province, which also includes a huge tidal flat wetland. Owing to high biodiversity in tidal flat ecosystem and healthy oceanic ecosystem, this area was designated as Dadohae Haesang National Park in 1981. Shinan Dadohae including Heuksan Do-Hong Do (-Do corresponds to Island) and Bigeum Do-Docho Do are well known for their island vegetation, migratory birds, and biodiversity. Jeung-Do, famous for its tidal flat ecosystem and biodiversity, was designated Provincial Park of Jeollanam-do. The excellence of ecosystem, landscape and cultural attributes gave significant reasons to designate these areas as the 3<sup>rd</sup> UNESCO Biosphere Reserve in the Republic of Korea in 2009. Since this designation, research has been carried out to develop a management plan for sustainable development based on a balance of man and nature systems in biosphere reserve areas. In the management plan, several special strategies related to global climate change and low carbon society were adopted, such as to monitor changing socio-economic standards as well as to monitor changing ecosystems of island and coastal environments. Because education on sustainable use of energy and resources is also an important issue in the island system for accomplishing a low carbon society, this was also included. The most important issue in the management plan, however, is related to the environmental adaptation process of human society on islands given that these areas are limited resource areas.

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## Methodical Basis for Analyzing Landscape Diversity

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Landscape diversity is an essential level of biodiversity, because it determines the diversity of species and genes. Therefore, the description of landscape diversity can be used as an indicator for biodiversity in monitoring systems. In actual monitoring systems in Germany or China no indicator exists at this level. A main reason for this is a lack of data to describe landscape structure and landscape diversity for larger regions. Landscapes consist of two kinds of structures: patches and boundaries which are three-dimensional, extending above and below the surface (Cadenasso, Pickett et al. 2003). These boundaries, called “ecotones”, are dynamic and play several functional roles in landscape diversity; for example, they control the flux of materials between ecosystems and influence biodiversity (Fortin, Olson et al. 2000). Another part of information which has often been ignored is “small landscape elements” inside the patches. Actual nationwide data, such as the official land use data (ATKIS) data in Germany do not provide sufficiently detailed information to small-scale structure of the landscape, such as hedges, tree lines and a group of trees in fields or the riparian woodland etc.

In this paper, a method developed by the author for describing landscape diversity will be presented. Based on the object-oriented image classification technique, the first step is to classify the main land use classes from remote sensing data (e.g. from the German sensor RapidEye). Thereby, existing land use data like vector data of the official land use survey and elevation data, are used as a reference (Walz & Hou, in press). The second step is to identify the small-scale landscape elements inside the land use classes and the possible boundaries between the patches which are related to biodiversity. Afterwards the information on internal heterogeneity of land use classes (e.g. plot structure) and the additional elements (small-scale landscape structures) and the diversity of the whole landscape will be described and calculated in a three dimensional perspective. With the help of the additional information the biodiversity can be better present on the landscape level.

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## Ecological Carrying Capacity – A Way for Creation of Sustainable Land Use

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Carrying capacity of the landscape expresses the rate of tolerable (suitable) land use at which no damage is done to the environment, its components and ecosystem functions. It forms a basis for a new spatial organization of the territory following out from the confrontation of natural conditions with the contemporary land use. The outcome of assessment is the establishment of the degrees of ecological carrying capacity (according to natural landscape types), i.e. suitability or elimination of the contemporary land use and a proposal of measures: (a) the 1<sup>st</sup> degree of ecological carrying capacity = suitable (acceptable) land use (contemporary land use need not be changed; it is under the threshold of ecological carrying capacity); (b) the 2<sup>nd</sup> degree of ecological carrying capacity = medium suitable (still acceptable) land use (contemporary land use may be left unchanged although this corresponds less to landscape ecological conditions of territory; it is not necessary to change the land use; contemporary land use nears to the threshold of ecological carrying capacity); (c) the 3<sup>rd</sup> degree of ecological carrying capacity = unsuitable (unacceptable) land use (contemporary land use must be changed from the ecological viewpoint, because it exceeds ecological carrying capacity, it is necessary to propose except new land use also revitalization measurements).

On the basis of this definition has been elaborated the methodology of ecological carrying capacity which has been applied on the 2 model territories: Slovak Republic and Czech Republic in the scale 1 : 500 000: (a) map of natural landscape types (map of types of abiotic complexes), which has been created on the basis of relief dissection, physical properties of geological substratum, soil types and temperature-moisture characteristics of climate; (b) map of contemporary land use, where 4 basic units have been created: arable land; grasslands and pastures (meadows and pastures, heterogeneous agricultural areas, wetlands, permanent cultures); forests and semi-natural areas; unevaluated areas (urbanized and industrial areas, water surfaces); (c) map of limits and potentials for arable land, permanent grass stands and commercial forests. Dissected spatial units were elaborated according to the natural landscape types and they correspond with different limitation of the land use.

The purpose of the evaluation was to prepare the optimum proposal for selected activities (arable land, grasslands and pastures, forests and unevaluated areas) in the maximum harmony with natural conditions. The proposal is an optimum state if natural abiotic limits (relief, soil, hydrological and climatic limits) are fully respected. Ecological carrying capacity should be used especially for the proposal of new activities in the landscape. Their specification will be also based on the limits for nature conservation, protection of natural resources and environmental stress factors.

**Acknowledgement:** The contribution was prepared within the grant project of the Ministry of Education of the Slovak Republic and the Slovak Academy of Sciences No. 2/0114/10 Identification of purposive landscape features as the basis of landscape ecological research.

## A Preliminary Study on the Value of Ecosystem Services in Taipei City

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With global climate change, urbanization, and urban expansion, the issues of urban land-use transition are a global concern and one of the greatest challenges for ensuring human welfare. Ecosystem services (ES) provide humans with many necessities of life and survival, such as provisioning services, regulating services, supporting services, and cultural services. ES are becoming an important scientific exploration of ecosystem and urban ecology. Furthermore, assessing the value of ES is also a significant research topic among interdisciplinary sciences of ES, including landscape ecology, urban ecology, urban forestry, and ecological economics. For the urban environment, wetlands and forests are the most important ecological life support systems; therefore, they are called as “kidney of the earth” and “the lungs of the city”. In order to mitigate and regulate urban problems, the Millennium Ecosystem Assessment (MEA, 2005) developed the conceptual and methodological ES-based framework to assess options that can highlight the contribution of ecosystems to human well-being. Additionally, urban green resources play multiple important roles on ecology, society, economics, microclimate regulation, aesthetics, health, recreation, shape of urban spaces and other values in Taipei City. The preliminary results on the value of ES showed that the total value of Taipei’s green spaces is about 225,479,000 euro per year, including the value of oxygen release (626,000 euro/yr), reducing the loss in adsorbing sulfur dioxide (7,000 euro/yr), and purifying net water storage capacity (224,846,000 euro/yr).

**Keywords:** Urban ecosystem, Ecosystem services (ES), Green resources

## Concentration Variations of Several Ions in Stream after a Wildfire

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In May 2006, a high intensity wildfire occurred in Songling forest region in Daxing’an Mountains, China. The concentration changes of eight ions ( $K^+$ ,  $Na^+$ ,  $Ca^{2+}$ ,  $Mg^{2+}$ ,  $Cl^-$ ,  $Br^-$ ,  $NO_3^-$  and  $SO_4^{2-}$ ) were measured in burned and unburned streams after fire from May to Oct., 2006. Results show that the most ions flux were higher in burned stream than that in unburned stream during the sampling period, and the greatest concentrations of most ions transported from burned stream occurred in July. After fire, the most amplitude chemical ion was  $Ca^{2+}$ , whose average concentration was  $5.50 \text{ mg}\cdot\text{L}^{-1}$  higher than that in unburned stream, and the total concentration of every chemical ion presents a trend  $Ca^{2+} > SO_4^{2-} > Na^+ > Mg^{2+} > NO_3^-$ .

The average concentrations of  $\text{Ca}^{2+}$ ,  $\text{SO}_4^{2-}$ ,  $\text{Na}^+$ ,  $\text{Mg}^{2+}$ ,  $\text{NO}_3^-$  showed an increase trend, but those of  $\text{K}^+$ ,  $\text{Cl}^-$ ,  $\text{Br}^-$  had a decreased trend.  $\text{SO}_4^{2-}$  had the largest loss among these anions, followed by  $\text{NO}_3^-$ . Overall, the increase degree of cation was greater than that of anion after burning.

**Keywords:** Forest fire, Stream, Water quality, Nutrients, Fire effect

## **Integrated Assessment of Ecosystem Services as a Decision Support Toolkit for Regional Ecosystem Management: the Chinese Loess Plateau Case**

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Ecosystem services (ES), as measures of ecosystem functions and beneficiaries, are introduced and applied in ecosystem management with growing development of the conceptual framework and quantification methodologies. However, there are still many problems to link the integrated assessment of ecosystem services into regional ecosystem planning, management and decision-making. The main challenges include trade-offs and impact analysis of land use management options on ES, and integrative landscape planning and decision-making tools. This paper provide the conceptual design of our decision support toolkit for regional ecosystem management, which based on integrated assessment of ecosystem services, and show its application in the Chinese Loess Plateau.

The framework of this manage-oriented ES simulation and assessment platform, provide not only the dynamic modeling for quantifying multiple ES, but the scenarios construction and synthetic analysis modules. The scenarios construction can simulate the various land use and land management alternatives, and environment change such as climate change. To simulate the policies of ecosystem management with different allocation strategy, it support the scenario construction approaches including threshold-zoning, site-specific change identification, auto-allocation of land use, landscape dynamic-modeling and benefit-pursuing. The synthetic analysis module, based on the quantification of ES and the results of different scenarios, performs the trade-off analysis between multi-ES, explores the spatial interaction of ES between neighboring regions, and compares the benefit efficiencies of different management policies. Moreover, it uses the multi-objective optimization model to support decision making for regional planning and management.

## **A Comparison Study of Healthy Benefits of Three Types of Greenspaces in Beijing**

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Degraded environments have become a serious problem with rapid urbanization in China. Urban greening is thought as a cost-effective way for creating a better living environment. In order to assess the health benefits of urban greening, three types of greenspaces in Beijing were investigated for their impacts on the concentration of aero anion, human comfort level, concentration of CO<sub>2</sub>, and the level of noise within the greenspaces. The results showed that daily average aero anion concentration in the control site was only 68 ions/cm<sup>3</sup> whereas those of a forest park, a street landscape, and a roadside greenbelt were 15, 11.5 and 8.5 times higher, respectively. Human comfort level, as decided by the combination of temperature and relative humidity, was the highest in the forest park compared to other sites. The levels of CO<sub>2</sub> in all greenspaces reached the highest and lowest point at around 10:00 am and 14:00 pm, respectively, matched well with the photosynthetic activities of vegetation. The noise levels in greenspaces were all lower than that of the control site. In summary, the health benefits of greenspaces improved as the amount of vegetation increased. Also the benefits were higher in leaf-on season than in leaf-off season. It is recommended that large forest parks should be given more attention in urban greening efforts for their higher health benefits.

## **Research on Evolution of Urban Lake in Daqing City Based on RS/GIS During Rapid Urbanization**

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Daqing is called as “The city with Hundreds of Lake”. Unfortunately, urban lakes have fallen into an awkward situation with the rapid development of urbanization, resource exploitation, and sharp increase of urban population in recently years. The numbers and areas of urban lake have sharply decreased; some urban lakes have deposited; some became swamp. Additionally, soil erosion caused by human factors has shoaled and reduced reservoir capacity. Trade-waste sewage and domestic sewage flow into lakes, which has caused the deterioration of water quality.

This study presents a GIS/Remote sensing-aided procedure to monitor urban lake area change in Daqing city, which grew rapidly in the 1970s. Four time-series Landsat images, the year of 1979, 1989, 2001 and 2008, were used here. Lake's border maps were made by NDWI (Normalized Difference Water Index) index and IILI (index of lake loss intensity) of 154 lakes were calculated for analysis. The results showed that the total areas of lakes in the urban area decreased up to 132.49km<sup>2</sup> from 1979 to 2008. The temporal and spatial distribution of lake loss was affected by several factors such as city construction, oil resource exploitation, transportation construction, policy guide etc. The urban lake can be well protected after changing into lake park. The present study suggested that legislation and lake planning were two approaches for urban lake protection.

## How the changes of biodiversity of the under growth affect soil respiration in subtropical forest?

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Maintaining biodiversity has become a global concern and requires the implementation of sustainable management practices at a range of spatial scales. Forested ecosystems are no exception. The fate of much of the China's terrestrial biodiversity is linked to the management of human-modified forest landscapes in the humid subtropics. In order to promote the production of wood, under growth had been lopped off in some subtropical forests. How will this action affect the microbial community and quantity in soil? Whether soil respiration will be effected later? We studied the forests of *Pinus Massonisna* Lamb, *Castanopsis carlesii* (Hemsl.) Hayata and *Cunninghamia lanceolata* (Lamb.) Hook. Each kind of the trees had the under growth lopped off in their forest to be contrasted. The hypothesis is that reduce biodiversity of the under growth had decrease the microbial community and its quantity in soil. Then the soil respiration rate had decreased. This paper had explained the relationship among biodiversity of under growth, the microbial community and quantity in soil and soil respiration.

**Keywords:** Biodiversity, Under growth, Microbial community, Soil respiration

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## The Simulation of Land Use Change in Poyang Lake Region

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Poyang Lake Region is located in Jiangxi Province, which includes 11 counties around Poyang Lake, covers an area of 197216.5 km<sup>2</sup>. Over the past 30 years, the regional land use/land cover changed obviously because of the changes of natural conditions and increasing



intensity of human activity. In this period, the unused land decreased 29251.25 ha, the cultivated land decreased 8459.06 ha, the housing and gardens land increased 22247.51 ha, and the water area land increased 22651.75 ha. Contemporary, some landscape index for land use changed obviously, the Number of Patches (NP) decreased from 18040 to 17571, the Largest Patch Index (LPI) increased from 13.3985 to 15.8938, the Shannon's Diversity Index (SHDI) decreased from 1.6143 to 1.6091. and the Aggregation Index (AI) increased from 94.7527 to 94.9168. In order to find the driving forces of land use/land cover changes around Poyang Lake Region, Ten factors, that is, gross domestic product at current price (GDP, million Yuan), population density (persons/km<sup>2</sup>), mean elevation (m), mean slope (based on 90m DEM), direct distance to nearest city (m), direct distance to nearest major river (m), direct distance to nearest main road (m), average yearly precipitation (mm), average yearly temperature (°C) and soil fertility class (1 to 6 class) were selected to simulated the land use/land cover changes in CLUE-S model. The simulation results shows: GDP and population density have strong relevance with the changes with unused land, cultivated land and housing and gardens land, and the changes of water area land hasn't evident relevance with the 10 factors.

## **Chinese Urban Form in the Past Three Decades: Pattern and Process**

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With the growing acceptance of sustainable development, researchers have refocused on the old topic of urban form. A “good city form” or “sustainable urban form” are believed to enhance economic vitality and social equity, and reduce the deterioration of the environment. Recent discussions of “urban sprawl” in the United States and the “compact city” in Europe have lent credence to this renewed issue. However, most of the urban form studies were limited to developed countries while in the developing countries with dynamic setting, researches about urban development pattern and its changes have been lacking.

In the past three decades, China has undergone rapid urbanization and great socio-economic transition from planned economy to market economy, causing a intensive and radical urban form change. However, there is no a general, systematic and complete understanding of China's urban form change. Limited studies centered on individual cities or cities in the coastal regions, while inland cities were largely ignored. Moreover, most of the studies were traditionally qualitative rather than quantitative analyses.

This research employed four time-series Landsat images, including late 1970s, late 1980s, late 1990s, and present to investigate the pattern and process of Chinese urban form in the past three decades. The chosen ten big cities include five cities in the coastal regions and the other five inland cities. A selection of spatial indicators were defined and computed in order to draw an insightful understanding of Chinese cities' urban form. Comparisons of spatial metrics between coastal and inland cities and among four time periods were carried out. Socio-economic dynamics and mechanism were explored for the difference that exhibited.

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## Urbanization and its Impacts on Water Quality in a Subtropical Coastal Watershed, Southeast China

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Urbanization which transformed natural landscapes into anthropogenic impervious surfaces is recognized to have local, regional to global consequences for water quality and aquatic ecosystem (Allan, 2004; Bierwagen et al., 2010). Impervious surface area (ISA) becomes one important indicator to represent urbanization process, nonpoint source pollution and stream health and their linkages between each other (Arnold and Gibbons, 1996). This study investigates ISA dynamics and its effect on the water quality in a subtropical coastal watershed in Southeast China, which has enormous influence on the region's economic and ecological health. The spatial and temporal changes, as well as the development density of urban land use are determined by analyzing the impervious surface distribution using Landsat satellite imagery. In-situ sampling was conducted for 16 sub-watersheds with different level of urbanization (Fig.1). The relationships between urban land use and its environmental impact was explored using regression analysis against water quality parameters including  $\text{NH}_4^+\text{-N}$ , TP and COD in these sub-watersheds. The results show ISA has been noticeably increasing in terms of sub-watersheds in the last 20 years. There are strong associations existed between  $\text{NH}_4^+\text{-N}$ , TP, COD and the extent of ISA within each sub-watershed.

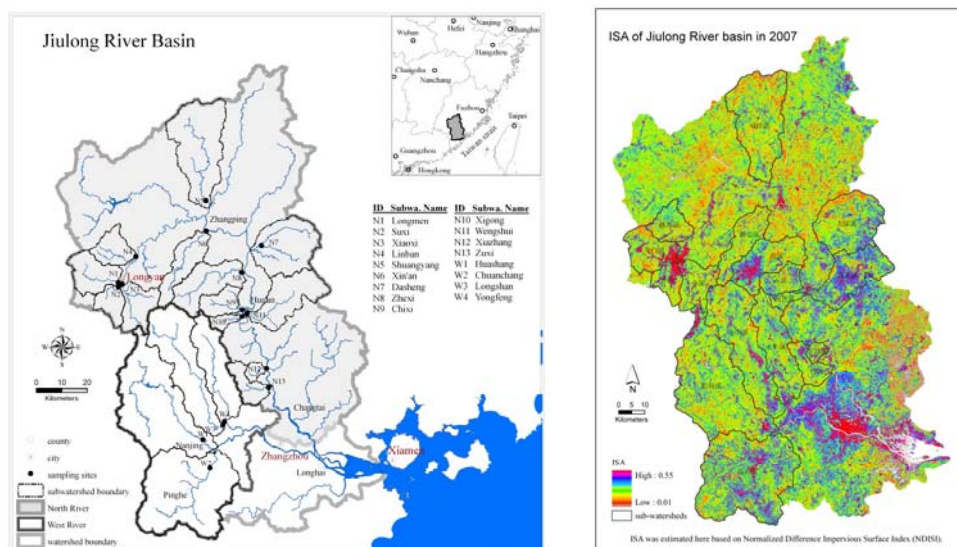


Fig.1 Study watershed and ISA mapping

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## **Take Driving Forces of Landscape Ecology as a Linkage of Landscape History and Sustainable Landscape Planning**

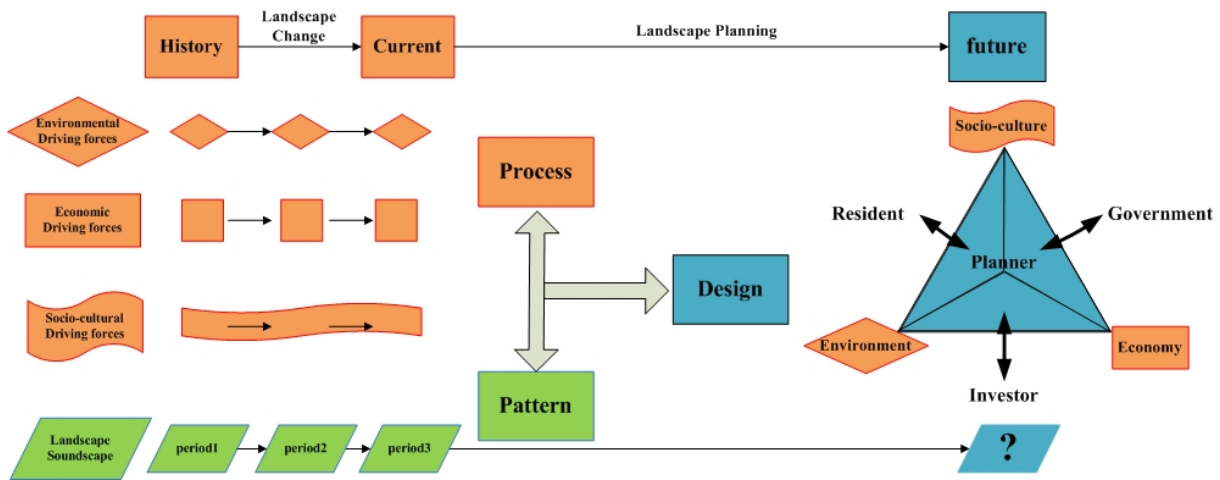
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Sustainable landscape planning needs the knowledge of landscape history. The driving forces of landscape change could and should be the linkage of past and future, i.e. the landscape history and landscape planning. Based on the new paradigm of “Pattern-Process-Design” in Landscape Ecology, a landscape planning framework, which focuses on optimizing landscape pattern, is proposed to analyze how to connect environmental, economic, and socio-cultural forces to residents, investors and governments.

Over the past few decades, landscape has changed dramatically, accompanying with rapid but imbalanced developments in China, especially in western region. According to documental records, historical maps and interviews, we formulate “time line” to explore the changes in landscape scale and three primary driving forces of Danling, a county in southwestern Sichuan, during 1953-2008. We confirm the importance of geomorphological characteristics, which plays as the restricted force for landscape development. Thus, we shape the baseline landscape pattern based on the geography and microenvironment analysis. Economic development remains the constant driving force for Danling, and agriculture development is the main economic force before 1998. In order to keep the balance of agriculture, industry and tourism, we reshape the current landscape pattern to achieve urban-rural integration. As a typical region under Chinese agriculture civilization, Danling residents have “FengShui” awareness and “unity of man with nature” subconsciousness. From the residents’ perceptions of the cause and consequence of the landscape change, we discover that this culture could act as an adjustable driving force to keep people feel happy and satisfied. Based on our results on landscape change, we propose scenario planning to supple the demands of sustainable landscape development.



## Energy Hierarchy and Landscape Sustainability

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The study of ecosystem suggests principles by which energy flows generate hierarchies in all systems. All ecosystems in the landscape are associated with energy transformation and converging transformed products toward centers of hierarchy, recycling un-used materials to dispersed background, and feedback to reinforce its supporting environment. A hierarchy can be seen as an organized pattern with many small units at one level contributed to fewer units at the next higher level. Due to the spatial variant characteristics of the natural environment, the different types and amount of energy received on the earth are not homogeneous which thus generates a spatial heterogeneous pattern of landscape. Energy from life-support and production systems of a heterogeneous landscape is transformed and converged spatially toward consumption centers. This paper considers the ways the energy hierarchy principles may apply to the sustainability of a landscape. All energy transformation can be arranged in a series and the concept of transformity is introduced in this paper to indicate position of an energy flow in the series. A hierarchical system with energy network can help explain how energy and matter can be produced and recycled through each level of energy transfer. Evaluation of energy flows can help identify zones of spatial hierarchy, which will help indicate the design properties needed for the landscape to be sustainable such as the territory of support and allocation or investment of energy and materials that match the hierarchical status of the landscape.

## **An Agent Based Land Use Model Integrating Land Market, Land Management and Ecosystem Function**

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Land use and land cover change in suburban areas is accelerated by the urban sprawl development in North America. The sprawl path is associated with the heterogeneous socio-economic status and preferences at the household level. Heterogeneity of individual decision-making process becomes the challenge which traditional top-down land use models are incapable to simulate. In addition, the sprawl development brings considerable pressure on natural environment and human living, for instance, fragmentation of landscape, intervention and loss of natural habitat and biodiversity, increase of carbon release and urban heat island. However, the process and contribution of land use change to the ecosystem, in specific, the carbon cycle, is not well known. Therefore, an integrated model is designed to simulate the land use change and its consequential impacts on carbon storage and flux caused by diverse land management strategies.

This integrated model consists of three sub-models. The first one is an agent-based land use model incorporated with the land market mechanism. In this model, heterogeneous households evaluate land parcels according to spatial location and individual preference. And the final transaction is made via a budget constraint and competitive bidding process. The second sub-model is an agent-based land management model. Developers in this model buy large parcels from farmers and sell small parcels to the household. Different households will adopt different land management strategies (e.g. irrigation, weeding, and fertilization) on their parcels. Different management strategies lead to the change of local aesthetic level and this effect will be feed back to the first model. At the same time, its impacts on local carbon cycle are estimated by the third model, BIOME-BGC, which is used to calculate the carbon flux and storage in individual pools (e.g. root, stem and canopy). Thus the integrated human-environment model is constructed.

This model is implemented in the Eclipse development environment and built on the RePast Symphony java libraries. Various kinds of data, including residential preference surveys, land management surveys, field measurements of biomass, land use maps, and historical social-economic data, are collected in Southeastern Michigan, and used to calibrate and verify the performance of the model.

The objective of this integrated model is to provide a research tool to incorporate the human-environment system from bottom-up and to analyze how land management strategies, land market mechanisms and related policies affect the land use patterns and carbon exchange.

# **Defining Optimal Sampling Effort for Large-scale Monitoring of Invasive Alien Plants: a Bayesian Method for Estimating Abundance and Distribution**

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Monitoring the abundance and spatial structure of invasive alien plant populations is important for designing and measuring the efficacy of long-term management strategies. However, methods for monitoring over large areas with minimum sampling effort, but with sufficient accuracy, are lacking. Although sophisticated sampling techniques are available for increasing sampling efficiency, they are often difficult to implement for large-scale monitoring, thus necessitating a robust yet practical method. We explored this problem over a large area (~20,000 km<sup>2</sup>), using ad hoc presence-absence records routinely collected over four years in Kruger National Park (KNP), South Africa. Using a Bayesian method designed to solve the pseudo-absence (or false-negative) dilemma, we estimated the abundance and spatial structure of all invasive alien plants in KNP. Five sampling schemes, with different spatially weighted sampling efforts, were assessed and the optimal sampling effort estimated. Although the data are dominated by taxa that occur in low numbers, the more abundant species showed a lognormal species-abundance distribution, with the 29 most abundant taxa being represented by an estimated total of 2.22 million individuals, with most exhibiting positive spatial autocorrelation. Estimations from all sampling schemes approached the real situation with increasing sampling effort. An equal-weighted (uniform) sampling scheme performed best for abundance estimation (optimal efforts of 68 records per km<sup>2</sup>), but showed no advantage in detecting spatial autocorrelation (247 records per km<sup>2</sup> required). With increasing sampling effort, the accuracy of abundance estimation followed an exponential form, whereas the accuracy of distribution estimation showed diverse forms. Overall, a power law relationship between taxon density (as well as the spatial autocorrelation) and the optimal sampling effort was determined. The use of Bayesian methods to estimate optimal sampling effort indicates that for large-scale monitoring, reliable and accurate schemes are feasible. These methods can be used to determine optimal schemes in areas of different sizes and situations. In a large area like Kruger National Park, the uniform equal-weighted sampling scheme performs optimally for monitoring abundance and distribution of invasive alien plants, and is recommended as a protocol for large-scale monitoring in other protected areas as well.

## Spatio-temporal Dynamics of Giant Panda Behavior across a Coupled Human and Natural System

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Animals interact with their landscapes in complex ways across space and time. Understanding the processes underlying such phenomena is especially important for endangered species, which face increasing threats from human influences on their fragile environments. One such species is the international conservation icon - the giant panda (*Ailuropoda melanoleuca*), an elusive animal whose behavior in the wild is not fully understood. We obtained a novel telemetry dataset detailing temporally and spatially-explicit habitat use by GPS-collared adult wild giant pandas inhabiting Wolong Nature Reserve in China, a coupled human and natural system which is home to not only about 150 wild pandas but also nearly 5000 local residents. We conducted analyses of spatial and temporal autocorrelation of individual panda habitat use patterns across seasons and built habitat selection models describing the effect of landscape characteristics (including geophysical, vegetation, and human impact factors) on panda habitat use over space and time. While many habitat use studies attempt to control for autocorrelation rather than characterize it as we do here, our analysis revealed new insights into the complex relationship between wild pandas and their spatially and temporally-variable resource (bamboo). Our results show the distinct punctuated pattern of habitat use by these animals, with concentrated spatial use of localized resources for short (1 to 2 week) bouts followed by short-range dispersal events to neighboring patches, a pattern governed by a negative feedback of declining food (bamboo) availability on duration of patch occupancy. Our findings also demonstrate the importance of water as a key resource dictating panda use of space and the sensitivity of individual pandas to human impacts such as livestock grazing and timber harvesting. This study has significant implications for the understanding of panda ecology and design of management plans for this endangered species. The findings also provide a more nuanced perspective on the carrying capacity of habitat by characterizing the behavioral adaptations of individual animals to limited resources, while also highlighting the effect of human impacts on individual animals over space and time.

# Sustainable Urban Environment and Landscape Architecture in the Era of Globalisation

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Contemporary landscape architecture truly has an interdisciplinary nature. It is not just garden design as it was in past centuries, but is the field which works with a broad variety of landscapes on different scales: from regional to the city and park design, from urban to rural and to national parks and reserves. Today landscape architecture is recognized as an “umbrella” discipline which combines knowledge in urban planning, urban ecology, architecture, art and heritage history, engineering, green structure design and even human behavior and health.

Taking into consideration the interdisciplinary character of landscape architecture, it is no surprise that the landscape architecture department of the Swedish University of Agricultural Science was an initiator of a new concept of *Resilient Citylands (Sustainable Cities as Resilient Citylands (SUCAR))*, which is a progressive interdisciplinary vision of sustainable urban environments and resilient green cities (Berg P.G. et al., 2011). It is based on best international sustainable practices on West European eco-cities, East European Ecopolis, Swedish local communities and international integrative green planning. *Resilient Citylands (RCL)* is defined here as human settlements with a high level of integration with primary production-, ecosystem services- and recreation providing landscapes in all scales outside and inside cities. RCL's are characterised by a high functional biological and social diversity with a potential for long-term sustainable life-support, with high capacity to resist degradation and with a flexible ability to adapt to changes in the surrounding world. *Resilient Citylands* is required to develop positive innovative strategies and involving specialists from different disciplines to adopt an interdisciplinary approach. It is also called for the trans-disciplinary relations between scientists and practical planners on the one hand and citizens and local authorities on the other. The chosen sustainable resources framework for SUCAR is based on the cutting-edge policy documents of the United Nations Habitat agenda (UNCHS, 1996).

The nature of the *Resilient Citylands* approach is very close to contemporary landscape architecture research and practice, featuring key interdisciplinary sustainability issues like urban ecology, biodiversity, green structure design, citizen health and intersensory conception of landscape values (Murphy, 2005). Our understanding of SUCAR is based on a range of different scale systems of European cities which include regional productive landscapes embedding cities and green large-scale wedges or blue lines of rivers and lakes intertwined with urban structures, as well as small-scale parks, gardens, street plantings, swales, green roofs and green walls which we are going to discuss in this paper.

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## **New Trends in Design of Urban Biodiversity**

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In the era of globalization there is a real necessity for a new conceptual framework for the design of urban biodiversity. The practice when landscape design schemes just used plants as an instrument for “filling” the spatial structure of architectural projects has passed. A new vision based on the perception that each landscape architecture composition is an ecological dynamic entity is required. Novel design approaches such as Bush Gardens (Australia), Pictorial Meadows (UK), xeroscaping, wild lawns, wildlife habitats and wildlife gardens (USA) are using models from nature (different ecosystems or their fragments) as an inspiration for planting design (Ignatieva, 2010). These innovative “design with nature” concepts are powerful visual tools for reinforcing urban biodiversity and making it more visible and recognisable for the general public as well. Some recent trends in landscape design are even broader and include not only plants but insect and animal populations, for example bird, butterfly and lizard gardens (Barnett, 2008). In a time of rapid urbanization and recent financial crisis, there is renewed interest in creating urban “edible” landscapes (community gardens and orchards, edible lawns) to replace unsustainable common urban biotopes such as lawns and flowerbeds that consume a lot of energy and resources (Allen et al., 2010).

These new developments in the design of urban biodiversity reflect our current economic crisis and the impacts of climate change resulting in the search for an integrated concept of design for urban biodiversity at different scales: from the master plan level (creating connection and integrated green infrastructure) to medium scale (design residential green areas or public parks) to the fine scale of “living streets”, green roofs and domestic lawns. Now is the time for creating different design “palettes” with desirable urban plants that can change the “face” of our cities and make them not only sustainable but recognisable and memorable. Different examples of such new approaches will be discussed in this presentation.

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## Plant Diversity on Floodplains: An Attempt to Establish a Cities' Biodiversity Index

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A floodplain has various topographic features and thus provides a variety of soil moisture conditions and habitat niches. At the same time, people also have used floodplains for settlement and food production from ancient times. In Japan, about 50 % of the population and about 75 % of the properties concentrate on floodplains that correspond to approximately 10 % of the total land area. Indeed, many cities are built on or near floodplains. A serious problem has arisen that many species on floodplains have been extinct or threatened because of human activities including development, decreased flood magnitude and frequency by river banks and dams, and alien species invasion. Therefore, it is important to establish an index which indicates conservation status of biodiversity on floodplains. In this study, we focus on plant diversity on floodplains.

Most of waters on floodplains in Japanese cities can be classified into rivers, paddy fields, and irrigation ponds. The size or length of waters are basic indicators of biodiversity, which directly reflect impact of human activities. For example, wetland area in Japan decreased from about 2,100 km<sup>2</sup> around the late 19th century to 800 km<sup>2</sup> in recent years because of filling and drainage of wetlands. In the plain of Kyoto city, total river distance including small rivers and canals decreased from 338.8 km in 1931 to 258.0 km in 1979. Waters maintained by human such as paddy fields, irrigation ponds, swimming pools and biotopes can be recognized as alternative habitats. Connection between waters can be another indicator. Both paddy fields and irrigation ponds in cities often lost connection to waters. Most of small rivers and canals that connected to waters disappeared because of filling and of converting to culverts.

Furthermore, the quality of habitats may be important. Function of paddy fields as nursery of biodiversity has degraded by modernized agriculture such as farm land consolidation, increased use of chemical fertilizers, herbicides and pesticides. Some of irrigation ponds were filled and others became eutrophic environments due to wastewater and abandonment. To assess quality of habitats, indicator species or taxa for a target region may be necessary. Examples are endangered species intrinsically vulnerable species because of their limited habitats and dispersal abilities such as *Aldrovanda vesiculosa*, and endangered species that was once common such as *Monochoria korsakowii* in Oguraike, Kyoto. We need to consider general characteristics of appropriate indicator species from case studies.

It is essential to create flood-prone lands and to re-inundate areas to restore flora and fauna on floodplains. A good example of a floodplain restoration is the Azame-no-se restoration project at the Matsuura River in the Saga Prefecture. Although it is not easy to create flood-prone lands in Japanese cities, establishing cities' biodiversity indices that indicate status of biodiversity on floodplains will be first importance to raise public awareness of nature on floodplains.

## **The Importance of Phosphorus in the Role of Inland Waters as a Sink/Source for Nitrogen**

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Nitrogen export from watersheds is a major concern for eutrophication in coastal marine ecosystems. As a result of this concern, much emphasis is currently placed on the amount and fate of land applied nitrogen in watersheds. Ecological stoichiometry predicts that nitrogen flux will be directly coupled to the availability of phosphorus as a limiting nutrient on productivity leading to increased demand/uptake for nitrogen, or resulting in shifts favoring nitrogen fixation. Thus, P availability can determine the degree to which a given watershed will result in a net uptake/loss of N. At moderate P levels, inland waters can function as sinks (balance productivity) while at the extremes of P limitation (excess N relative to P) and P excess (resulting in N limitation) watersheds can become highly unstable with regard to assimilation and N export. This talk will present data summarized from the literature and several experiments to illustrate how P availability can determine the role of inland waters in becoming a source of N to downstream systems.

## **An Approach for the Evaluation of Biodiversity (cultural service) from Designs of Nature in the City**

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Preserving open or natural space as wildlife habitat and spaces where children can play is currently a very important issue in urban areas. Additionally, “Children’s Play” is an important experience in learning about the structure of nature whilst “Environmental Education” has been afforded much greater importance in primary and secondary school education in Japan since 2002.

Forman (1995) discussed habitat fragmentation and how it occurs naturally as well as a result of human activity. Habitat fragmentation has already been caused by the development of housing projects in cities. If we create a green space in an urban area, it will serve as a stepping stone for species dispersal (Forman, 1995). Even if the site is not large, it can contribute to ecological education in the urban area. Fjortoft and Sageie (2000) have discussed the natural environment as a playground and learning arena as a way of rediscovering nature’s way of teaching or “learning from nature”. They also mentioned that landscape diversity was related to different physical structures and the vegetation, which were important for children’s spontaneous play and activities.

It is thus becoming very important to preserve open spaces as biotopes these days. Previous studies have mainly focused on children's experience of a place and their particular preferences of an unstructured environment. However to date there have been no studies on how children interpret a place and space (Hart, 1979; Moor, 1986; Fjortoft and Sageie, 2000).

We have designed a school garden, a river bank and a town park over the last 8 years. The aim of these projects was to create areas for preserving biodiversity, children's play and ecological education that could simultaneously form an important part of an ecological network in an urban area. Additionally, we will discuss and evaluate the index of biodiversity (cultural index) by children's play.

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## Designing a School Biotope for Children in Urban Areas – Planning and Implementation Process for 8 years

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There has been a rapid decrease in the amount of open or natural space in Japan in recent years, in particular in urban areas due to the development of housing. Preserving these areas as wildlife habitats and spaces where children can play is a very important issue nowadays. This project to design a garden in the grounds of a primary school in Fukuoka City in the south of Japan started in 2002. The aim of this project is to create an area for children's play and ecological education that can simultaneously form part of an ecological network in an urban area. Children at the school, their teachers and a number of university students participated in the planning and construction phases of the project and in making improvements to the school biotope.

"Process planning" was used to plan the school garden given the length of time the process was expected to take. In addition, "MFLP" (Ito et al., 2003, 2010) was used to plan the school garden for space scale planning. In other words, this is a method to think about how to

manage the space for various ways.

As a result of this project, 52 kinds of plants have started to grow in the garden and several kinds of birds and insects regularly visit it. In addition, research has shown that there are over 180 different ways in which the children play in the garden. Furthermore, they have learned about the existence of various eco-systems through playing there and their participation in 120 workshops related to the garden for 8 years. They have also actively participated in the development of an accessible environment and have proposed their own ideas for the management of it.

The aim of this project is to create an area for children's play and ecological education that can simultaneously form part of an ecological network in an urban area. Additionally, we would like to discuss how to plan and manage urban green spaces for human health and eco-environment quality from a landscape planner's point of view focusing on the methods used to plan it.

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## **Can Satoyama Offer a Realistic Solution for a Low Carbon Society? Public Perception and Challenges Arising**

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Establishment of a low carbon society is a pressing issue for our generation, yet already urbanized societies with their massive demand for energy are struggling to find feasible solutions. Japan is an example of such a society. We must consider not only the search for new technologies for using renewable energy, but also a shift in the form of society. Study of *satoyama* (*Socio-ecological Production Landscape of Japan* (UNU, et al., 2010)) has highlighted the revival and potential role of rural landscapes in Japan, which provide food and energy from local natural resources more effectively, and allow for a sustainable society. However, the question is how we are to implement effective strategies in this area.

This study aims to face up to such challenges by analyzing the contemporary public perception of rural landscapes in Japan. Data used is from the "100 Japanese rural landscapes contest", which was conducted by one of the biggest Japanese newspaper companies in 2008. More than 4000 nominations were collected from the public in which they answered the question "Tell me the rural landscape you like and why". The nominated sites were given

coordinates and combined with topographic datasets using GIS, and classified into landscape types using cluster analysis. A text mining tool was used to extract keywords from the written appeals, and correlation analysis was used in order to investigate what aspects of rural landscapes are valued in which type of rural landscape.

The result showed that the majority of the nominations were for sites of Forest Type (88% forest cover in 1km<sup>2</sup>). The most closely correlated keywords are related to the landscape: beauty, traditional culture and history, and 80% of the people who nominated them were people living outside of the region. The next most popular rural landscape was the Mixed Type (60% forest, 20% paddy fields in 1km<sup>2</sup>). Again, about 80% of the nominators were from outside of the regions and the keywords were associated with biodiversity and preservation activities. Paddy Field Type sites (paddy field >60% in 1km<sup>2</sup>) were significantly associated with *Furusato* (Home), and Urban & Suburban Type sites (built-up land 50%) were concentrated in the Kanto Region, and they were nominated mainly by local citizens for their nature activities.

The results indicated people's physical detachment from rural landscapes and production activities, a finding compatible with the report the *Japan Satoyama Satoumi Assessment* (UNU, et al., 2010). Instead, a new type of mental attachment has been created, mainly focused on the value of cultural services such as scenery, traditional culture and nature experiences. This indicates that a low carbon society using *satoyama* knowledge requires a new "pleasure" aspect for people to get involved and complete participation in physical work could not be expected unless an emergency arose. In any case, it will be challenging to get enough actors involved to make *satoyama* a viable solution towards a low carbon society.

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## A Study on Urban Home Gardens in the Garden City- Bangalore

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Home gardens are rich biodiversity green spaces in the city. However, this resource is less researched and is poorly acknowledged for its contribution to the urban environment. The rapid urbanization in the recent years has led to the conversion of huge households to smaller units of housing and high rise apartments, leading to reduced garden spaces. In many of the private lands, vegetation gives way for concrete structures for a higher economic value, which has led to the maximum utilization of the land area for housing purpose. This study was conducted to determine the floral diversity in 137 home gardens in the city of Bangalore. A survey was also conducted to understand the management of these spaces and the interactions of the residents with urban wildlife. The sampled area consisted of small houses (<2500 sq ft),

medium houses (2500 – 5000 sq ft), large houses (> 5000 sq ft), each category of houses had their own characteristic plant communities. The tree distribution was found to be largely dominated by the trees which are grown for their utilitarian purposes. Most of the plants in the homes were planted for their ornamental and cultural values. The gardening trend can be directly related to the architecture of the houses and the lifestyle of the people. Due to the increasing land prices, it is difficult to expect people to maintain huge spaces for gardens, but it is very essential to maintain greenery in homes for their ecosystem services. These garden spaces with their rich biodiversity within the crowded concrete areas of the city are very essential for their aesthetic, social, cultural and ecological values.

## **Social Learning and End-state Emulation: Strategies for Climate Change Adaptation**

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Whilst understanding the basis of climate change is scientific, coping with changed climate is a social challenge. Stability or predictability of weather was the background framework upon which all human activities were based. Knowledge and wisdom amassed over generations hold true within this frame of reference. However, incessant *developmental* activities, especially post industrial revolution have distorted this reference frame. It has increased the probability of unpleasant outcomes for human actions like water harvesting, crop and animal husbandry, human ailments, etc. to uncomfortable levels and is threatening to unsettle the very social fabric of human societies.

Sustainable development and climate change adaptations are two ways of expressing the same issue. Overarching scientific background of the architects of these phrases has favoured their confinement predominantly within science and engineering disciplines. Scientific studies have helped us realize that climate change is inevitable. In the scramble for an effective adaptation strategy, we have overlooked the solution already provided by Albert Einstein in his words '*No solution exist to a problem, under conditions, which in the first instance created the problem*'.

Coping with climate change and sustainable development are beyond scientific realm. Technical knowledge and scientific counsel alone, has limited ability to influence societal change. Much of the public discussion on climate change impacts have focused on national or international policy initiatives that would reduce carbon emissions. There has been much less discussion about how local and regional communities might adapt to the reality of climate change impacts over the next century. Despite scientific strength amassed while understanding the challenges of climate change and sustainable development, fact that mankind has adopted a less enlightened course, testifies that these policies are the just ends in themselves without means.

Collective human action is the *sine qua non* for successful adaptation strategy (Jaishanker, 2010). Ingenious social engineering is the best trigger of collective action. The author describes social learning and end-state emulation and identifies their strengths in tapping informal institutions and enabling social inertia as potentially effective engineering techniques to enhance adaptive capacity to address residual uncertainties (Farber, 2008) associated with climate change.

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## **Export of Solutes from Watersheds: Stationarity and Inequality from the Mississippi to the Kissimmee**

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What controls the temporal dynamics of the load of solutes, such as nitrogen (N) and phosphorus (P), from watersheds to receiving water bodies? For example, the external load of total P from tributaries to Lake Okeechobee has exceeded the regulatory limit of 140 tonnes/year by an average of more than 300 tonnes/yr for more than two decades, despite concerted efforts to reduce P application rates in the basin. Based on a synthesis of data from the basins of the Baltic Sea, Lake Okeechobee, and the Mississippi River, it is shown that inter-annual variations in exported loads for geogenic constituents, and for total N and total P, are dominantly controlled by discharge. Emergence of this consistent pattern across diverse managed catchments is attributed to the anthropogenic legacy of accumulated nutrient sources generating memory, similar to ubiquitously present sources for geogenic constituents. A theoretical explanation for the observed patterns is offered. Further, a framework is introduced for characterizing the temporal inequality of stream discharge and solute loads, illustrated with application to the Kissimmee River and other tributaries to Lake Okeechobee. Ongoing and future efforts to protect the lake are heavily dependent on treatment wetlands whose design must appropriately consider the temporal variability in both flows and loads. While flux-averaged solute concentrations are likely to be stationary, intra-annual flows and loads are shown to be highly non-uniformly distributed. Multiple decades of daily observations are used to show that 90% of the total flow is generated in as little as 10% of the time. Because of biogeochemical stationarity, the temporal inequality of loads tracks that of flows nearly exactly. Important implications are that (1) inter-annual variations in load can be robustly predicted given discharge variations arising from hydro-climatic or anthropogenic forcing, (2) water quality problems in receiving inland and coastal waters may persist until the accumulated storages of nutrients have been substantially depleted, and (3) remedial measures designed to intercept or capture exported loads must be designed with consideration of the intra-annual load inequality.



## **Urban growth patterns at multiple scales**

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A combination of rapid population growth and an accelerating demographic shift from rural to urbanized habitats has resulted in urbanization becoming an increasingly global phenomenon. The drivers, trajectories, and consequences of such globally distributed land-cover change are not well understood. The landscape patterns resulting from urbanization influence processes at neighborhood, whole city, regional, and global scales. To improve understanding of urban landscape changes, remote sensed imagery, multiple models, model-data fusion, and scenario analysis approaches are becoming a widely used suite of tools. Here, I present research spanning these tools to address several linked questions addressing urban landscape change. These studies range in scale from individual cities, Los Angeles, CA and Phoenix, AZ USA, a network of cities across the southwestern United States, and global urban syntheses. I use these studies to exemplify a general framework for understanding landscape changes with particular relevance to the scale of urban influence. At fine scales, urbanization tends to homogenize the landscape while at broader scales urbanization tends to increase heterogeneity and then finally at broader still scales, urbanization again tends to homogenize ecological patterns. These trends are observed in patterns of land-cover, microclimate, and soil structure.

## **USDA National Institute for Food and Agriculture Research, Education, and Extension Programs Supporting Ecosystem Services**

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The use of agricultural lands is changing in both the intensity and the diversity of products being provided for human consumption. The grand challenge for agriculture is how to reconcile agricultural productivity with environmental and social integrity. Agricultural and forest lands and environs can be managed to respond to increasing demand for resources and services which it can provide while valuating the health of the environment.

Agricultural lands, encompassing over 940 million acres of working ranch and farm lands or approximately half the U.S. landmass, have had major impacts on the function, production, and economics of ecosystem services. Agricultural production is dependent on many ecosystem services such as nutrient cycling, pest control, and pollination. Management of agroecosystems can enhance or degrade the ability of these systems to provide ecosystem services such as clean water and air, habitat and food sources for biodiversity, soil conservation, carbon sequestration, disease and invasive species suppression, and climate regulation.

Agricultural ecosystem services provide for a vast array of goods and services in a multitude of agricultural ecosystems. Support for ecosystem services research, education, and extension activities in the USDA National Institute for Food and Agriculture (NIFA) portfolio relate

primarily to three strategic goals: benefit production agriculture, improve the quality of life and increased economic opportunities, and enhance the natural resource base.

NIFA funds about 2000 competitive research grants yearly and approximately the same number of formula-funded (direct payment to institutions of higher education) research projects. There are over 24 ecosystem services that are generally related to agricultural activities. Seven specific components of these services have received priority through NIFA funding opportunities and relate to three major challenge areas of Global Food Security, Bioenergy, and Climate Change. These components are: clean air, water quality and abundance, carbon sequestration, soil conservation and quality, biodiversity, nutrient cycling, and aesthetics and recreation. A CRIS search of active projects indicates that several hundred projects are funded each year that relate specifically to one or several (bundled) ecosystem services or as part of a larger programmatic interest. This presentation will demonstrate the types of projects funded and a general overview of high impact results.

## **Spatial Patterns in Land use/cover of Cross-border Area of Tumen River in the Early 1900**

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Land cover, defined as the physical surface condition of the land, is likely to change as a result of land use change (Turner et al., 2001). The spatial and temporal heterogeneity of ecological systems is widely assumed to influence ecological process, and measures of landscape pattern are commonly used to characterize this heterogeneity (Forman and Godron, 1986; Gustafson, 1998).

Tumen River is the border area of China, North Korea and Russia. This area has abundant natural resources which make great potentiality of economic development, but its environment is fragile in recent years. Especially in the part of North Korea, its unregulated felling due to poverty and backwardness has resulted in numerous negative effects on ecological condition seriously. There is little artificial destruction in the early 1900 in this area, so the land use pattern in that time was natural and relatively untouched. This study supposed to reconstruct the original states of the spatial patterns of cross-border area of Tumen River based on the topographic maps drew in Manchuria Period, and analyzed the characteristics of land use pattern and distinguished the distinctive features between different counties. It would be helpful to recover the ecological environment in the cross-border area of Tumen River.

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# Landscape Pattern Analysis of Yinzhou New City Zone Based on High Spatial Resolution Aerial Photos

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Urbanization has changed the landscape structure of cities and caused unnatural phenomena while ecological processes have been obstructed. Ningbo, a classic city, is the central city of the south Yangtze River Delta and is one of the economically developed coastal areas. The Yinzhou District is an important region of the development of Ningbo Central District. With urban spatial analysis combined with some metrics, this paper attempts to quantitatively analyze the landscape pattern of Yinzhou New City Zone, based on the land use of Gis-datasets derived from 1:5000 high spatial resolution aerial photos of 2009. According to the theory of landscape ecology and the characteristics of study area, the article classified the urban landscape into 6 types, namely, hard surface, water, public green, protective greenbelt, agriculture, and road. Applying the spatial pattern analysis software FRAGSTATS 3.3, this paper includes these following four aspects: (1) urban landscape structure of patch; (2) class-level metrics of landscape types; (3) landscape-level analysis; (4) patch size distribution. The results show that there are numerous and well-proportioned landscape components in Yinzhou New City Zone, which has formed the massive isotropic landscape in the progress of urbanization. Land used for construction occupies 49.96%, mainly in the northern region, along north of the Yinzhou Road. Agriculture, with an area of 1785.51hm<sup>2</sup>, occupies 23.9%, mainly along south of the Yinzhou Road. Water network, crowded and distributed evenly, is a typical model with urban features in south of the lower reaches of the Yangtze River. The hard surface which has higher landscape fragmentation, is complex and is most obvious in human disturbance. Among three kinds of urban green, the public green displays higher patch density with the edge density of 8.22 and 76.65 respectively. This indicates that the public green is quite seriously fragmented and complex; but the agriculture, concentrated in southeast of Yinzhou New City Zone, is more unitary, and the patch density and the edge density is lower, with 2.34 and 41.46 respectively. Each type is predominantly the small size patch, taking up 71.01%. The patch distributions at mesoscale level or above are few. The agriculture has a higher mesoscale patch and a bigger scale patch, occupying 35.43% and 30.29% respectively. 73.94% of public green patch is identified as small scale patches with less than 1hm<sup>2</sup> of the area.

**Keywords:** High spatial resolution, Aerial photos, Landscape pattern, Yinzhou New City Zone

## **Multi-scale Assessment on Vertical Pattern Diversity and its Ecological Effects in Cultural Landscape of Hani Terrace, China**

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The interrelations among landscape pattern, ecological process and scale are the main topics in landscape ecology. Landscape pattern reflects the results of ecological processes. At the same time, the former impacts on the dynamics of the latter. And both of them are occurred at different scales of space and time, that is, spatial and temporal heterogeneity of pattern and processes. Therefore, scale dependence and transformation became the hot topic in ecology, geography and other sciences related with space and time. Cultural landscapes are produced by, and reflected, the long-term interaction in indigenous societies of humans and nature. Owing to the high elevation differences, mountainous areas have obvious vertical patterns compared with flat areas. Yunnan Province of southwest China is the homeland of ethnic groups and the shelter of numerous wild plants and animals where have rich agri-cultural landscapes. Taking the cultural landscape of rice terraces created by the Hani and other ethnic peoples in Yunnan Province, Southwest China as the case study, using digital elevation model, landuse maps combined with field survey, this paper analyzes: (1) Landscape pattern at regional (prefecture) scale, including Yuanyang, Honghe, Lvchun and Jinping County in Honghe autonomous prefecture in Yunnan. (2) Landscape pattern at Yuanyang county scale. (3) Landscape pattern at Malizhai river basin scale. (4) Landscape pattern at upper basin scale of Quanfuzhang river. (5) The ecological effects of vertical patterns in Hani rice terraces landscape.

**Keywords:** Multi-scale, vertical pattern, diversity, ecological effects, cultural landscape, Hani Terrace

## **Ecosystem Services and Biodiversity Conservation in Traditional Biocultural Landscape in Eastern Asia**

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Ecosystems and landscapes are experiencing growing pressures including global climate change, land use change, pollution and invasive species in which anthropogenic impacts are the main drivers, which caused biodiversity loss and other related problems. Ecosystem services was defined as the goods and services provided by ecosystems that benefit human well-beings, which has emerged over the last decade as a powerful mechanism to understand the relationship between human well beings and its ecological dependence on natural resources and ecosystems. Taking Hani rice terrace landscape in SW China and Satoyama landscape in Japan as objects, this paper analyzes: (1) The basic geographic distribution and natural background of the two landscapes, such as location, area, terrain, climate, elevation, landscape compositions and their area proportion. (2) Ecosystem services and human well beings of the two landscapes, including provisioning services (rice, wheat, fishes, bamboo shoots, wild fruits and mushrooms, firewood, timbers, straw, fodder, medical plant, and etc. ), regulating services (e.g. water, natural hazard and pest regulation), cultural services (recreation and heritage), and supporting services (e.g. nutrient cycling). (3) Biodiversity of the two landscapes (including biodiversity in forest, rice terraces or paddies, and levees). (4) Conservation history of the two landscapes, and (5) Relationship between ecosystem services and biodiversity conservation under global climate change and globalization of economy.

**Keywords:** Ecosystem services, Human well beings, Biodiversity conservation, Biocultural landscape

## **Advances in Research of Ecological Vulnerability**

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How to observe and define ecological vulnerability has a very strong reference value for maintaining the eco-system stability and sustainability. Based on analyzing the research on ecological vulnerability at home and abroad, this paper discusses about research on direction, scale and methods of ecological vulnerability, and finish a summary of the assessment of ecological vulnerability and forecasting of ecological vulnerability. Both the assessment of ecological vulnerability and forecasting of ecological vulnerability have the same research approaches, for example, confirming research subject, choosing research object, collecting and analyzing research data, confirming analysis mode and so on. And there some differences the analysis models between the assessment of ecological vulnerability and forecasting of ecological vulnerability. Finally, it discovers that the imperfect research framework, inconsistent research methods and uncoordinated relationship between research and precision are the main problems of research on ecological vulnerability. There are four aspects should be considered for the future research: (1) Deepen the depth and extend the extent of research on ecological vulnerability; (2) Enhance the communication and integration between ecological vulnerability and other subjects; (3) Do more research on policy responses of ecological vulnerability; (4) Build a comprehensive and systematic ecological vulnerability research system which contains vulnerability dynamic monitoring and comprehensive assessment and trend forecasting by using “3S” technology.

## An Innovative Management System in a Thai Conservation Forest

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Regardless of formal laws and regulations, collecting non-timber forest products (NTFPs) is an important income-generating activity for some villagers living in Thai conservation forests. In San Charoen and Huay Klaeb, Nan province, NTFPs contributed approximately one third of the total household's income. The strategies of harvesting NTFPs were closely related to the livelihoods of the collectors. While some specific products were deliberately sought, many NTFPs were harvested indirectly whilst the collectors were cultivating their fields and travelling to and from their plots of land. The NTFPs harvested for household consumption included bamboo shoots, rattan shoots, wild vegetables, wild fruits, medical plants, mushrooms, insects or their products and wildlife. Some NTFPs were also collected for use as raw materials, eg. construction, tool handles, poles and fencing. All households collected fuel wood.

The main product collected for trading was the fruit of the sugar palm (*Arenga westerhoutii* Giff.). In both villages there was a strong relationship between income and the quantity of sugar palm harvested. This relationship is hardly unexpected as NTFPs compose approximately one third of the total household's income in both villages. Further, sugar palm contributes about ten times the income of other NTFPs in San Charoen and double the income of other NTFP's in Huay Klaeb. The harvesting and use of NTFPs is influenced by a variety of factors such as available natural resources, land use and cropping systems, cultural preferences, market values for NTFPs, alternatives to NTFP collection, seasonality and labor availability. The strategies adopted by communities to utilize NTFPs are dynamic and they respond to changes in the available resource base and changes in the villagers livelihoods.

In San Charoen, the villagers had established an innovative management system for NTFP collection. Every household had responsibility for a 'household forest' where it has the right to collect fruits of sugar palm. The management system had resulted in direct benefits to the villagers including reduced competition which led to fruit being harvested at the optimum time and fruit being left on every plant to ensure regeneration. Some villagers domesticated sugar palm in their lands. Within this village the community rules were enforced and additional regulations relating to NTFPs such as a restriction on trading bamboo shoots and rattan stems were generally adhered to.

**Keywords:** Innovative management system, Conservation forest, Sugar palm (*Arenga westerhoutii* Giff.)

# **Land Suitability Assessment for Oil Palm (*Elaeis guineensis* Jacq.) Plantation in Landak Regency, West Kalimantan Using Multi Criteria Decision Analysis and GIS approach**

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Oil palm (*Elaeis guineensis* Jacq.) plantations have expanded rapidly in Indonesia as a commercial plantation in the last decade to fulfill the high demand of its product both at the local and international markets. To develop the biggest palm oil exporter in the world, Indonesia government is planning to extend oil palm plantations in several targeted provinces, particularly West Kalimantan has its highest projection. In this study we determine land suitability for oil palm plantation and possible land for new oil palm plantation in Landak Regency, West Kalimantan as a case study.

Method used in this study is Multi Criteria Decision Analysis and spatial analysis using Arc GIS software. Relevant physical factors of climate, soil, topography, water source availability, and accessibility are considered to assess land suitability for oil palm plantation and current land use are considered to determine the possible lands for new oil palm plantation. All data are stored and analyzed in Arc GIS 9.3.1. The results indicate that combination of current land use and land suitability assessment using MCDA and GIS approach has created the possible lands for new oil palm plantation and been useful for planners to generate the future direction of oil palm plantation in this region. Therefore, this study is very important for local government in order to manage and allocate the possible land for new oil palm plantation without destroying tropical rainforests and the other protected areas.

## **Acknowledgements**

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## **Surface Water Dynamics, Contaminant Transport and Transformation, and Management of Watersheds**

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The fate and effects of contaminants in the environment has generated considerable public concerns at various locations and various spatial scales. The spatial pattern of land use and the spatial variability of contaminant loading can directly affect the hydrological and the fate and transport processes due to landscape fragmentation across the topography and their proximity to streams and other water bodies. In order to facilitate water quality management and watershed management, we need to understand the interaction and integration of spatial processes across terrestrial and aquatic components of the whole watershed. We developed a spatially-distributed watershed model to capture the movement of water and contaminants across the landscape. We examined how groundwater and surface water flow, how sediments are eroded and transported, and how dissolved, bound, and particle-sorbed contaminants and nutrients move and transform on land and in water bodies in a 2-dimension watershed. We found that the location of the source zones in relation to the landscape directly affects the location and magnitude of the deposition zones and hence can affect field data collection efforts and the watershed management plan. In addition, channel bed erosion and deposition is important to understand and quantify since over long periods of time a channel reach may at times be a source for sediments and contaminants and then at other times a sink for those same sediments and contaminants. Through our investigations, we found that hydrologic and biogeochemical processes vary greatly in different spatial and temporal scales. As the spatial and temporal scales increase, lumping of processes and loadings can result in a “washing out” of small scale features and processes such that inappropriate management plans may be implemented which will not have the desired effect. Careful attention to spatial and temporal scales will allow land managers to design and control spatial configurations of land use to reduce and control runoff and contamination risks. Land managers and water quality monitors need to consider and incorporate the spatial and temporal variability into their management plan. Our model can provide insight and facilitate their analyses.

## **Towards a Global System of General Habitat Categories Linking Reflectance Habitats and Species**

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The linking of in situ and RS data requires a common system of habitat classification. Such a system should be follow a transmissible and reproducible procedure for surveillance and



monitoring of habitats. Without rigorous rules, changes from baseline records cannot be separated reliably from background noise. A General Habitat Category (GHC) Classification System is developed that satisfies these requirements and can provide consistent habitat data and that can support a range of policy initiatives and scientific projects (Bunce et al 2008). The system links with the FAO LCCS system (Di Gregorio and Jansen ), and is based on classical plant life forms, used in biogeography since the nineteenth century and on their statistical correlation with the primary environmental gradient.

The basis of the GHCs is the classification of plant Life Forms produced by the Danish botanist Raunkiaer in the early 20th century. These Life Forms e.g. annuals or trees, transcend species. They are based on the scientific hypothesis that habitat structure is related to the environment. The General Habitat Categories and the Life Form Qualifiers have 160 GHCs derived from 16 Life Forms (LFs), 18 Non Life Forms (NLFs) and 24 Life Form Qualifiers (Bunce et al 2011). They have been field tested in all the environmental zones in Europe (Metzger et al 2005) as well as in Mediterranean and desert biomes in Israel, Tunisia, South Africa and Australia. Variation within a General Habitat Category is expressed by environmental and global qualifiers, which are combinations of soil humidity, nutrient status, acidity and other habitat characteristics. To make this system global further testing in tropical biomes, both forests and savannahs, in desert biomes and extension into wetland and coastal biomes is needed.

The distribution and change of landscape ecological parameters, such as connectivity and fragmentation, can be derived and their significance interpreted.

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## **The Spatial Heterogeneity of Resources Mediates Grazing Impacts on Vegetation in Mongolian Rangelands**

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Assessing grazing-induced degradation in arid and semi-arid rangelands with stochastic rainfall regimes has been a challenging issue. Non-equilibrium rangeland model suggested that low and erratic precipitation cause patchy and variable resource distribution and that prevent herbivore populations from effectively tracking resource availability. And thereby herbivores have a lesser impact on vegetation dynamics. However, Illius and O'connor (1999) predicted that key resource areas, which are heavily used during the drought periods, are more prone to be deteriorated by the concentrated grazing impacts. Yet, such theoretical predictions have not been empirically tested. In this study, we focused on the role of spatial heterogeneity of resources to assess how they mediates the grazing impacts on vegetation under highly variable environments. Specifically, we tested the hypothesis that grazing impacts on the resources areas heavily used during drought would be greater than other areas.

Study areas were situated at Mandalgobi in Mongolia. We set study sites at four typical vegetation community types (*Caragana*, *Allium*, *Achnatherum*, *Reaumuria* community) that were located on a land catena: hill, tableland, pediment and depression. We interviewed key informants about four community types to examine how local pastoralists explore these communities during usual summer and drought summer. In order to determine the grazing impact on each community, we carried out vegetation survey and dung counting at grazing plot and non-grazing plot in each sites. In order to describe the differences in response to grazing at each community, we calculated dissimilarity using a Sorensen's quantitative dissimilarity index between grazing and non-grazing plots in each community.

Our results showed that local pastoralists make use of the spatial heterogeneity of resources for livestock survival in study area. According to key informants, during usual summer they use *Allium* community where have high forage value species, but during drought *Allium* community has few vegetation and they use *Achnatherum* community where have high vegetation biomass. Therefore *Achnatherum* community would have a role of key resources in this area. Our result also showed that the spatial heterogeneity of resources mediates grazing impacts on vegetation. The number of dung in *Achnatherum* community was highest in all four communities types. Floristic composition of *Achnatherum* community were more affected by grazing than other communities. These results supported our hypothesis that grazing impacts on key resources areas are greater than other areas. Thus, our study provided the empirical evidence that the spatial heterogeneity of resources mediates grazing impacts on vegetation. Furthermore, we suggests that grazing management would be necessary for sustainable rangeland production even under highly variable environments.

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## **‘Kappa’ as an Historical Indicator of the Relationship between Waterside Environments and Human Life**

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Challenges of landscape ecology should involve human perception on their surrounding environments in relation to the spatial traits. An attempt of the study is to clarify regional difference of the human perception on the interactive process between physical environments and people’s life at watersides by analyzing folklores on “Kappa”; legendary creature, a type of water-deity.

*Kappa* has two opposite characteristics; one is as disaster carrier and another is as luck carrier. The *Kappa* in some region has both characteristics and brings both disasters and lucks to people (*Kappa A*), while the *Kappa* in another region brings only disasters (*Kappa B*). Hypotheses are i) difference of occurrence pattern of *Kappa A* and *Kappa B* might represent difference of human perception on interactive process between waterside environments and people’s life, and ii) the process might be constrained by physical conditions of waterside where people live. If these hypotheses are adequate, distribution of *Kappa A* and *B* can be estimated by physical parameters.

The folklores on *Kappa* were collected at 100 sites from all over Tokushima, Shikoku Island, Japan. Maps of *Kappa* distribution and several environmental parameters were overlaid, and the parameters that affect to distribution of folklores on *Kappa A* and *Kappa B* were identified through decision tree analysis.

As a result, folklores on *Kappa A* are found at the watersheds where paddy fields are presence and mean slope inclination is less than 20.1. The area corresponds with flood plain formed by large rivers. While folklores on *Kappa B* are found at watershed where paddy fields are absent and SPI is over 0.79. The areas are along main rivers in mountainous area and their tributaries. The area without the folklore on *Kappa* is on mountain slope without rivers.

The method is useful to make classification and mapping the cultural regions based on history of people’s life. The map might be applicable to regional planning and design.

## ***Satoyama* in the Urban Range in Japan Pattern, Process and Implication to Urban Planning**

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*Satoyama* is a mosaic landscape, comprised of an integrated social and ecological network of

a village and its surroundings, such as agricultural lands, open forestlands and forests. The *Satoyama* landscape used to be sustained by activities of local people to obtain provisioning services from the ecosystem, such as wood for fuel and grass for fertilizer, and the activities have helped to sustain wildlife. The background made Japanese government to propose “**Satoyama Initiative**” to the world that represents a vision to realize societies in harmony with nature. But how do we identify and find its distribution in Japan?

The *Satoyama*, however, is declining because of urbanization and abandonment due to fuel revolution and innovation of technology. The human-nature relationship is becoming disconnected and many disturbance-dependent species that inhabit *Satoyama* have become threatened. However, volunteer groups formed by urban people have started to restore *Satoyama* in their surroundings. There is a strong possibility that urban development could destroy *Satoyama*, but at a same time high social capital within the urban environment could be used to conserve and restore the *Satoyama*.

1) A method to identify and find *Satoyama* region from throughout Japan was developed by taking notice of its mosaic structure; Shannon-Wiener index,  $H'$ , was calculated by using aerial ratios of forest, cropland and residential area for all 1km meshes, and the result was shown as a map. Then meshes of high mosaic,  $H' > 0.6$ , were extracted and defined as *Satoyama* region.

2) All of Japan in two decades (the 1980s and the 2000s), was classified into urban range, urbanizing range and out of urbanizing range, values that can be automatically extracted by using a GIS database of land use. Then the land use change of *Satoyama* in those ranges was compared. Aerial ratio of land use change from *Satoyama* to residential and/or industrial area was particularly high in urban range comparing to the other ranges.

3) To evaluate the social capital in the ranges, density of NPOs, needs explanation which represent biodiversity, ecosystem and *Satoyama* as keywords for the aim of foundation, was compared among different types of land use change. The result showed that the density of NPOs is high in urban and urbanizing ranges, where destruction of *Satoyama* is conspicuous due to construction of new towns. It is considered that people who have moved to new towns give a value to retain *Satoyama*, because of its ‘naturalness’, and obtain cultural service from it through volunteer activities.

*Satoyama* in urbanizing range has potential value for people who newly come into the region, and provide them good opportunity to touch with nature through volunteer activities. However it sometimes causes conflict with the people who live there from the past, namely farmers. A platform for promoting involvement and collaboration should be prepared in the urban planning.

## **The Effects of Forest Cover Type on Seasonal Distribution of Black Woodpecker (*Dryocopus martius*) in Shast Kalate Forest, Gogan Iran**

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Plants as an important part of habitat, supply the basic needs of the birds. The cover type and structure of plant species covering the region, could affect the distribution and richness of the species. Therefore, the information about the vegetation cover type plays an important role on the studies of the birds. In this study, the influence of forest cover type on the distribution of Black Woodpecker (*Dryocopus martius*) in Shast Kalate forest, was studied. Four types of vegetation cover namely Fagus, Fagus– Carpinus, Carpinus– Parrotia, and Parrotia– Carpinus– Quercu was examined. In total, 72 sampling points were determined and the number of black woodpecker observations for each sampling points was collected for three seasons, namely summer, autumn and winter. The Results of statistical analysis, based on multiple regressions, showed that for three seasons in total, the habitat preference was for Fagus, Fagus– Carpinus, and Carpinus– Parrotia forest cover type, respectively. There also was no habitat preference for Parrotia – Carpinus Quercu forest cover type. Furthermore, due to low temperature, the dependence of this species to Carpinus– Parrotia forest type was higher in autumn and winter as compared to the summer. The results indicated that the forest stands that are occupied by this woodpecker have higher percentage of beech and due to the high affinity of Black Woodpecker to the forest habitats with beech cover type (Fernandez and Azkona., 1996), it is essential to control severe exploitation of such habitats (Garmendia *et al.*, 2006).

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## Linking Pattern to Process: The Implications of Landscape Change for Catchment Management and Water Quality

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This paper examines bank erosion and channel change on the downstream reach of the Daly River, Northern Territory, Australia. The Daly River is a significant groundwater-fed river situated in the wet-dry tropics of Northern Australia. There is a keen interest in sediment accumulation in the river due to the catchment's potential for agricultural development. Wet season flow of the river is high and dry season flow is maintained by groundwater that results in a unique freshwater system supporting numerous life forms. Flood during the wet season reshapes the river channels and banks, causing erosion and deposition. The River bank is associated with riparian vegetation that is rich in species diversity although the vegetation is not strongly varied along the study reach. Melaleuca species forms the first layer of vegetation along the river, and lower terraces and are susceptible to loss by river flows. Further up to the riverbank is closed canopy monsoon forest. The levee and floodplain are

dominated by Eucalyptus communities. The riparian vegetation is also complemented by tropical grasses and occasional rainforest patches. The spatial distribution of vegetation is largely controlled by water availability and soil type and depth, and is disturbed by fire and grazing. In addition feral animals mostly pig and buffaloes are degrading the riparian system and increasing susceptibility to erosion. Only small areas of the catchment have been disturbed by grazing, cultivation, and development, therefore in comparison to rivers in Southern Australia, the Daly River can be regarded as largely undisturbed. In order to undertake a retrospective study of change high resolution Quick Bird data, aerial photographs and field data were used. Quick Bird data was captured in August 2010, whereas aerial photographs were analysed from the year 1963 and 1975. In addition field work was carried out in 2010.

The results determined that the channel has been widened. Between 1963 to 1975 the total change in channel width was 4.3m, and from 1975 to 2010 it was 9.4m. This suggests an overall mean channel change for the study period of 13m. The total area of erosion and sediment production also increased significantly from 1963-1975 to 1975-2010. These findings coincided with an increased rainfall and river discharge for the same period. This study also approximated how much sediment is accumulating inside the river via channel walls. Slumping largely caused by ground water, and bank erosion by fluvial abrasion, are the dominant processes of erosion. The results demonstrate the importance of landscape ecological studies that attempt to link patterns and process in the landscape, and the information gained from this study will provide more in depth knowledge on the role of this important functioning river system to a wide range of community groups, researchers, river managers and decision makers interested in managing the Daly River catchment, especially as the potential of the catchment is explored for further agricultural development.

## **The European Competition “Capitals of Biodiversity”**

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People’s awareness of environmental issues is influenced crucially by their experiences of nature in their everyday surroundings. Because worldwide most people are living in cities urban biodiversity is an important key to devote greater attention to the global loss of biodiversity. An unexpectedly rich biodiversity can be found in many European cities, towns and villages. The reasons are that they were founded in natural rich places and additionally urbanization creates a high variety of new habitats, which provide manifold living spaces: Gardens and parks, different types of settlements, wastegrounds etc.

Municipalities can do a lot to protect our biodiversity and to provide healthy and livable surroundings for their citizens and for future generations. The decision IX/28 of the 9th Conference of the Convention on Biological Diversity (CBD) held in Bonn in 2008, underlines that successful biodiversity conservation requires full dedication of cities and local authorities.

The project “Capitals of Biodiversity” honors and highlights these municipalities and communicates their performance on a national and European level. The competitions started in 2010, the UN International Year of Biodiversity, in France, Germany, Hungary, Slovakia and Spain. In each country, the municipalities are supported with a training program. The competition is focusing on the following five indicators: ‘Nature in the city’, ‘Environmental education and environmental justice’, ‘Protection of species and biotopes’, ‘Sustainable use of biodiversity’ as well as ‘Concepts, communication and cooperation’. This presentation will give a closer inside in this competition by example of the Central German city Gotha.

## **Designing Low Carbon Society through *Pekarangan* Management of Rural Communities in Java, Indonesia**

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“*Pekarangan*” is an Indonesian term for homegarden which refers to the small scale of agro-forestry practices that have contributed significantly on low carbon society (LCS) when they are properly managed. In Indonesia, *pekarangan* covers more than 7.5 % of land 2009. The system in *pekarangan* probably contains some amount of carbon (C) stocks. Its ability to provide simultaneously the households needs and at the same time store amount of C makes this system a viable project types under the Clean Development Mechanism (CDM) of the Kyoto Protocol, with its objective of emissions reduction and sustainability development. A CDM Project that facilitates a minimum threshold of enabling conditions that make *pekarangan* possible should qualify for C credits (Roshetko et al., 2007). Currently, lack of reliable inventories/estimates and uncertainties in the estimation upon C sequestration potential of *pekarangan* made some difficulties in the analysis (Kumar, 2006). Therefore this research tries to provide some robust techniques and analysis to estimate them.

Our assessing of *pekarangan* role in term of carbon stock assessment (CSA) was conducted through interviewing and measuring of biophysical condition in 96 households which are located in four watersheds in West Java, Indonesia. In each of respective watershed level, four groups of *pekarangan* were defined in a purposive random village. Those four groups are G1 that has a *pekarangan* size less than 120 m<sup>2</sup> with does not have other agricultural land (OAL), G2 (*pekarangan* size < 120 m<sup>2</sup> with OAL < 1,000 m<sup>2</sup>), G3 (*pekarangan* size between 120-400 m<sup>2</sup> with no OAL) and G4 (*pekarangan* size between 120-400 m<sup>2</sup> with OAL < 1,000 m<sup>2</sup>).

We analyzed the potential for C storage in *pekarangan* and its role in reducing CO<sub>2</sub> concentration in the atmosphere. The result showed that *pekarangan* could mimic the structure and diversity of mature forest (natural forest) up to 20%, which means *pekarangan* has high C sequestration ability and can eventually gain economic value in CDM scheme. The community should consider a suitable agro-forestry practice (Kaswanto et al., 2010), such as *pekarangan* to propose this project. In addition, our results showed that plant species diversity does not have significant correlation to high C sequestration, but it occurred because of

biological N<sub>2</sub> fixation and relatively low herbivore pressures.

### **Acknowledgement**

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## **Landscape Ecology Based Approach for Assessing *Pekarangan* Condition to Preserve Protected Area in West Java**

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As widely known that the landscape ecology based approach focused on three aspects, they are structure, function and dynamic or change (Forman and Godron, 1986). The fourth aspect which was added lately is culture. These four aspects were tried to be elaborated into homegardens condition as an ecological process in human activities. As a traditional homegardens in Indonesia, *pekarangan* played an important role in order to build a low carbon society management. In order to conserve protected area, *pekarangan* could be one of solutions to keep people to stay in their village. In other hand, people will not encroaching forest to search more income, because they could have it from *pekarangan*.

Our assessing of *pekarangan* condition was conducted through interviewing and measuring of the ecological, economic and socio-cultural of 96 households which are located in four watersheds of West Java, Indonesia. The level of landscape management are affected by the size of land, therefore we considered the scale of ownership of *pekarangan* size. In each of respective watershed level, four groups of *pekarangan* were defined in a purposive random village. Those four groups are G1 that has a *pekarangan* size less than 120 m<sup>2</sup> with does not have other agricultural land (OAL), G2 (< 120 m<sup>2</sup> with OAL < 1,000 m<sup>2</sup>), G3 (120-400 m<sup>2</sup> with no OAL) and G4 (120-400 m<sup>2</sup> with OAL < 1,000 m<sup>2</sup>).

Our research statistically proofed that *pekarangan* have contributed significantly to ecological conditions, household incomes, and also nutrition (diet) to the family members. The ecological conditions, both horizontal and vertical biodiversity, showed that *pekarangan* have high contribution to help the environment more sustain. The level of biodiversity which are indicated by species richness (Margalef Index), species density (Shannon-Wiener Index), species diversity (Simpson Index) and similarity (Sørensen Index) showed that *pekarangan* have high biodiversity. Our research also proofed that *pekarangan* production contributed up to 11.5 % of household's income, and 12.9% of household's diet in term of food expense. One



of our recommendations is that the community should consider a suitable agro-forestry practice (Kaswanto et al., 2010), such as *pekarangan* for better management in the future. In addition, *pekarangan* as an agro-forestry system also can contribute significantly to a region's carbon budget while simultaneously enhancing the livelihoods of rural community (Arifin and Nakagoshi, 2011).

This research was supported by the Global Environmental Leader (GEL) Education Program for Designing a Low Carbon Society (LCS) of Hiroshima University, Japan. The preliminary survey was supported by Rural Development Institute in Seattle, USA and Department of Landscape Architecture, Bogor Agricultural University, Bogor, Indonesia.

## **Is Ecotopia Possible? A few Proposals for Urban Ecology**

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The purpose of this presentation is to examine a few stable state ideas from a classic novel titled "Ecotopia" written by Ernest Callenbach.

Sustainability is one of the keywords for 21 century. Mitigating global warming has been the main environmental topic, and reducing CO<sub>2</sub> emission has been the global target. Nuclear energy was advertized to be the alternative CO<sub>2</sub> free power source, reducing our dependence on the conventional coal and/or oil burning power plants.

However the accident in Fukushima Daiichi Nuclear power plant which was caused by The Higashi-Nihon Earthquake and Tsunami revealed nuclear energy is hazardous and uncontrollable once accident occurs. The accident made people to think the necessity of altering the goal of the society from economic growth to sustainable state and shifting life style from mass consumption to eco-friendly one.

One of the hints for ecological society is found in Ecotopia. The author illustrated environmental friendly social system, technology, and ecological way of living. A few of his ideas imagined in 30 years ago came into reality. We can find many Ecotopian evidences such as wind mill energy station, photovoltaic power generation, organic recycling system, and so on in the current cities around the world. Many individuals and groups of people try to change their lifestyle more eco-friendly. In this presentation, I would like to show some of the ideas in the novel actually practiced, forming the basis of urban ecology.

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## **Next Step of the CBI – through testing of the city of Nagoya**

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At the City Biodiversity Summit 2010 held as an associated event to CBD-COP10, the Aichi/Nagoya Declaration\*<sup>1</sup> was adopted. The declaration sorts out the relation between cities and biodiversity from four different points of view: services of urban ecosystems, potential of urban ecosystems, dependence on ecosystems outside cities, problem-solving ability of cities. In addition, it indicates that biodiversity and ecosystems need to be valued and managed as part of cities’ infrastructure and integrated into all aspects of local governance. Such growing interest in cities led to the CBD-COP10 decision, the Plan of Action on Subnational Governments, Cities and Other Local Authorities for Biodiversity. The plan of action endorses the application of Singapore Index on Cities’ Biodiversity (CBI\*<sup>2</sup>). The Singapore Index is composed of three components: native biodiversity, ecosystem services and governance & management. However, it seems insufficient for an evaluation index of urban ecosystems. This is because the index focuses on conservation of natural areas and does not provide guidance for evaluating urban green spaces and restoring urban ecosystems. A study on the distribution of wild birds inhabiting in Nagoya shows surprising results: a number of species in urban parks such as Nagoya Castle ranks higher than in semi-natural forests. The study also found out that the difference of influence between green spaces on same scale cannot be overlooked. This brings out the importance of the quality of green spaces (design and maintenance) and the connectivity between surrounding green areas. The purpose of developing index is not to rank cities or green spaces but to pull out the potential of urban ecosystems and the problem-solving ability of cities. Therefore, I’d like to suggest differentiating landscape management and site management, and evaluating both sides of potential (output) and performance (outcome).

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Aichi/Nagoya Declaration on Local Authorities and Biodiversity:

<http://www.kankyo-net.city.nagoya.jp/citysummit2010/>

CBI user’s manual: <http://www.cbd.int/authorities/gettinginvolved/cbi.shtml>

## **Adaptive Co-management of Forest Resources: A Case of Takamaru-yama Sennen-no Mori, Tokushima, Japan**

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Takamaru-yama Sennen-no Mori (TSM: Thousand-year Forest in Mount Takamaru) was initially established by Tokushima prefecture (one of the four prefectures composing the island of Shikoku, Japan) and now managed by Kamikatsu Satoyama Club (KSC). The KSC itself is a consortium of 10 local organizations (i.e., NPO, local companies, and study groups). The KSC, in consultation with the local Tokushima government, academics and professionals, and local citizen groups, plans and organizes forest nurturing projects such as natural forest restoration and environmental education. The KSC, through its year-round programs and activities, provides opportunities for interaction among different groups such as urban and rural residents and people with different interests on the use of forests. While this type of active adaptive co-management of natural resources (in this case, forests) by local entities with diverse interests is considered ideal, in Japan there are more unsuccessful cases of management where only the government bodies are involved in the management with little local input, or where the transition of power to manage from the government to local groups has failed. The Kamikatsu case is presented as one of the few successful examples of (1) the successful transition of power to manage from the government to the local interest groups, (2) two-way sharing of knowledge between the academics/professionals and local residents, and (3) locally-led, adaptive co-management/governance of natural resources.

To support this claim, the paper shows the result of the analysis on the natural forest restoration project through the lenses of panarchy concept, examining forestry policies and knowledge sharing/transfer in particular. With many Cypress plantations in desperate need of maintenance, the national government's forestry policy is arguably stagnant at the conservation phase of the adaptive cycle with no easy solution to the declined national forestry industry. With the TSM being a symbolic forest restoration project for the Tokushima prefectural government, at the prefectural (regional) scale, its forestry policy aims to serve the regional needs and the greater societal aspiration to live in harmony with nature. Therefore, on the adaptive cycle, the state of the policy is recognized as being in the re-organization phase. At the local Kamikatsu scale, the forestry movement shows a new direction into locally-led, adaptive co-management of forest resources. Therefore, on the adaptive cycle, we argue that the local is in the growth phase but it is still in its early beginning. Knowledge transfer between scales also contributes to the success in the Kamikatsu case. Both professional knowledge and local/traditional knowledge are successfully transferred across scales and time. Finally, the case was also examined to see if it supports the features of or the conditions for the emergence of adaptive co-management: (1) enabling legislation, (2) multi-level organizational structure, (3) flexible institutions, (4) social networks, (5) leadership through key persons and trust building, and (6) learning by doing. We have found that the case satisfies all the conditions but with varying success. The weaknesses were found in systematic monitoring, public participation, a social network structure, and the mismatch of budget cycles. However, overall, the Kamikatsu case is one of the few successful examples of adaptive co-management of forest resources and provides valuable lessons to develop another successful resource management framework.

## **Ecopolis and New Urban Functions**

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Ecopolis is a project which was started in 1980 in the science city of Pushino, in the former Soviet Union.

City ecology and environmental consequences of urbanisation was not discussed and was not a focus of public policy in the USSR. It was mostly studied in different demographic and social settings.

The ecological approach of the Ecopolis project was initiated by the biology faculty of Moscow State University and supported by the USSR Academy of Science and town administration.

The methodology of the multidisciplinary program was based on the philosophy of the coherent development of landscape (including carrying capacity) and settlements (Brundy and Kavtaradze, 1984). After the preliminary publication of field studies, laboratory investigations were undertaken. Special attention was given to social and psychological aspects of urban life, human behavior, biodiversity and landscape dynamics (Kavtaradze, 1987; Zheveleva et al., 1989)

Pushino science-city was considered a “town of future” as no impact from industry was experienced there, and only recreational activities were encouraged. The impact of this urban planning was carefully studied in all seasons and showed that recreational needs (walking, gathering flowers, fishing, hunting and mushroom picking) actually used an area more than 600 times greater than the city itself.

Later training and education of local deputies led to the possibility of expanding the urban planning timeline utilised by officials to a “geological time scale”. Only after participation in long term modeling were participants (volunteers, deputies and local activists) ready to consider and discuss future landscape changes in both the city and human habits, to model a “common vision of desired future” with the prioritisation of the values of sustainable development in mind (Kavtaradze, 1991; 2001 ).

Local city nature reserves were planned and established, with a special service implemented to manage them by participants such as volunteers. Through social practice communities started to “think globally and act locally”. Special projects which encouraged the participation of local school teachers and school children were implemented. Urban ecological services, as a new facet of public policy, was included in planning and special laboratories were established to support municipal governance.

The Ecopolis experience provides a link between academic philosophy and everyday human practice, leading to the first steps of a coherent development of regional ecosystems and urban milieu. This is a new function of modern cities: biodiversity and ecosystem restoration has become a subject of system dynamics modeling (Kavtaradze et al., 2010; 2000).

## **Tracing Deciduous Component in a Heterogeneous and Fragmented Archipelago Landscape Using SPOT 5 and Landsat TM Imagery**

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Landscape pattern is one of the corner stone concepts of landscape ecology. All landscape patterns, however, are artefacts of our measurement scale and thematic resolution. This is an important indication of the fact that all landscape patterns do not have biological reality, or have varying meaning to different organisms. This is of primary interest when automated image analysis of satellite imagery is used for land cover and vegetation classifications and environmental monitoring processes.

Traditionally, land cover classifications based on satellite imagery have paid little attention to fragmented and complex elements of the landscape, such as grasslands and deciduous forests. These components are typically treated as spectral noise between more robust classes and as such they are obliterated from the final classification through post-classification procedures. This is unfortunate as deciduous component, including wooded grasslands and spontaneous deciduous forests succession on former grasslands, is generally pinpointed as the main carrier of biodiversity in the rural landscape. Furthermore, grasslands are not merely a land cover group but also represent the dynamic geographical transition zone between the arable landscape and the forest landscape dating back to the preindustrial Nordic village society. Changes in this transition zone can be monitored only if a modified grassland concept is used.

We present a case study where the diversity of the deciduous component is studied in a fragmented landscape of Finnish archipelago with the aid of different classification techniques of satellite images. Our paper explores to what extent land cover history, or landscape memory can be determined in the present day landscape structure using key qualities and spatial analysis in satellite imagery in combination with sources of detailed landscape data. We show that detection and identification of spectrally robust elements of the heterogeneous grassland component using SPOT satellite imagery, combined with high precision acquisition of training data from CIR aerial photographs, indicate several problems of confusion to be overcome. To narrow down the complex target element, a hybrid classification model in several steps is needed, including both unsupervised and supervised classifiers. The aim of the presentation is to discuss if the deciduous component can be directly studied in satellite imagery or if we can use proxy properties, i.e. hidden structures, at a higher order of scale to find means to address potential biodiversity status and land-cover-history trajectories of the deciduous component in fragmented landscapes.

## **Targeting Nitrogen Export at the Landscape-Level: The Role of Landscape Sinks**

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One of the major advances in catchment science over the last 25 years has been the realization that certain areas of the landscape have the capacity to function as removal sites (i.e., “sinks”) for water-borne nitrogen (N). We present a geospatial tool for local catchment managers to prioritize restoration and conservation based on the extent and location of N sinks (Kellogg et al., 2010). Our approach couples landscape-level field studies with readily available geospatial data (e.g., soils, digital terrain data, land use) to track the pathway and fate of N at the landscape level from source areas through critical hydrologic and geomorphic attributes of stream reach ecosystem N sinks in lower order catchments. Areas of high N sink capacity can be within or along stream reach ecosystems and include certain types of wetland riparian zones, reservoirs and lakes, and particular features within lower-order streams, such as pools or organic debris dams.

The risks of catchment N export can be diminished in catchments where sinks intercept and transform N moving from upland sources. In contrast, where landscape sinks are absent or are bypassed by land management practices (e.g., tile drainage or storm water conveyance systems), land uses generating N losses pose a greater risk of catchment N export. We will illustrate the approach through case studies from southern New England, USA. This approach will permit decision makers and landowners to target best management practices (BMPs; e.g., intensive source controls or stream reach ecosystem restoration) in subcatchments that lack N sinks. In subcatchments with important N sinks, the method will provide guidance to protect these critical areas.

Retention time plays a critical role in the effectiveness of landscape N sinks. Both climate change and land use changes can contribute to changes in catchment runoff and retention time within biogeochemical N sinks. We will explore examples of these potential changes to the patterns and processes controlling watershed N dynamics.

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## **Challenges and Opportunity for REDD in Nepal**

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The Reducing Emissions from Deforestation and Degradation is the proposed financial mechanism which would provide developing countries with incentives to reduce forest sector emission. Today, deforestation and forest degradation is the second largest source of human induced GHG emissions contributing to almost 20% of emission globally.

The study entitled Challenges and Opportunity for Reducing Emission from Deforestation and Degradation is mainly focuses on: identifying the drivers of deforestation and degradation, proximate causes and underlying causes of deforestation, the REDD mechanism will addressing current problems i.e. the poverty alleviation, adaptation, biodiversity conservation etc.

This study intends to help those institutions, which are involved directly or indirectly in Climate Change, Carbon Trading, REDD, PES and to other related line agencies.

The research was done in the Sundari and Buddha Shanti Community Forest of Nawalparsai districts. The respondent is generally selected as Dalit and ethnic groups, 10 % households of each community forest user group were randomly selected from their constitutions. Data were collected by direct field observations, semi-structured questionnaire survey, group discussions and personal interviews. The simple statistical tools such as mean, percentage, correlation, regression etc. were used for data analysis.

The results showed that the main drivers of deforestation and degradation in both community forests are migration, illegal cutting, and lack of forest resources. There are still need awareness raising programs about the Carbon trading, Climate Change, Global Warming. Most of the user groups are interested to plantation and conservation works if they get fund from any other recourses.

## **The Evaluation and Spatio-temporal Analysis of Land Use Change for Planning and Management - An example of Thailand.**

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Land-cover change has been identified as one of the most important drivers of change in ecosystems and their services (Reyers B. et. al, 2009). The purpose of the research was to explain change in the nature of land use on temporal scale using different method. We also evaluate land use quantity and characteristics of various landscapes in North of Thailand. For landscape management, GIS platform can be used to mapping of the spatio-temporal land use/land cover changes in an accessible to supplement the available tools. In this study, land use/land cover were classified into 5 classes; forest area, agriculture area, infrastructure area, water bodies and unused land. Bio-physical data were collected and compiled into GIS database. The change of land use/ land cover detection was conducted by using overlaying technique. The study was based on a five-year time period, during 1995/2000 to 2000/2005

and 2005/2010. The change in forest cover between 1990 and 2010, Thailand lost an average of 28,850 ha or 0.15% per year. In total, between 1990 and 2010, Thailand lost 3.0% of its forest cover or around 577,000 ha. The study results include; 1) Spatial difference between the various landscapes in North of Thailand was developed to analyze land use/land cover change process. 2) The useful information for planning and management in landscape level was provided of interactions between natural and human well-being.

**Keywords:** Land use/land cover, Evaluation, North of Thailand, GIS.

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## **Spatial Interactions between Landscape Elements as Criteria for Landscape Planning Decisions**

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Landscape heterogeneity is a prerequisite for diversity of possible types of land use. While planning human activity in a landscape it is critical to take into consideration interdependencies between landscape components and by so doing to make forecast of chain reactions in landscape under anthropogenic influence. Investigation of lateral linkages between separate landscape units is needed also to predict transfer of disturbances to distant areas. On the other hand, value of landscape unit depends not on its inherent property only, but also is controlled by neighboring units to a great extent. Evaluation of landscape unit being planning object and choice of appropriate management practice should take into account wide geographical context. This requires thorough geographical analysis of regional scale (higher hierarchical order) geosystems aiming at assessment of typical or unique properties of landscape unit of interest. Landscape planning is based on the concept of multifunctionality of landscapes. The task of crucial importance is minimization of conflicts between stakeholders. Possible compensation of loss of resources for this or that land use type after certain scenario is a serious challenge for landscape planner.

Spatial properties of landscape elements (size, orientation, shape, core/edge ratio, mutual location, neighborhood, proportion, distance to other elements etc.) are assumed to affect



intensity and direction of matter and energy flows. This results in diversity of land use opportunities. Location and spatial properties of landscape elements involved into agriculture and timber harvesting is critical for formation of runoff, soil properties, recovery of plant cover, animals' abundance and migration.

We compare parts of landscape with different spatial patterns of similar elements (e.g. forests, meadows, arable lands etc.) with the purpose to reveal:

- distance and direction of remote effects in a landscape induced by interactions between landscape elements;
- buffer and protective functions of certain landscape elements in relation to matter and energy flows generated within other elements;
- rates of increase or decrease of soil and plant cover properties under the influence of processes generated in neighboring landscape elements;
- contradictions between requirements of various land users to properties of soils, plant cover, water regime, animal populations;
- restrictions for use of agricultural and logging technologies imposed by neighborhood of landscape elements;
- necessity and possibility of changes in land use pattern in order to provide opportunities for environmentally friendly and economically effective multifunctional land use.

Regional examples of planning approach for combination of forestry, agricultural, nature protecting activities for various landscapes in the forest zone of European Russia are demonstrated

## Mapping Landscape Functions at Large Scales

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Currently only very few *regional to global scale* models are available to assess the capacity of land to deliver ecosystem goods and services. This is in contrast to the rapidly growing depositories of geo-referenced environmental data, which await exploitation with newly emerging simulation tools, preferably process-driven models. However due scale issues, knowledge and data gaps, process-driven models are often unavailable. One way of solving this problem is to develop 'expert-' and 'literature-driven' rules that generate function assessments based on land properties. The task is a challenging one, and requires careful checking of where and under what conditions complex interrelations can be replaced by

simple look-up tables.

This paper describes recent work that builds on an earlier study which sought to map ecosystem functions at European scales using expert- and literature-driven binary links (Kienast et al., 2009). Binary links were used to express whether specific land-uses or other environmental properties have a supportive or neutral role for ecosystem services. The current work refines the approach and extends it to the continental US and Mexico. Input data include (a) land-use, (b) net primary production, and (c) bioclimatic and landscape properties (e.g. mountainous terrain, adjacency to landscape and nature protection zones).

In addition to estimating the current potential of different areas to deliver services, a novel aspect of the work is the analysis of marginal changes in service output resulting from recent historical land use change (1990 - 2000), and whether expected land use change by 2030 might alter the capacity to deliver specific services.

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## **Determinants of Interprofessional Cooperation in Sustainable Urban Development: the Case of Voluntary Environmental Rating and Assessment Schemes**

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The urban development discussion has been substantiated that sustainable buildings offer major potential for environmental sustainability. Both mandatory (building codes, taxes) and voluntary (building rating schemes) instruments are used to reduce the impact of construction and reduce pollution in urban settings. Not only buildings but overall sustainable urban development criteria have been included in the development of voluntary rating and assessment schemes such as the *Leadership in Energy and Environmental Design (LEED)* around the world to address issues of ecological relevance. As a model for social change and inclusion of different points of view, Green Building Councils (GBCs) have been established all over the world and promoted as a forum for state and non-state stakeholders to develop effective strategies to reduce the impact on the natural environment.

Many efforts are being made to establish GBCs in developing countries with a dominant role of OECD countries (especially the US, UK, Australia and Canada) in this process. Developed countries have also been quick to export their “own” voluntary building rating schemes such as LEED to other parts of the world. While some proponents have argued that these schemes offer an excellent opportunity for experimenting with new strategies to encourage sustainable

urban development; others have questioned whether voluntary strategies are worth being promoted on a large scale.

Urban sustainable development, however, is dependent on the strategies of public officials as well as industry professionals' attitudes and willingness to implement sustainable practices. The same is true for the decision to include voluntary environmental rating schemes in their work practices. There are many different professional groups (e.g. urban planners, architects, engineers, landscape architects, real estate firms) active in building projects and it depends on their cooperation advance sustainable urban development. This area, however, has been understudies for quite some while.

Hence, this paper aims to fill this gap in the literature and analyzes the determinants of cooperation in the adoption process of voluntary environmental building rating and assessment schemes. This study of stakeholder groups in the planning, building and construction sector is grounded in theories from the policy transfer and environmental psychology literatures. Most importantly, the aim is to understand potential conflicts between professional groups and suggest strategies how this cooperation can be improved to advance sustainable urban development.

## **Status and Management of a Degraded Riparian Zone near the Geum River in Korea**

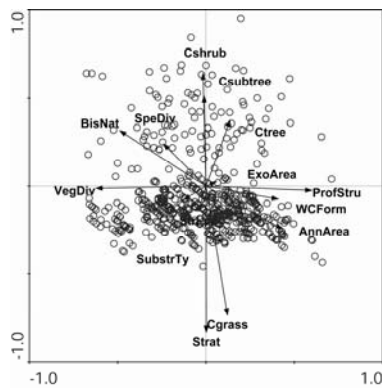
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The vegetation serves as food for herbivores and functions as egg-laying sites and a refuge. Vegetation also decreases water speed, controls soil erosion, and purifies the water (Petts and Calow, 1996). Riparian vegetation captures the substances eroded by water flow and contributes to water quality. Furthermore, plant root systems stabilize the river bank and decrease flood damage (Salinas and Guiado, 2002). Riparian vegetation, an important mediator of land-water interactions, provides habitat for animals and other organisms; however, riparian vegetation zones have been altered by agricultural and urban development in Korea. This riparian vegetation survey was conducted to obtain information vital for the ecological restoration and management of the Korean Geum River ecosystem. At 100 study sites along the Geum River, we recorded the landscape elements of the Geum riparian zone. We then surveyed the riparian vegetation associations in the area and overlaid those areas corresponding to trees, shrubs, perennial herbs, annual herbs, exotic plants, cultivated lands, and damaged lands on a geographical map. We also reconstructed the cross-sectional landscape. The mean values of vegetation diversity, exotic plant area (%), annual plant area (%), and species diversity were  $6.47 \pm 0.26$ ,  $5.44 \pm 1.01$ ,  $11.98 \pm 1.20$ , and  $22.69 \pm 0.93$ , respectively. The landscape elements of the herbaceous plants were more spread out, compared with those of the woody plants, and 23 sites were composed strictly of herbs. Our results indicate significant differences in landscape composition among the study sites. For example, at some sites, exotic plants, cultivated lands, and damaged lands dominated the

landscape, comprising 25.7, 62, and 68.9%, respectively, of the area. The riparian landscape reference model suggested by these results may be applied to studies of other well-conserved riparian zones. We propose that the material pathways and transport of organisms from land to water at Geum River depends on the patchy distribution of these diverse landscape elements.



**Figure 1.** Ordination diagram based on a detrended canonical correspondence analysis of species and environmental matrix of Geum watershed. Open circles indicate 638 quadrats. Quantitative environmental variables are indicated by arrows (WCForm: watercourse form; ProfStru: profile structure; SubstrTy: substratum type of channel; Ctree: cover of tree layer; Csubtree: cover of subtree layer; Cshrub: cover of shrub layer; Cgrass: cover of grass layer; Strat: vegetation stratification structure; VegDiv: vegetation diversity; ExoArea: exotic plant area; BisNat: bisect naturalness; SpeDiv: species diversity).

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## The Concept of Ecosystem Services Applied to Biodiversity: A Case Study of Biguemdo, Republic of Korea

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The concept of ecosystem services is used for decision making on landscape management and planning because it makes it possible to express ecosystem value in economical terms. Ecosystem services support habitat conservation to sustain biodiversity by identifying which areas are more or less profitable. This information is very helpful for sustainable landscape management and planning. Biguemdo is an island located in the Southwestern part of the Republic of Korea that is famous for the cultivation of sun dried salt on tidal flats. Islands in general have limited natural resources compared with main land. As Biguemdo has beautiful landscape and relatively high biodiversity, it was designated as a National Park in 1981 and also a UNESCO Biosphere Reserve in 2009. The main land use types are forest, agricultural field, and salt field. The tidal flats of Biguemdo have been used to cultivate laver, collect common octopus and shell and so on. Local people have been and are using the tidal flats with indigenous knowledge that is aimed at sustainable usage. Ecosystem services on Biguemdo support the natural resources and cultural services that should be taken into account in future policies on landscape management and planning. They warrant habitat conservation for sustainable natural resource management as this will, among others, contribute to conserving biodiversity.

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## Conservation of Landscape Diversity as the Prerequisite of Sustainable Development of the Russian Priamurje

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Long-term regional development plans especially for resource oriented-economies, like the Russian part of the Amur Basin (Priamurje region) lack adequate natural resource use feasibility studies and environmental regulations for several reasons. First and foremost, the economic development of the region has a relatively short history (little over 100 years) and is mostly resource-oriented; resource cycles are still incomplete and resource losses are significant. The concentration of production in several centers cause severe local environmental problems. High vulnerability of natural complexes to anthropogenic impacts causes considerable transformations of geosystems.

The urgent need for an adequate ecological policy makes very important the consideration of Priamurje regional specifics for developing its effective economic strategy. Ecological planning of a territory in this respect seems to be the major working instrument. It is aimed at conservation of landscape diversity, and thus, allows improving the system of special protected areas, introducing relevant conservation requirements for most important natural complexes, supporting restrictions on certain economic activities there. Landscape diversity is viewed both as a natural heritage and a real reserve for ecological and economic development of a region and a country as a whole.

Under the national program "The Russian Far East and Zabaikalje" landscape diversity assessment in Khabarovsky Krai has been undertaken in the territories of different levels, including municipal districts, big social and economic centers in the Lower Priamurje (the cities of Khabarovsk and Komsomolsk-on-Amur) and their suburb zones.

The data base, collected to analyze and assess landscape diversity in Khabarovsky Krai, includes the following blocks: natural conditions; vulnerability potential; resource and ecological potential; anthropogenic transformation rate; resource-use priorities; development restrictions. Typical landscape abundance in the system of special protected areas has been studied. Landscape diversity assessment allowed identifying ecologically valuable landscapes that need conservation and special resource-use requirements. They were included

into the scheme of Khabarovsk Krai territory planning as elements of the ecological carcass that need various conservation regimes.

The analysis of existing practices of Khabarovsk green belt conservation and legal requirements for forest park and forest areas of Khabarovsk suburbs was compared with relative experience of other Russian cities in creating suburb green zones. Khabarovsk uniqueness is its status of the capital of the Far Eastern Federal Okrug and the national frontier city. These city peculiarities have been considered in planning its suburb green zone that involved the compilation of landscape and vegetation maps, selection of highly landscape diverse territories, functional zoning of geosystems, recommendations for optimal landscape conservation and use management.

Studies were financially supported with the Russian Foundation for Basic Research grant 10-05-98011 and the Project of Far Eastern Branch of the Russian Academy of Sciences № 09-I-OH3-06.

## **Spatially Explicit Quantification of Diffuse Phosphorus Emissions from Natural and Anthropogenic Sources into Water Bodies**

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While point sources of phosphorus are in most cases easily identified, the diffuse inflow via different channels is difficult to account for. Surface runoff or subsurface artificial drainage systems contains nutrients and pollutants of diver's origin. Analyzing annual land-use and climate induced changes in the water balance using GIS and remote sensing techniques can contribute to a spatial quantification of the impact on substance flows in meso-scale catchments. In the grassland dominated Mondsee catchment (Austria) on a size of 250 km<sup>2</sup> at the pre-alpine/alpine border emissions of phosphorus have been analyzed using a modular modeling system. The modules include an artificial drainage model, an object based image analysis (OBIA) driven land-use intensity model, climate models (precipitation, temperature, evapotranspiration, ...) and hydrological models to quantify the phosphorus discharge on 96 sub-catchments and finally the nutrient load per year into the lake Mondsee. Environmental perspectives, specifically process-driven methodologies were introduced to assess the spatially explicit potential of phosphorus discharge to surface waters based on surface runoff, soil erosion, subsurface drainage runoff, interflow, and groundwater emissions. Climatic data models such as precipitation and transpiration have been developed to assist the hydrological modelling framework. Although geoprocessing in Geographical Information System (GIS) environments is not new, the idea to initially build a framework based on a combination of ecological perspectives and spatial information on land use / land cover, elevation, soils, water cycles, and farming practices is still the exception. The challenge and flexibility of the open modular GIS approach lies in the semi-operational rules relating to specific assumptions and regional settings validated according to field water measurements. We seek to embrace the challenges of different approaches in catchment estimations and have tested different ways to decompose complex natural environments into focal units resulting from processes and

functions provided by nature utilizing topological relations in order to be able to model between different environmental objectives. The comparison of water measurements and the modelling results varies significantly for some of the 96 sub-catchments. This is because of the modelling approach taking into account longer time horizons than the measurements which took place in two measuring periods in the year 2005. However, the direct contribution of phosphorus to the Mondsee measured was 12 tons per year in comparison to 17 tons per year modelled. Here, the difference can be mainly explained due to high differences of phosphorus emissions in the snow melting period correlating with climatic events. This study intends to update the international scientific community on further approaches to phosphorus modelling and to clarify the logic of the processes to delineate potential areas of high phosphorus discharge at a raster resolution of 50m. We use the model to predict changes in phosphorus discharge by defining land-use alterations which need to take place to prepare the future landscape for closed substance cycles. Furthermore, the model is used to demonstrate possible perspectives for landscape planning practices using scenario techniques. The sustainability assessment, the terminology used, steps and elements of the general assessment procedure are defined on behalf of the assessment of the Mondsee catchment in Austria as an example. The case study presents the implementation of the methodology in practice and its benefits, e.g., the improvement of planning based delineation of the landscape units based on their inherent structure and potential.

## **WebGIS Based Analysis of Alpine Climate Change and Water Consumption to Discover Regions Prone to Water Scarcity**

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Since the beginning of systematic monitoring of meteorological phenomena in the year 1861, many scientific studies underpinned that increasing climate change has happened in the last two centuries. In Europe it is expected that even the water-rich Alps, in particular the Southern Alps, will be affected by severe droughts due to climate change. The rapid increase of the near surface air temperature within the last decades has already led to pronounced indications of climate changes; especially in the Alps where we face changes twice the global average since the beginning of last century. The probability for the occurrence of extreme weather conditions, floods and droughts has already increased in many places. These seasonal shifts, where a high number of both deluges and droughts have been noticed in a regional context, have also already been observed in the Alpine area in recent years. Seasonal decrease and uneven distribution of precipitation and groundwater recharge patterns are already the case in the southern, western, eastern Alps, and central alpine valleys. In the Austrian Alps, +200 years' time series indicate increasing temperatures and decreasing precipitation as well as significant decrease of groundwater recharge in the order of 25% in the last 100 years. In parallel to the seasonal shifts of water availability, increasing anthropogenic water abstraction is exacerbating the water scarcity problem. These have direct effects on drinking water supply, aquatic biology and water quality. Anthropogenic change and pressure on alpine water resources is strong at the local and seasonal scale, mainly due to water use for energy

and cooling water, irrigation for agriculture, water use for tourism and artificial snow production with water conflicts emerging.

Within the Alpine Space comprehensive climate related data assets exist. Although notable amounts of data have already been prepared digitally, data accessibility is still extremely limited. Thus, we established a web platform to improve the access to spatial data for public sector bodies, private companies and citizens in the Alpine area in order to provide decision support and awareness rising. Analysis of climate change for a defined time period is possible by listing tables of e.g. temperature and precipitation values or to view an on demand graph on temperature or precipitation trends. In parallel we analyse water consumption from society and tourism based on statistics at NUTS 2 and NUTS 3 level indicating the spatially explicit water consumption on these administrative regions.

Further developments will cluster, integrate and keeping alive the findings of climate and Alpine Space related projects and makes datasets, results and aggregated knowledge available over the long term to the expert community, decision-makers, and practitioners. We consider aspects of data organisation, data harmonisation as well as semantic and technical interoperability in order to produce seamless geospatial information and to improve the data access for the wide community of different user groups. The accessibility of digital climate data for better (re)usage and exploitation will be one of our focal aspects implemented in a Web Processing Service.

## **Development of Indicators in Urban Contexts: DPSIR and Ecosystem Services**

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Benchmarking biodiversity is an important tool for political decision making. In other words, capturing the trends and status of urban biodiversity is challenged by current rapid changes, including increasing population flow into urban areas and multiple pressures on neighboring ecosystems.

For this reason, it is aimed here to highlight relevant findings from both ecological and social sciences in the development of urban and biodiversity indicators. It is pointed out that the current system is fragmented although benchmarking biodiversity and natural resources has a long tradition in nature conservation.

It examines the applicability of a model to an urban city in Japan. The objectives of this study are three-fold. First, it reviews and summarizes the historical development and relevant existing studies of urban and biodiversity indicators and the "DPSIR" ("Drivers-Pressure-State-Impact-Response") model is presented and its main critiques are summarized. Second, trends in scientific studies in specific journals are identified. Third, practical lessons for a Japanese local municipality, the city of Nagoya, are derived from two previous sets of reviews. The applicability of the "DPSIR" to current practices of the city of



Nagoya is examined to assess the relevance of the model to real situations.

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## **A Framework Research of Green Space Network Development for the People and Ecology in Cities**

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As a result of urbanization, the world's population has become increasingly concentrated in cities and the urban area has consequently been sprawling. The byproducts of rapid urban development was manifested with the reduction of natural resources and worsening conditions of urban environment, as well as increasing urban climatological and ecological problems (Gordon, 1990). Urban green spaces are viewed as the last remnant of nature in urban areas, and typically perform important functions, including maintaining biodiversity, preventing soil erosion, absorbing rainwater and pollutants, as well as mitigating urban heat island effects (Attwell, 2000). Urban green spaces can also provide considerable socioeconomic benefits, such as providing amenity-recreation venues, reducing work-related stress and increasing property values. However, in the absence of an explicit market price for a unit of environmental amenity and also a reasonable recognition of their environmental, ecological and socio-economic functions, the benefits and importance of urban green spaces are usually ignored or underestimated by urban planning policy-makers with the consequence that remnant urban green spaces have shrunk in size and have been gradually encroached upon by urban development and sprawl. In this research, a framework method for comprehensive planning of urban green spaces for the people and ecology was proposed through the case study in Jinan City. The method provides a framework for applying

landscape ecological principles, Geographic Information System (GIS) and Remote Sensing (RS) to the urban green space planning and management to focus on the goal of realizing a sustainable green space network for compatible multiple purposes. The case study in Jinnan City and the proposed green space planning framework fill the gap that urban green space planning is always lack of quantitative methods and theoretical basis or a holistic framework.

**Keywords:**Urban green spaces, Spatial pattern, Amenity, Ecological network, Comprehensive planning, Landscape ecology

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## Urban Biodiversity Research and Design in China and Europe: a Comparison

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Urban biodiversity refers to the variety of living organisms (including genetic variation) and habitats found in and on the edge of human settlements. Urban biodiversity is determined by the planning, design and management of the built environment. With the rapid growth of urban agglomerations the quality of urban biodiversity will crucially influence global biodiversity.

After a brief review on the history of biodiversity research and design in cities of China and Europe I will give insights of recent biodiversity research programs and their application in urban design and management.

In Europe the first studies started in the 15th century and focused on urban plant biodiversity of ruins, castles, gardens and parks. With the development of urban ecology in the 1970s comprehensive studies on plant and animals (biotope mapping) were conducted in many European cities. Today these data are applied to infrastructure and landscape planning and several cities have conducted urban biodiversity programs. In contrast there is a major lack on the level of the design for biodiversity of parks and gardens today, although Europe has provided already in the 18th century good examples with the "English garden" style.

In China, urban biodiversity studies began with birds and animals at the beginning of 20<sup>th</sup> century. With the introductions of theories and methods from urban ecology of Europe and landscape ecology of North America in 1980s, large scale pattern-process studies gradually

became the mainstream in big cities. Nowadays, the concept of “near-natural” which indicates the similarity between managed community structures and natural ones is important for sustainable design of green spaces in cities. But due to insufficient dialogues among ecologists, designers and policy makers, few data and results can be really put into practice. Until now an overall standardized program for biodiversity investigations in urban areas is still in need.

With the introduction of the current efforts in urban biodiversity research and design in cities such as Berlin and Shanghai, we get a closer insight for challenges and opportunities in this field.

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## Historical Changes of the Ecological Network in Southwest and Northwest Hungary

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The ecological network is embedded into the landscape and consists of a series of ecosystems where the connectedness of habitats allows transport and migration processes. It is not a stable system as human activities greatly influence the state, the naturalness and the spatial pattern of different habitats both natural and artificial. This research aimed at assessing the historical change of the ecological network in two transboundary regions of South and Northwest Hungary, in Órség and in the Fertő-Hanság basin. It has been carried out within the TransEcoNet (Transnational Ecological Networks in Central Europe) project, coordinated by the Technical University Dresden. The main purpose of the project is to develop a method for evaluating the history, the state of the area and for planning the restoration of ecological networks.

Based on the military survey of the Austro-Hungarian Monarchy, three historical time layers (end of the 18th century, mid 19<sup>th</sup> and end of the 19<sup>th</sup> century (Arcanum, 2006, 2007)) of the land cover have been assessed and compared with the actual state of the area. 60 land cover categories were identified and include every type occurring in any time layer of the military surveys at a scale of 1 : 28 800. The relief and the possible habitat types have been taken into consideration in the definition of the historical land cover types. The actual state is shown by the Hungarian CORINE Land Cover map of 1999, at a scale of 1 : 50 000 (referred as CLC50, FÖMI, 2000), that is significantly more detailed than the European CLC2000 (EEA, 2000).

The valuation was based on the spatial structure of the land cover types that are different in naturalness and in land use intensity. It has been assumed that the transport functions and the isolation effect between the habitats primarily depend on the naturalness, and not on the habitat types as a continuous structure of the same habitat is impossible because of the different natural conditions. While the artificial areas have mostly impermeable barriers, the natural and semi-natural habitats don't stop the migration or the transport. Therefore the emphasis should be put on the naturalness and on its transformation in the historical context.

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## **Non-timber Utilization and Landscape Value of Lotus-Mesquite Mixture Stand (Case study: South of Boushehr province, Iran)**

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For many years, the Iranian Forest Service has been implementing forest management plans in tropic and sub tropic forests using a number of different approaches. These have met with limited success owing to conflicts of interest and expectations between the local communities and the forest service, but we see a wide range of degradation in these forests. It seems that traditional forest application would be changing to multiple use management for achieve to sustainable development. Main species of this stand are Lotus (Rhamnaceae: *Ziziphus spina christi*) and Mesquite (Fabaceae: *Prosopis spicigera*) and growth in arid and semi-arid area often (Rechinger, 1963). The soil of this site mostly is light, calcareous and has good influence capacity (Cole et al., 1982). Strong roots of these trees can be enduring the active lime of the soil. Maximum tolerance to EC of soil is 8 milli mohs and has better grow in alkaline soils. Lotus has edible fruit that could be use as desserts and people of the area sell them in local markets. Lotus leaves use as hand and hair cleaner or material for making shampoo and its seed bark use for animal feeding. Mesquite has edible seed for animal feeding. This species is a suitable index to find under ground water specially vein of water near the surface. This broad leaved mixture stand supports various herbal layers on growing

season with the landscape of savanna. Natural honey, charcoal from dead trees or branches and seeds and leaves for animal feeding are other kinds of utilization of the stand (Allen et al., 1995). With regard to research parameters, this mixture stand have high capacity for landscape planning in coastal area and developing the ecotourism as well as cooperative forestry, also the area is near the biggest oil and gas field (South Pars field) in the world, therefore we would be keep a balance between nature and industries. So, in spite of these various applications and suitable income, cutting trees to obtaining wood and land would be prohibiting.

## **History of *Satoyama* Landscapes: Empirical Examples of the Impacts of past Landscape Changes on the Present Grassland Species Distribution**

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*Satoyama* landscapes, the Japanese traditional agricultural landscapes, have undergone abrupt changes during the past 50 years by agricultural intensification and rapid urbanization (Takeuchi et al. 2003). Recent development of Geographic Information System (GIS) enabled us to quantitatively analyze historical landscape changes in *satoyama* since the early Meiji era (more than 100 years ago). We analyzed the impacts of past land-use on sites and surrounding landscapes on the present distribution of grassland plant species in woodland edge vegetation established on former semi-natural grasslands in the *satoyama* landscape in the northeastern part of Kanto region close to the metropolitan area. The soil chemical conditions showed differences especially in soil pH and soil P availability (Bray II) between past cultivated or reclaimed grassland and reference semi-natural grasslands. The higher soil pH and P availability might persist for a long time period (at least more than a few decades), and significantly affect recolonization of grassland species and invasion of exotic species. Positive effects of the surrounding habitat proportions were only detected on uncultivated sites. The past landscape of more than 50 years ago (i.e., the proportions of grassland and woodland areas in the 1950s) significantly affected the present grassland species richness in forest edge vegetation, which can be an evidence of “extinction debt” (Koyanagi et al. 2009). We also found trait-based differences of grassland species’ responses to the past landscape changes. Grassland species with short dispersal ranges (i.e., tall summer flowering, short-distance dispersal forbs) showed significant relationships with recent habitat proportions, while long dispersers (i.e., tall summer flowering, long-distance dispersal forbs) showed significant relationships with past habitat proportions of more than 50 years ago. Thus, the latter species could have sustained their populations in the fragmented landscapes. Information on historical landscapes are essential for understanding present diversity patterns of species. Quantitative analyses of historical maps can provide many empirical evidences of long term impacts of the past human activities on plant species distribution.

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## **Climate and Land Use Change Adaptation Measures: The Case of the Czech Republic**

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Changes in atmospheric composition and climate together with socio-economic, land use, and biodiversity changes crucially affect the capacity of multifunctional landscapes to provide the array of vital ecosystem services (Rickebusch and Metzger, 2011). At present, climate change and land use change are recognized as the most pressing global environmental problems (Pielke et al., 2005; Boyd et al., 2008) as they significantly influence ecosystem services like carbon sequestration, water flow regulation, food and fibre production and others.

The vulnerability to climate and land use change varies significantly across regions and sectors in Europe. Therefore, making the adaptation a context- and location-specific pose the key challenge (EEA, 2010). In the context of the projected climate change impacts, national and regional adaptation strategies gain increasingly more importance. The proposed adaptation measures cover responses that are so-called grey measures (technological solutions), green measures (ecosystem-based adaptation) and soft measures (managerial options, behavioural changes) (EEA, 2010).

This poster presents the case of the Czech Republic adaptation capacity to climate and land use change, with respect to the most vulnerable sectors, such as water landscape management, agricultural production or the urbanized landscape. Based on climate indicators, historical land use analysis and integrated landscape assessment we map regional vulnerability to climate and land use change and identify regions experiencing the most rapid land-use change and high sensitivity to predicted climate change impacts.

We compare vulnerability maps results with adaptation measures proposed in the Czech adaptation strategy. The main purpose of the adaptation responses is to reduce vulnerability of socio-ecological systems and further strengthen their resilience. The proposed adaptation measures are presented with respect to the current international and EU policy framework and potential policy implications for the Czech Republic are outlined.

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## **Integrative Urban Planning for Sustainable Environmentally Oriented Society in Transitive Cities: Central European Experience and Case Study Bratislava, Slovakia**

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The aim of the contribution is to test the following three hypotheses:

- 1) Processes of dynamic urban development in central Europe brought many open and hidden imbalances between social, economic and environmental qualities at the turn of the century.
- 2) The changes after 1990 (“velvet revolution”) opened the way towards more environmentally oriented approaches based on strengthened environmental awareness among residents, but they were radically confronted with the introduced value systems of consume oriented society and their social situation.
- 3) It is possible to identify a direct link between social change after 1990 and orientation of urban planning towards sustainable development.

The explanation in the paper is based on case study from Bratislava, capital of the Slovak Republic bringing a brief description of its territory, historical overview (1976-2010), identification of important urban development milestones and challenges affecting urban planning and definition of backgrounds for conflict situations in Bratislava during last 4 decades (Kozova et al., 2001). Based on this information on Bratislava as the typical representative of central European cities the hypotheses are verified. In the conclusions local environmental, social and economic solutions, local prosperity with respect to consequences of global environmental problems (climate change, loss of biodiversity...) and effects of globalization are discussed with the aim to formulate recommendations focused on the preconditions, must be created to enhance and ensure green or environmental society as real social and economic phenomenon in central European cities (Ahern, 2006, Kozová et al., 2010, Wu, Hobbs, 2007).

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# Urban Landscape Systems – Analyzing the Soil of Berlin and of Seoul

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Ecological, socio-economic, and planning perspectives must be integrated when dealing with urban, cultural landscapes (Pauleit, et al. 2010). Although landscape ecology was developed for natural regions, it provides a valuable approach for the cultural landscape of the city when it is correlated to urban morphology history. Correlating these perspectives is done in form of layered maps in our research, on which this paper reports. Landscape is a key term: it has a functional hierarchy of layers – i.e. climate, geology, geomorphology, hydrology, soil, vegetation, fauna, land-use, and landscape pattern (Mücher et al. 2003) – the soil layer is the turning point where abiotic processes and anthropogenic processes start influencing each other: soil is a continuous record of this influence. To understand the urban landscape as a system, a soil-landscape analysis method is tested on Seoul and Berlin. The Berlin morphology has a history that started in or before the 12<sup>th</sup> century; Seoul was founded in 1392 AD. Berlin had a gradual evolution with several larger expansions. Seoul witnessed an explosive expansion after the Korean War, ever since the nineteen sixties. From a point of view of landscape ecology and natural geography the landscape of Seoul is a complex system of Quaternary alluvial with older systems; Berlin is a more simple post-glacial system. It is shown how ecological functioning of the systems of soil, water, and vegetation, correlates with historic occupation patterns, constituting an urban landscape system. On top of this, urban identity is understood better by correlating the contemporary occupation pattern to this landscape system. Strategies for dealing with the city in the future could be based on such an understanding as indicated in this paper. The urban landscape system approach connects fragments of reductionist scientific analysis, deductionist urban planning strategies, and fashionable design. It forms a sound basis for smarter, more convergent strategies for planning, engineering, and designing urban environments.

Data on Seoul stem from a running research project at the Seoul National University (Lab on Landscape in Seoul 2009, 2010; Kuitert 2010). For Berlin extensive use is made of the wealth of data available on the web in the Environmental Atlas of Berlin (Berlin Senate Department for Urban Development -2011).

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# **Forest Conflicts' Influence on Local People's Livelihoods: A Case of Conflicts between Timber Companies and Farmers in the Mankranso District of Ghana**

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Off-reserves in Ghana provide an important source of timber resources for the wood industries and also livelihood support to forest fringe communities. However, over the past decades, there is overwhelming evidence of a decline in the maximum utilisation of forest off-reserves due to several factors. The management of off-reserves is faced with contested roles of the formal and informal institutions, both claiming access to timber and non-timber forest products (NTFPs), land and benefit-sharing rights. The institutional changes in the off-reserve areas have contributed to forest livelihood conflicts with nagging effects and deforestation through chainsaw operations and farmers' willingness to destroy trees in the off-reserve communities. This thesis describes both the formal and informal institutions in the context of the study area and how they impact forest conflicts dealing with crop damage compensation, access rights, benefit-sharing and land tenure disputes. The Sustainable Livelihood Framework by DFID in 1999 is used to measure the influence of forest conflicts between timber companies and farmers and the impact of these conflicts on the livelihoods of the farmers in the off-reserve area of the Mankranso District. The findings from the research show that forest conflicts have impact on social capital, natural capital and financial capital of the farmers and is concluded with a policy reform recommendation to secure farmers' access, tenure and benefit rights for a sustainable collaborative forestry management for the off-reserve areas of Ghana.

**Keywords:** Off-reserves, Forest Conflicts, Formal and Informal Institution, Livelihoods

## **From biodiversity indicators on site level to a pan-European view**

*An integrated, multi-scale Earth observation service for habitat monitoring based on structural assessments, change detection and modelling*

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Since the implementation of the European Habitats Directive (92/43/EEC; HabDir) in 1992, the underlying concept of establishing a network of 'sites of Community interest' (NATURA 2000) has been widely recognized as an innovative and powerful means to implement biodiversity monitoring in the spirit of the UN-CBD (Convention on Biological Diversity). The Directive poses specific requirements on three levels of implementation. On the level of individual sites, trends in area and quality of protected habitats need to be monitored. On the level of EU Member States (MS) this information needs to be aggregated to conservation

status reports, including range, area, quality, impacts and threats information. The EU compiles a composite report to follow up on the conservation status of habitats and species in Europe and the achievements of the HabDir within so-called biogeographic regions.

The habitat directive – as the name indicates - focuses on habitats as areal features. For these habitats Earth observation (EO) mapping and monitoring techniques can be applied to analyse their structural qualities and change dynamics (Langanke et al., 2007) and thus support their conservation (Vanden Borre et al., 2011). The EU FP-7 project MS.MONINA ([www.ms-monina.eu](http://www.ms-monina.eu)) develops and provides specific EO-based services based on status and change maps as well as structural indicators derived from EO data. The project will demonstrate how the required information can be integrated between the levels through vertical service chains, as the requirements on member state or EU level imply more than ‘collecting’ data from the respective lower levels. On MS level, authorities are required to report on habitat status of the entire area, also outside the network of protected areas. To reach from site level monitoring to MS relevant information, specific up-scaling methods need to be employed. Habitat modelling techniques will be coupled with the integration of satellite data at different spatial resolutions (very high to high) in an object-based class model. Thus, the administrative ‘multi-scale’ concept to a certain degree reflects the ecological scaling ladder with a focal level embedded in nested hierarchical levels. A full match between administrative and ecological levels is unlikely, not only due to great variations in MS sizes, but up-scaling along a hierarchical ladder will support the ‘conditioning’ of biodiversity information on higher political levels with their specific requirements according to the HabDir.

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## **Decision-making for Rural Landscape: An Interdisciplinary and Trans-scale Approach in Piedmont (Italy)**

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‘Decision-making for rural landscape’ is the title of a research project aimed to address the decision-making process towards the conservation and valorisation of the rural landscape quality. The study area is a hilly vineyards agro-ecosystem located in Piedmont (Italy) composed by three sample areas of about 5500 ha in total. This landscape is part of a bigger

site candidate to become part of the UNESCO heritage. Termorshuizen *et al.* in 2009 have asked some interesting questions used as starting points for this research: ‘How can the available knowledge in various disciplines be integrated into structure-function-value chains?’ and ‘Are there any available methods suitable for the application in collaborative decision-making?’. Planning and designing sustainable rural landscapes implies to consider driving forces acting not only on farms and agricultural practices, but also on settlements, demography, and economy. The paper shows the interdisciplinary and trans-scale approach pursued in the research and explains how results of an expert based approach can concretely contribute to a local planning and design model for a better future rural landscape. In particular, according to an holistic process, the landscape was investigated by means of agronomy, ecology, history and architecture. The GIS based method intersected the main landscape characteristics in order to define, as much objectively as possible, a landscape classification that can be useful for the future planning strategies in the area. Furthermore, guidelines for local landscape governance will be proposed.

**Keywords:** Landscape ecology, History, Perception, Landscape quality, GIS, Land use

## **How Physical-biological Feedbacks Control the Evolution and Restoration Prospects of Large Wetlands Worldwide**

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Large wetlands and floodplains such as the Florida Everglades, the Brazilian Pantanal, and Yangtze and Yellow River deltas evolve under complex interactions between physical and biological factors. Emergent vegetation is governed by hydrology in that it colonizes locations with moderately shallow water depths and low flow velocity. In turn, vegetation increases the variability of velocities, slowing flow over vegetation patches while focusing and increasing flow through intervening channels. Vegetation-mediated flow patterns create distinct zones of sediment entrainment and deposition. Organic sediment production (also dependent on local hydrology) and redistribution within patches of emergent vegetation are the chief land-building processes, thereby governing vegetation colonization and closing the feedback loop.

Like many landscapes governed by physical-biological feedbacks, large wetlands can evolve distinct, self-organized patterning of vegetation and topography. Patterning can be integral to ecosystem function and ecosystem services, sustaining high biodiversity and establishing corridors for dispersal. However, like other ecosystems governed by strong physical-biological feedback, patterned wetlands are often subject to catastrophic shifts in landscape configuration due to disturbance. For example, much of the patterned ridge and slough landscape of the Everglades has shifted to an emergent vegetation monoculture following decades of anthropogenic changes in flow velocities and water levels. Interest in restoring patterned landscape structure has necessitated in-depth understanding of how physical-biological feedbacks impact landscape evolution trajectories and restoration prospects.

We conducted pioneering fieldwork in the Everglades to quantify how microscale vegetative flow resistance impacts bed shear stresses and sediment transport patterns at large scales, as well as how organic sediment flocculates and is redistributed across the landscape. Based on field results, we developed a cellular automata model, RASCAL, which simulates the sediment redistribution and differential peat accretion feedback mechanisms. RASCAL enables prioritization of restoration management, revealing that landscapes degrade most rapidly from decreased water levels, followed by decreased flow velocities, followed by altered flow direction. Because of the generality of RASCAL and the feedback processes simulated, results are applicable to large wetlands worldwide. A global sensitivity analysis revealed that the simulated feedbacks may be responsible for a wide variety of floodplain and wetland landscape patterns. Parallel-drainage landscape patterning, such as that found in the Everglades, evolves only under a highly specific combination of hydrologic conditions and is prone to catastrophic degradation resulting from changes in water level, flow velocity, and/or flow direction. Unfortunately, the model shows that the former landscape patterning cannot readily be restored by merely reversing hydrologic perturbations. First, managers must take steps to decrease the abundance of emergent vegetation that has colonized historic sloughs.

## **Recent Trends of Landscape Changes in Central European Mountains (Sudety Mts case study)**

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The study presents the changes of cultural landscapes, which occurred in the central European mountains in the post World War 2<sup>nd</sup> period. The study area includes the Sudety Mts on both sides of the border, which is Poland and Czech Republic. The analyses are based both on field mapping, cartographic and statistics materials from various time periods, air photographs and literature studies.

In the entire region various trends and phases of landscape changes can be observed in the last decades with prevailing two opposite trends of socio-economical development, which lead to environmental changes of various extent and durability. These are:

(1) Depopulation, which locally started at the end of the 19<sup>th</sup> century and was intensified after the 2<sup>nd</sup> World War and lasted in general until the mid-1980's. The period was characterized in the Sudetes by stagnation or regression of regional development, which was due to, among other, substantial depopulation, decapitalization of properties, housing crisis and barriers in the industry development (Ciok 1991). The environmental results of these socio-economical changes were as follows: disappearance of settlements and field roads, secondary vegetation succession on abandoned grounds, increase of forest stands (natural and plantations), amelioration of condition of the natural environment. In general, the renaturalisation of the environment was observed in that period, with development of many various ecotones, increase of biodiversity and landscape diversity, as well as limitation of soil erosion, which was very intensive in the previous period (Latocha 2009).

(2) In the recent two decades a substantial increase of new single-family houses (mainly holiday houses) and tourist infrastructure (e.g. skiing, viewing towers) can be observed, which becomes excessive in some places. The trend of new spatial planning developments has been additionally enhanced after Poland and Czech Republic joined the European Union in 2004. From that time many new landscape changes can be observed in the region. It refers mainly to land use pattern, as in many areas the previously dominating spontaneous secondary vegetation succession on the abandoned grounds has been substantially limited or reversed due to the renewal of agricultural practices (e.g. cutting of hay meadows) on the basis of EU supporting funds and implementation of agri-environmental schemes. The environmental effects of these new processes are as follows: revival of rural areas; renewed expansion of built-up areas; limitation of development of natural secondary vegetation succession; re-enhancement of slope processes (soil erosion); loss of landscape value, as a result of a disturbed spatial order, due to chaotic development of new buildings and little respect to traditional local architecture.

The study presents quantitative and qualitative characteristics of these various trends in the context of their potential impact on the environmental system. The differences and similarities in landscape changes between Polish and Czech parts of the Sudetes are also presented.

## **Evolution of cultural landscapes on the basis of cartographic analysis (SW Poland case study)**

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The aim of the presented study is twofold. On one hand it is a methodological study, showing the applicability of various cartographic analysis in the assessment of landscape pattern change. On the other hand the study presents the qualitative and quantitative changes of rural cultural landscape in the selected areas of SW Poland (central Europe) in the last c. 100 years. The entire region was subject to substantial demographic, political and economic changes due to changes of state borders after the World War 2<sup>nd</sup> and changes of political and economical systems in Poland in the post-war period. All these factors influenced also the environmental system and landscape features.

The cartographic analysis are based on comparison of topographic maps 1:25 000 from various time periods, starting from the 1880's until present times. For selected areas, where the landscape changes were the most spectacular, more detailed analyses were conducted, based on aerial photographs and ortophotomaps. ArcGIS 9 was used as the main tool for analyzing all cartographic data.

The landscape change was analyzed on the basis of comparison of the extent, numbers, length and derivative parameters of main landscape features, which included the network of settlements, field and forest roads and the land use pattern with main focus on the extent of the forested areas.

The resulting comparative output maps show a high spatial variations between the study areas as far as the qualitative and quantitative features of landscape change are concerned. Although the general historical background for the entire region is the same, there are local differences of socio-economical constraints. Moreover, the natural environmental conditions, such as slope angle, slope length, slope aspect etc. seem to be crucial for the final results of landscape change within the last century in all the analyzed areas.

## **Evolution of Agricultural Landscape in Hong Kong**

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Hong Kong is one of the most commercialized cities in the world. Although the impression as a forest of skyscrapers has been deeply embedded in the people's mind, it is astonishing for the high area of greenery preserved in the peri-urban and rural landscapes. However preservation of rural landscape outside country parks is facing major challenges.

The rapid decline of rural and agricultural landscapes can be reflected by the shrinkage of active farmland from 8670 ha in 1975 to 1861 ha in 2009. In terms of farming patterns, it has evolved from mixed farming with efficient ecological systems such as mulberry-dyke-fish pond (Zhong, 1982), to conventional specialized farming and now a reemergence of organic farming with increasing interaction with urban city. On the other hand, there are about 4000 ha of abandoned farmlands facing numerous land conflicts such as dumping of constructional waste, which has been termed as 'rural blight' and elaborated through land use planning (Jim, 1997). These conflicts have brought irreversible changes to the rural landscapes of Hong Kong. Under these changes, agricultural activities are evolving to different forms in the city. The transformations on the functions and quality of the rural and agricultural landscapes will need to be further investigated.

This ongoing research will further investigate the transformations and adaptations of rural and agricultural landscapes in Hong Kong. The key factors behind such transformations will be analyzed. Information will be collected from stakeholders. This will help filling in the knowledge gaps of agricultural research in Hong Kong and provide some suggestions towards establishing related policies.

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## Climate Change - an Introductory Survey with a Focus on China

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China is one of the fastest growing countries in the world. The coastal zone is one of the areas with the highest density of human populations on earth. As climate change increases, the vulnerability of these areas and therefore providing for the population, becomes more and more challenging. Global and especially regional models provide a good opportunity for future forecasts, especially for highly variable parameters such as precipitation, which provides nearly 80% of the annual precipitation that occurs in China depending on the size of monsoons, in the monsoonal months of May until October (Kalnay et al., 1996). Regional as well as global climate models, are still divided in their results and show different precipitation scenarios (results can show an annual change of -20 % to + 20 %, the IPCC Scenario A1B shows +10 - 15 % (IPCC, 2007). A more clear prediction is given for change in temperature. Depending on the IPCC scenario, the increase in temperature ranges from 1 – 5 °C until 2010 (with quite high spatial differences). For the last 50 years, re-analysis data shows a 0.5 °C increase in annual mean temperature in China. With this increase of the temperature, the expected rise in sea surface levels (0.2 to 0.6 m) and the resulting flooding will also become problematic for highly populated coastal areas of China (IPCC, 2007).

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## Spatio-temporal Dispersion of *Ips typographus* (L.) in Bavarian Forest National Park: – A Long-term Quantitative Landscape-level Analysis

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The relationship between abiotic and biotic factors and the spread of the European spruce bark beetle, *Ips typographus* (L.), was investigated at a landscape level over a model period of 18 years in the Bavarian Forest National Park in Germany. Deadwood areas - where *Ips typographus* - caused tree mortality of 100 percent - were photographed annually using Color-infrared aerial photography and digitally recorded in vector form. Thirty-two static and

dynamic habitat variables were quantitatively determined using spatial pattern analysis and geostatistics from 1990 to 2007 at the landscape scale. The importance of the presence of deadwood areas for thirty-two habitat variables for the occurrence of the bark beetle was quantitatively recorded using an Ecological Niche Factor Analysis (ENFA).

It was shown over a long model period that the intensity of the bark beetle infestation went through different phases over the 18-year study period. No mono-causal correlations could be found between individual habitat factors and the spread of the bark beetle over the entire model period. On the one hand, these findings underline the complexity of the system, on the other hand, this could be interpreted as a possible explanation for conclusions drawn by previous studies that differ from each other.

The importance of individual habitat variables and the combinations of variables varied to different extents within these phases. An examination of the cumulative importance of the habitat demonstrated that landscape metrics such as the distance from the site of the previous year's infestation, the area and the perimeter of the infested areas from the previous year are of great importance for the incidence of the bark beetle, but not across all years. Of equal significance for assessing the size of the area and the distance of the deadwood areas from the sites of the previous year's infestation are the size of the areas, the perimeter of the deadwood areas and the proximity index. An evaluation of the stages of forest succession showed that cumulatively, a short distance between the infested areas and the forest areas with conifers in the early stages of growth was an equally important habitat factor from 1990 to 2007. By quantitatively recording habitat factors that are significant for the spread of the bark beetle it may help predict areas that are at risk and thus to develop suitable management strategies to minimise or stop the spread and the effect of the bark beetle.

## **Ecosystem Functioning and Biodiversity Conservation in Nigeria**

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In this paper, ecosystem function was defined as 'the capacity of natural processes and components to provide goods and services that satisfy human needs, directly or indirectly'. The functions been performed by the ecosystem was discussed under four primary categories. These are regulatory function, production function, habitat function and information function. These functions are carried out through three processes (energy flow, water cycling and nutrient cycling) which connect all the parts of the ecosystem together. These processes and interactions between components are crucial to maintain life on earth and to perpetuate the regenerative capacity of living organisms. The paper further reported that changes in the components or the conditions that they are in could greatly affect the speed at which these interactions take place. When a forest estate is clear felled for urban development, many biodiversity are lost and therefore, the three processes involved in ecosystem functioning are disrupted and the systems life supporting capacity is at stake.



# Remote Sensing Applications for Precision Farming: Site-specific Grazing Management in Fine Scale Pasture

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Precision farming requires timely and detailed site-specific information to optimize the efficiency of pasture resource. Satellite imagery has been widely used to evaluate pasture condition in large area and ground-based spectral measurement has been used to apply the appropriate sampling strategy. The objective of this study is to demonstrate potential of various remote sensing tools for estimation and mapping of pasture green biomass (GBM) and quality in fine scale pasture. For estimation and mapping of pasture parameter, the potential of two kinds of ground-based spectral measurements and ALOS/AVNIR-2 image were demonstrated and it is main parts of the author's Ph.D dissertation.

(1) A portable spectroradiometer (MS-720, Eko Instruments Co., Ltd., Japan) with 350-1050 nm range was used to estimate pasture GBM and crude protein (CP) concentration. Genetic algorithm-based wavelength selection with partial least squares (GA-PLS) regression was used to estimate pasture parameters, and the optimal sapling interval was calculated using a geostatistical approach. For monitoring and mapping purposes, the predictive accuracy ( $R^2_{cv}$ ) of GA-PLS model for GBM and CP concentration was 0.55 and 0.42, respectively. A hyperspectral radiometer sampling interval of less than about 15 m was suitable in mixed-sown pasture (Lee et al., Accepted).

(2) A hand-held crop measuring device (Seiikukei, EBARA Co., Ltd., Japan) was used to estimate pasture GBM and CP content before and after pasture trimming and geostatistical analysis was applied to estimate their spatial and temporal variations. Geostatistical analysis using semivariogram indicated that the spatial distribution patterns became strongly homogeneous with decreasing average of GBM and CP content after pasture trimming.

(3) Regression analysis using vegetation indices and multiple linear regression (MLR) analysis were conducted to determine the relationship between AVNIR-2 images and ground measured GBM. The estimation of GBM using ALOS/AVNIR-2 images with MLR model ( $r^2 = 0.45$ , evaluation index value = 26.3%) was more precise than vegetation indices (NDVI,  $r^2 = 0.27$ ; NDVI green,  $r^2 = 0.28$ ; SAVI,  $r^2 = 0.25$ ). It indicates that MLR analysis using ALOS/AVNIR-2 image was considered to be practical accuracy for GBM estimation.

For estimation and mapping of pasture parameters, the hand-held hyperspectral radiometer and the hand-held crop measuring device may thus be simple and easy method and ALOS/AVNIR-2 images are able to provide spatial distribution map with practical accuracy in fine scale pasture.

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## **Edge Effects in Urban Forests –Responses of Humans and other Organisms**

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Urban green offers a great potential for different kinds of ecosystem services i.e. direct or indirect benefits for citizens. These services include such life-supporting functions as control of local climate and the hydrological cycle, pollination, production of food and the purification of water, and delivery of aesthetic and recreational experiences. Urban ecological understanding is necessary in order to maintain these services in cities while other disciplines are needed in order to understand how to best apply ecologically sustainable solutions.

In this presentation I will briefly present on-going research in Finland concerning urban ecosystems and their services, and highlight the need for ecological research to integrate with other disciplines in order to give applicable solutions for environmental problems. As an example of highly interdisciplinary, problem-driven research I will present a new program focusing on green roofs and their ecological, biodiversity and well-being potential.

Finally, I will summarise results from an interdisciplinary study concerning aesthetic, recreational and ecological aspects of urban green space biodiversity. This research project has studied urban forests and parks, and questions related to fragmentation and edge effect, as well as provision of dead wood. The main responses we have studied cover a range of organisms from microbes and plants to invertebrates and humans. It covers both theoretical-philosophical and empirical approaches in order to provide multidisciplinary understanding and guidelines for optimal solutions in urban planning and management.

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## **The Status of Reforested Wetlands in Forest Mosaic Landscapes of Western Europe**

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The concepts and methods of historical biogeography and landscape ecology allow investigating the evolution of forest landscapes. Overexploited during the 18<sup>th</sup> and 19<sup>th</sup> centuries for the huge needs of local industries, forests have been planted with coniferous

trees since the middle of the 19<sup>th</sup> century. The species used for the reforestations were first indigenous, like the Scots Pine and then exotic, like the Douglas-Fir, the Japanese Larch and the Sitka Spruce. The great plantations of coniferous trees had harmful consequences on the structure and functions of intraforest wetlands which punctuate the landscape mosaic. Today the attempt is to restore these environments using conservation ecology tools. The effectiveness of those works is questionable and raises the question of the natural dynamics of the vegetation within forestry. This study investigates sites and their status along a transect between the southeastern part of the Massif Central (France) including the Limousin, Brittany and Normandy (France) and sites in Northern Ireland (UK).

## Connecting Habitat Patches in Agricultural Landscapes

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In intensively cultivated landscapes, small and spatially isolated habitats represent a major pressure on biodiversity in terms of number and abundance of species. Corridors, connecting habitat patches can improve species movement and thus conditions for biodiversity. We present a model, where hypothetical corridors between existing habitat patches are created in a geographic information system. The model is based on a cost surface, where land-use classes are assigned a cost representing their suitability for creation of a corridor. E.g. extensive land use is assigned the lowest cost, while urban land use is assigned an infinite cost. The outcome of the model is a corridor network which spatially connects all habitat patches in a study area. Individual corridors can be ranked according to their significance for the whole network. I.e. corridors located central in the network are ranked higher than corridors located in the periphery of the network. Applying detailed land-use maps, the quantity of different land uses, which need to be converted into habitat corridors, is assessed.

The method has been tested for Naestved municipality, located in eastern Denmark. Hypothetical corridors were modeled for small rodent species, such as hares. Corridor widths depend on which kind of land-use class is crossed. On forested and extensively managed land, corridors are applied a width of 20 meters. On intensively managed agricultural land, corridors are applied a width of 50 meters. The resulting network for Naestved municipality consists of 324 corridors, covering an area of 662 hectares, which is 0.1 % of the total area of the municipality. The majority of corridors are suggested on intensively managed agricultural land (71 %). Furthermore, the ranking of corridors showed a cluster of 12 corridors of particularly high significance to the total network.

The model can form an important input to land-use planning in general and to planning of habitat corridors in particular. Furthermore, model-properties can be adjusted and further developed to fit other kinds of landscapes and/or other species groups.

# **Integrating Sources of Uncertainty in Scenario Development for Sustainable Forest Landscapes**

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Decision makers affecting forest lands in both developed and developing countries face an array of challenges emanating from uncertainties associated with natural events and human actions in combination with the degree of management control and/or influence they are able to exert.

The nature, sources and strength of such uncertainties directly affect decision-makers' capacities for effective action and their influence on forest sustainability.

Uncertainties emanate from both natural disturbances to the landscape and human activities either directly modifying forest status (e.g., harvesting, planting, conversion of the forest to other land uses) or constraining/enabling the decision maker's influence over that status. Together these natural and social uncertainties work to cloud future expectations and render anticipated futures vulnerable to continuing surprises.

What is needed are ways to envision possible futures that provide pictures of potential landscape change which incorporate the above uncertainties in a pragmatic way. The development of realistic scenarios is vitally important in this regard. A body of work does exist on scenario development and planning. For a given decision situation, it focuses on the design of a small set of contrasting scenarios to explore the uncertainty surrounding the future consequences of one or more courses of action.

This paper looks briefly at some general features of how natural and social uncertainties may be incorporated within scenarios depicting potential future trajectories for forest landscapes. Dimensional axes relating degrees of uncertainty to decision maker ability to influence outcomes are explored, as are the kinds of quantitative and qualitative information that can be incorporated and the role of forest landscape and land use models in scenario construction.

In contrast to exclusive emphasis on accurately predicting a particular outcome, the process of scenario development recognizes a variety of possible futures that include many of the important uncertainties in the system. Thus consideration of multiple possible futures, in which outcomes may range from optimal to highly undesirable, is essential to the process.

The ultimate goal of such efforts is to present a clear picture to decision makers (and others) of the constraints they are facing and opportunities for action that will sustain or enhance both the ecological integrity of the landscape and the social, cultural and economic sustainability of individuals and societies over time. To help decision-makers envision the range of actions they might take in confronting natural and social uncertainties, a viable set of scenarios will include the possible trajectories of the forest landscape that could follow from particular decisions. Aided by such a tool, the policy maker or resource manager may better chart a course of action that will lead toward both sustainability of forest ecosystems and enhanced social well-being.

# Effects of Tropical Successional Forests on Bird Community Composition: Vegetation Structural Changes and Landscape Heterogeneity

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Tropical forests are undergoing rapid transformation rates due to human action which has created over 600 million ha. of secondary vegetation. Particularly tropical dry forests (TDF) suffer large pressure due to conversion to agriculture and other land uses, creating a heterogeneous landscape matrix of agricultural land and successional forests. Changes in the landscape matrix affect patterns of animal species abundance and distribution, potentially reduce species persistence, and consequently influence community composition. The relative importance of landscape structure, i.e. composition and configuration, remains controversial. Likewise, landscape heterogeneity due to forest succession affects the variability in habitat quality as a result of differed site-specific features (e.g. vegetation structure). In Mexico, only 27% of TDF remains undamaged, and the most extensive contiguous areas of TDF occur in the Yucatan Peninsula long impacted by natural and human disturbances. Despite the prevalence of successional forests, few studies have examined their impact on higher trophic levels such as bird communities. The Yucatan Peninsula is a region of high avian endemism and an important area for migratory birds. This study examined the changes occurring in bird guild composition during succession correlated to vegetation changes and landscape heterogeneity in a TDF region in the Yucatan Peninsula. We used a SPOT5 satellite image to obtain a land-cover thematic map, and systematically sampled woody vegetation and used a double-observer approach to perform bird point counts in 274 plots distributed among four vegetation classes: 3-8 yr-old forest, 9-15 yr-old forest, >15 yr-old forest on flat areas and >15 yr-old forest on hills. We calculated landscape composition and configuration variables using the land-cover thematic map. Canonical Correspondence Analysis of vegetation and landscape variables showed that the total amount of variance in guild composition data explainable by the first axis was 45.8% (Total inertia: 0.55). Partial ordination revealed that the marginal effect of the vegetation variables set was 5%, whereas for the landscape variables set was 8% ( $P$ -value=0.001). Since the conditional effect (0.7%) was smaller than the marginal effects, we can conclude that the two sets of variables are not very redundant in explaining the guild composition data. Our results show that despite vegetation and landscape sets significantly explain the guild composition, further studies should be conducted in more heterogeneous landscapes. However, we believe this study provides important insights in the patterns of succession for bird communities, and guidelines for management and conservation.

## **Risk Assessment of Landscape Ecological Infrastructure in Rapid Urbanization Area**

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Landscape ecological infrastructure is essential to ensure the integrity of the ecological service and the connectivity of landscape processes and the urban ecological security (Ted Weber et al., 2006). However, the overwhelming urban sprawl in China has damaged landscape ecological infrastructure and has induced harm to regional ecosystem healthy. Consequently, some cities suffered from ecological disaster. It is important to conserve and develop landscape ecological infrastructure that how to identify and assess the landscape ecological infrastructure risk of impact of urban expansion, and how to get the strategies to reduce the risk of conflicts between the urban expansion and landscape ecological processes.

In this paper, some Chinese urban areas are used as case study, to discuss a method of risk assessment of landscape ecological infrastructure. Firstly, based on RS and GIS data in the period of initiation of rapid urban expansion, landscape security patterns were planned for flood and storm water management, bio-diversity conservation, cultural heritage protection and recreation, and then they were integrated into the comprehensive landscape ecological infrastructure which consisted of greenways and strategic hubs. Secondly, the landscape ecological infrastructure in the past is overlaid with existing landscape pattern to assess the landscape ecological infrastructure risk in the period of initiation of rapid urban expansion and risk patterns and risk index are calculated as the risk feature. Then based on the comparison between existing ecological status of records and the result of risk assessment, the method of the risk assessment is verified since the result is valid. Thirdly, the future urban expansion is simulated to forecast alternative future urban patterns, and the existing landscape ecological infrastructure is identified. Then risk patterns and risk index are calculated in the same method. Finally, it is put forward that the risk management measures of scheduling and spatial control from aspects of both land conservation and construction guidance in the risk area. The risk will be reduced and the landscape ecological infrastructure will be safe.

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## **Roles of Modeling in Adaptive Landscape Management**

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The dynamics of forest landscape over space and time is the ultimate concern in the decision making process of forest management, which includes three main interacting and interconnecting operational level components of forest resources, natural disturbances, and wildlife habitat management. The goal of forest resources management has been shifted from sustained yield, to maximal sustainable yield, to ecosystem-based management, and to the adaptive management. The paradigm of forest management has also been shifted from volume-based to value-based, and from emphasizing single objective of economic maximization of forest products to the multiple objectives of both forest products and ecosystem services for balancing regional economic development and eco-environmental improvement. The adaptive landscape management is essentially the adaptive management concept application at the landscape scale, which will allow more flexible implementation of various forest management options under changing environments, and learning from the past experience to improve future decision making. In this presentation, we discuss conceptual development in forest resource management, the advantages of adaptive landscape management in handling uncertainties that forest managers are facing, and the roles and challenges of modeling techniques in the implementation of adaptive landscape management.

## **The Urban Land Expansion in Chinese Cities: A National Perspective**

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Compared to rich literature on urban land expansion in Western cities, relatively little is known about the urban expansion and landscape change in Chinese cities in the last thirty years. Thus far, the relative research have remained confined to individual case studies in a single city, systematic analysis of the urban land expansion and its relative landscape change in a national perspective has been lacking. This paper utilized the data in 136 cities in China, gave an overview of the urban land expansion and its relative landscape change in most Chinese cities, then analyzed the spatial and temporal characteristics of the urban land expansion in a national perspective in China. The result showed the cities which have dramatic growth in urban landscape are concentrated on the Pearl River Delta and Huang-Huai River Basin, the urban landscape in the above two regions have changed much more both in quantity and rate than the northeast, west and central regions in the recent thirty years.

The result also showed for mega-cities in China as Beijing and Guangzhou, there existed a common temporal feature in urban landscape expansion: from the early 1980s to the year 1996, the urban landscape changed in relative constant speed; from 1996 to the beginning of the 21<sup>st</sup> century, the speed of the urban landscape expansion came to a very low stage because of the strict land use policy by the central government; then from the early 2000s to the year 2005, the urban landscape began to grow extremely fast; after this period until now, the changing of the urban landscape has slowed down to a relative lower speed because of the intensive land use policy.

# Spatiotemporal Pattern and Driving Forces of Urbanization in the Central Region of Yangtze Delta: A hierarchical Perspective

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Urbanization has profoundly transformed many landscapes around the world, resulting in pervasive environmental problems. Quantifying the spatiotemporal pattern of urbanization is important to understanding its ecological impacts and designing solutions. A number of hypotheses on urban growth have been proposed, one of which is the diffusion-coalescence hypothesis that urban sprawl proceeds as an alternate process between diffusion and coalescence. This hypothesis has been tested partially in several studies based on individual cities (e.g., Phoenix and Las Vegas, USA, Wu et al., 2011; Guangzhou, Yu and Ng, 2007; and Shanghai, Li et al., submitted). Here we examined this hypothesis by characterizing the hierarchical spatiotemporal patterns of an urban cluster with multiple cities – the central region of Yangtze Delta, China. This region has experienced rapid urbanization in recent decades, and provides an ideal study region for testing the diffusion-coalescence hypothesis. Our analysis focused on three hierarchical levels: county, city, and region. Several landscape indices (including Landscape Expansion Index, Mean Expansion Index, and Area-weighted Mean Expansion Index) were used to quantify urban development patterns based on maps derived from remote sensing data for years of 1979, 1990, 2000, 2002, 2005 and 2008. Our results supported the diffusion-coalescence hypothesis at the regional level, but not necessarily at the county and city levels. This finding implies that the validity of this urban growth hypothesis is scale-dependent. Population growth, industrialization, GDP, foreign investment, and China's economic reform policies were identified as the major factors driving the urban dynamics of the central Yangtze Delta region at different spatial scales.

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# How A Regional Ecological Planning Project Based on Landscape Ecology Effecting?

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This is to review the real effect of a regional ecological planning project in Hefei, Anhui Province based on the principle of landscape ecology, theory of security pattern and negative approach. The original result is presented as an ecological infrastructure in three scales with guidelines of implementation which is finished in 2006.

The review is made in three dimensions with some interesting results:

(1) In the principle and strategy dimension which is presented the ecological infrastructure network system in macro-scale and middle scale, the project is highly appreciated by local institutions and related professionals.

(2) In the approach dimension, our aim to prioritize the arrangement of non-construction areas by means of hydrological and ecological processes simulation, and to incorporate factors such as urban flood control, stormwater management and indicator animals turn to be new principles in different municipal sections.

(3) In the technic and engineering dimension, results are different: a. to sustain ecological processes in high density urban sprawl areas has to compromise to road construction and city zoning; b. the optimal uses of local natural resource to solve various ecological problems, effectively maintaining the health of urban and regional natural systems, enhancing the services of natural systems for city and local residents, and reducing construction capitals can't be integrated into one image, people see different perspectives; c. guidelines for planning and engineering tends to effect in different occasions which tells a truth that people need to be told how to do.

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## **Influencing Factors and Human Needs on the Use of Recreational Services of Wetland Parks in Beijing**

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As a scarce ecological resource for the city, wetland park has a variety of ecosystem services. Recreational services of urban wetland park are becoming a matter of concern for more and more people. The present study is based on data of 4096 randomly selected adult residents within 20 wetland parks in Beijing. Statistical methods were used to research the use of urban wetland park, and logistic regression analysis was used to investigate influencing factors on use of urban wetland park. And based on the fifth census data, the needs index of each block group for wetland park was calculated. Results showed that: (1) the travel time of respondents for the wetland park and frequency of use are closely related. 43.4% of the respondents need to travel less than 1 hour to reach the wetland park, among which 34.1% of the respondents visit the wetland park more than 12 times every year. 17.4% of the respondents visit the wetland park more than 12 times every year, among which 85% need to travel less than 1 hour to reach these wetland parks. (2) The decreasing sequences of influencing factors on use of recreational services for the wetland park were travel time, individual monthly income, private car, education level, occupation, and age. In addition, the interaction of gender and age has some influence. (3) To pleasure mental and body was the main reason for using wetland park for 90.58% of the respondents. (4) The needs index decreased with increasing distance from urban center. The needs of Dongcheng District and Xicheng District were higher than Chaoyang and Haidian District, and the needs of Pinggu District and Yanqing District were the lowest. The study provides decision-makers with important information for reasonable optimization of urban wetland park, design and planning of urban green space ecosystem and sustainable development of urban.

**Keywords:** Urban wetland park, Recreational services, Influencing factors, Human needs

## **Research on Coupled Human and Environmental Systems in Nature Reserves and Post-quake Reconstruction Policy Scenarios**

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This case study of the Wolong Nature Reserve examines the complexity of human–environment system interaction in nature reserves, and simulates the impact of future policy scenario on the socio-economic system, land use change and panda habitats. Taking the opportunity of major socio-economic system adjustment after Wenchuan earthquake in

research area, my study mainly focuses on: (1) giant panda habitat suitability assessment, migration corridors network analysis and their change after the earthquake; (2) human activities characteristics and its spatial extent; (3) socio-economic characteristics and decision-making mechanism of local farmers; (4) current policy analysis and future policy scenarios; (5) the influence of different policy scenario programs on local farmers' socio-economic system, landscape pattern and the panda habitats.

Using interdisciplinary research methods (including geography, economics, sociology, computer science and complex systems science), our research methods include: (1) GIS spatial analysis and modeling, (2) household interview questionnaires, (3) behavioral mapping, (4) multivariate statistical analysis and (5) multi-agent based model (ABM) simulation. The results show that: (1) the panda habitat and migration corridors were seriously damaged after the earthquake; (2) human activity (housing, farming, firewood collection, grazing, tourism, etc.) covers a large area, impacting giant panda habitats; (3) during the post-earthquake reconstruction, the farmland that is slated to be reforested will greatly change the living pattern and scope of activities for the local farmers, but because of the influence of the physical and biological environment and human activities, the panda habitat increasing is limited.

This research will provide detailed information about the interaction mechanism among post-earthquake reconstruction policies scenarios, human activities and landscape change in nature reserves, and will provide a reference for making strategic decisions on coordinating conflicts between biodiversity conservation and local development.

**Keywords:** Wolong Nature Reserve, Coupled human and environment system, Agent Based Model, Policy scenario

## **Preliminary Analysis on the Oasis Stability at the Landscape Level in Ejina Regions**

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The oasis, a most sensitive landscape type with highly heterogeneous in arid areas, is strongly disturbed by human activities (Cheng GD, et al, 1999.). The study on landscape stability is a major part in the research of ecological environment, for it is not only an important concept for people understanding the ecosystem but also providing a theoretical basis for the sustainable development of oasis (Liu XW, Zhou HCh, Li P, 2004). In this paper, the stability of Ejina oasis in the lower reaches was analyzed at the landscape level by using remote sensing techniques and GIS. Firstly, the patch types are classified on the basis of Landsat TM data acquired respectively in 2000, 2005 and 2010. Then the landscape diversity, landscape corridors complexity, ratio of substrate, changing rate of patch area, fractal dimension and other indices of the oasis landscape were calculated under the support of the landscape pattern analysis software FRAGSTATS 3.3 (ROBERTTW, WILLIAM D S, 1999.). Finally, the oasis

stability at the landscape level was comprehensively analyzed and compared in the recent ten years since the implementation of the Heihe Water-dividing Scheme.

The results showed that: (1) Before the year 2005, the grassland, forest, and cultivated land areas decreased while construction land increased remarkably. With the landscape diversity and heterogeneity decreasing, the landscape stability lowered. (2) After the year 2005, the grassland and cultivated land areas slightly increased, the oasis mainly existed in the form of large patches. The connectivity of oasis patches, complexity of landscape corridor inside oasis and the landscape stability increased gradually; (3) With the Heihe Water-dividing Scheme having been continually implemented, its role on recovering the area and function of Ejina oasis appeared gradually.

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## **Soil Changes Induced by Rubber and Tea Plantation Establishment: Comparison with Tropical Rain Forest Soil in Xishuangbanna, SW China**

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During the past three decades, drastic land use changes occurred in Xishuangbanna, Southwestern China, where rubber and tea plantation development induced large area of tropical forest and fallow cultivation loss. We evaluated the effects of land use and slope position on the soil physical-chemical properties in seven major land use types, namely disturbed and undisturbed primary tropical forest, abandoned cultivation land, different-aged rubber plantation and tea garden in Xishuangbanna. The results indicated that the most significant land use/cover changes were a decrease of tropical forest area from 69% to 44% and an expansion of area of rubber plantations from 1.3% to 11.8% during 1976-2007. While the number of forests fragments increased from 6096 to 8324 and the mean patch size declined from 217 to 115 ha from 1976 to 2003. Soil moisture content at top 20 cm was higher in different-aged rubber plantation than in the other land use types. Soil organic matter was higher in the two tropical forest types than in the other land use types. Total N concentration was high in disturbed tropical forest and low in tea garden and 18-yr-old rubber plantation. Soils in the two tropical forest types and abandoned cultivation had inorganic N concentrations about equally distribution between  $\text{NH}_4^+$ -N and  $\text{NO}_3^-$ -N. However, soil

inorganic N pools dominated by  $\text{NH}_4^+$ -N in rubber plantation and tea garden. Soil moisture, inorganic N,  $\text{NH}_4^+$ -N and  $\text{NO}_3^-$ -N concentrations under all land use types were higher in the rainy season than in the dry season. Significant difference in soil moisture, inorganic N,  $\text{NH}_4^+$ -N and  $\text{NO}_3^-$ -N concentration was detected for both land use and sampling season effects, as well as interactions. Clearly, land use changes from tropical forest to plantation have a profound effect on soil properties, especially on soil inorganic N,  $\text{NH}_4^+$ -N and  $\text{NO}_3^-$ -N concentration, and also have potential negatively impacts on environment.

## **An Assessment on the Recreation Value of Xishan Forest Park in Kunming**

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An assessment on the ecosystem service value has become the hot issue in current study of ecology and ecological economics. The assessment of recreation value is one part of them. Travel Cost Method(TCM) and Contingent Valuation Method(CVM) are both of the popular evaluation method for environmental value, which has been used widely to evaluate the recreation value of national parks and travel sites. The recreation value of Xishan Forest Park in Kunming was evaluated with Travel Cost Method and Contingent Valuation Method together in our research. Xishan Forest Park is one of the famous travel sites in Kunming, which attracts a large number of tourists all over the world. It will provide reference for tourism resources and environmental management to evaluate its recreation value. In this paper, with TCM, 600 questionnaires were issued and 577 ones were taken as valid questionnaires. There is 96.17% efficiently. Consumer surplus and travel costs come from the questionnaire survey, the total of them is the willingness to pay of consumer, same as the recreation value of Xishan Forest Park in Kunming. The result indicates that the recreation value of Xishan Forest Park of Kunming in 2010 is  $3.9 \times 10^8$  RMB Yuan. The recreation value of Xishan Forest Park in Kunming was also evaluated with CVM. With CVM, the willingness to pay of visits come from the same questionnaire survey, then calculate the average WTP for visiting Xishan Forest Park in Kunming. The result which the average WTP multiplies the total visits in 2010 is the recreation value of Xishan Forest Park of Kunming in 2010. The result is  $2.9 \times 10^8$  RMB Yuan, which is lower than the recreation values with TCM. At the same time, studying the correlation between average WTP and socio-economic characteristics, we found that age, income come to positively correlate with average WTP, but as to level of education, the correlation with the average WTP was not obvious.

**Keywords:** Xishan Forest Park in Kunming, Recreation value, Travel cost method, Contingent valuation method, Willingness to pay

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## Using Remote Sensing to Derive Vegetation and Soil Properties for Dust Emission Modeling in the Western United State

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Aeolian dust is an important component of the Earth's land-atmosphere-ocean system, and it affects the biosphere in a variety of ways, including biogeochemical cycles, regional climate, snow accumulation and melt, precipitation runoff, and human health (Li et al., 2007, Painter et al., 2010; Ravi et al., *in press*). On-site monitoring of dust emission at scales larger than landscape is logistically difficult as the extent and degree of wind erosion varies across both space and time. Recently, a new quantitative wind erosion model, WEMO (Okin, 2008) was developed that uses the distribution of erodible gaps between plants to characterize shear stress partitioning and distribution of shear velocity at the surface. The model has the potential to be used to quantify dust emissions at landscape to regional scales given the availability of a variety of vegetation and soil characteristics, such as plant height, width, spacing, and soil texture. In this study, a NASA/JPL Airborne Visible/Infrared Imaging Spectrometer (AVIRIS) will be flown in late April 2011 over select regions in the Colorado Plateau and Great Basin. Vegetation structure including plant height, width, and spacing as well as soil type will be estimated by employing the geometrical-optical radiative transfer model (Li and Strahler, 1985). These remotely derived soil and vegetation parameters will then be integrated into WEMO to generate an estimate of wind erosion and dust emission, supplied by the knowledge of free-stream wind speed and threshold shear velocity for each soil type.

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## **Impacts of Landscape Structure on Urban Heat Islands**

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Urbanization is undergoing at an unprecedented rate around the world, particularly in China in the past a few decades. One of the key impacts from the rapid urbanization on the environment is the effect of urban heat island (UHI). Understanding the landscape structure on UHI is critical for understanding urban ecology and city and regional planning.

This study investigated the relationship between UHI and landscape composition and configuration in Shanghai, China, based on the analysis of land surface temperature (LST) with respect to normalized difference vegetation index (NDVI), vegetation fraction (Fv), and percent impervious surface area (ISA). Two Landsat ETM+ images acquired on March 13 and July 2, 2001 were used to estimate LST, Fv and percent ISA, landscape spatial pattern metrics were calculated from a high spatial resolution (2.5×2.5 m) land-cover and land-use map. After exclusion of water pixels, data points in LST-NDVI, LST-Fv and LST-percent ISA feature spaces constitute characteristic triangle formations, and vary significantly with seasons. Although there are significant variations in LST at a given fractions of vegetation or impervious surface on a per-pixel basis, NDVI, Fv, and percent ISA are all good predictors of LST on a regional basis. There is a strong negative linear relationship between LST and positive NDVI over the region. Similar negative linear relationship exists between LST and Fv, but stronger. Urban vegetation could mitigate the surface UHI better in summer than in early spring. A strong positive relationship existed between mean LST and percent ISA. The residential land is the biggest contributors to UHI across seasons, followed by industrial land. Among the residential areas, low- to middle-rise buildings with low vegetation cover lead to much high temperature than high-rises or areas with high vegetation cover. A strong correlation between the mean LST and landscape spatial pattern metrics indicates that urban landscape configuration also influences the surface UHI. These findings are highly valuable for understanding urban ecology as well as city and regional planning with respect to their potential environmental impacts.

## Dispersals of flying foxes to a recovering Pacific island forest ecosystem

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Flying foxes (genus *Pteropus*) act as a keystone species on Pacific islands ecosystems by providing important pollination and seed dispersal services (Cox et al., 1991). They also demonstrate the ability to travel long distances over water, transporting seeds between islands that are potentially hundreds of miles apart (Shilton et al., 1999). These characteristics make *Pteropus* an important genus for conservation; however, flying foxes are threatened by habitat loss and overhunting throughout their range (Marshall, 1983). The Formosan subspecies of the Ryukyu flying fox (*Pteropus dasymallus formosus*) was believed to have gone extinct in Taiwan during the 1990s; recently, this species has been observed on two small islands off the eastern coast of Taiwan. In this study, the day roost locations of three radio-tagged individuals on Turtle Island, Taiwan, were tracked for up to six months using radio telemetry triangulation. During the tracking period, the bats each showed fidelity to non-overlapping territories smaller than 8 hectares, located in hillside and ravine forests. Turtle Island was the site of a small fishing community that cultivated much of the island's arable land until it was relocated in 1977. Interviews with former island residents reveal that flying foxes were not found on the island during this period of human habitation, suggesting that the bats only recently arrived after secondary forest regrowth. Two dominant species of figs found throughout the island, *Ficus septica* and *Ficus fistulosa*, are known to be the main food items of the flying foxes. Flying foxes are also the largest seed dispersers on the island, and can carry figs or defecate seeds long distances away. The availability of bat food resources on islands appears to be a major determinant in inter-island movements (McConkey and Drake, 2007; Nakamoto et al., 2010). These bats' long-term inhabitation of Turtle Island demonstrates the ability of a human-altered ecosystem to recover and adopt new habitat function through landscape connectivity. Sources of flying fox dispersal to Turtle Island could be an unknown population on the Taiwan mainland (10 km distant), or populations on the Ryukyu Islands of Japan (more than 100 km distant).

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# Comprehensive Assessment of Heihe River Basin Eco-environment Based on Multi-source Spatial Data

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The study of eco-environment is a focus for it provides a basis for the environmental management for sustainable development. In Heihe River basin the ecological environment has been degrading due to both the human activity and natural condition.

In this paper, the multi-source spatial database was built and mathematical methodology was explored and developed according to Landsat TM images, soil type data, DEM and meteorological material which reflect the general characteristics and regional difference (Wang et al., 2004). A set of indices were selected when making the evaluation model (Jiang et al., 2005), i. e. NDVI, humidity index, soil texture, temperature, precipitation. Then analytical hierarchy process (AHP) was used to determine the evaluation factors' weights (Zhong et al., 2005). On this basis, the evaluation model of eco-environment condition was built. Then a result map was obtained by using the overlay analysis and reclassifying function of raster-GIS (Geographic Information Systems). The index of ecological environment was divided into 5 grades. The higher the grade is, the better the ecological environment is (Zhang et al., 2003). At last, the characteristics of ecological environmental distribution were analyzed.

The result shows that the average index of ecological environment of Heihe River basin is 5.87 and it increases from the lower reaches to upper reaches. Most parts of the basin are at the third and the fourth grade, which illustrates that the eco-environment condition is not that good and balanced.

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# An Ecological Study of the Conservation of Herons in Rice Paddy Areas Based on Habitat Use in Takashima city, Shiga Prefecture, Japan

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Herons sit on top of the food web in the rice paddy ecosystem and are considered indicator species for ecosystem biodiversity. Herons are also highly dependent on rice paddy environment. In Japan, the population of herons has decreased since the 1960s following the modernization of agriculture and the loss of wetland and nesting areas. However, there are few studies on the effects of paddy field management and habitat use by herons. Research was carried out in Takashima city in Shiga Prefecture, Japan, where large numbers of herons are still observed. Eight rice paddy field areas and two main rivers: Adogawa and Kamogawa, were surveyed from May to October 2010. Interviews with local farmers on rice paddy field management were also conducted. The research period was divided into four seasons: the period from transplanting to before “Nakaboshi”; Nakaboshi (when each paddy field is drained); period from Nakaboshi to harvest; and following the harvest period. One-way analysis of variance was used to analyze habitat use for each season separately. The difference among seasons and regions of each heron species habitat use was analyzed with two-way analysis of variance for each area separately. In order to investigate the influence of the environmental factors on the number of each heron species (eg. water management at the paddy fields, distance from the colony) a generalized linear model (GLM) was used. Five species of herons were observed, with the statistical analysis showing seasonal and regional differences of habitat use among these species. All five species were observed from the period of transplanting but rarely after rice harvest. *Ardea alba* and *Ardea cinerea* tended to inhabit river areas, but the other three species preferred paddy fields. The GLM model also showed that the population size for the species were influenced by various environmental factors. The positive factor for the numbers of *Egretta intermedia* was paddy areas that were flooded during winter; for *Egretta garzetta*, it was the delay of transplanting and the period after Nakaboshi to rice harvest; for *Ardea alba* and *Ardea cinerea*, the positive factor was the delay of transplanting. The distance from the colony and the riparian forest were the negative factors for *Bubulcus ibis*. These results indicate that rice paddy field landscape patterns (paddy field-river-riparian forest) and paddy field management, especially during the transplanting period and flood control during winter, were of significant importance to habitat use by herons.

**Keywords:** *Egretta intermedia*, *Bubulcus ibis*, *Egretta garzetta*, *Ardea alba*, *Ardea cinerea*, rice paddy, water management, conservation

# Forest Management of Different Ownerships and its Ecological Effects: A Review

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It is a very critical time for forest right reform of community forest and public forest in China. Obviously, a forest reform will lead to huge ecological effects that we have no experience to face. Fortunately, it has been a long history of multiple ownerships forest management in Europe and America, and experts have done a lot of research on how forest ownerships affect the forest timber, biodiversity and landscape. Hence, it's definitely necessary to review and refer to their experiences and problems to serve our reform. This paper summarized different forest ownerships' management aims, their effects on landscape, and the relevant policies that have been taken. It is proved out that public forest is managed for maintaining sustainability and serving social development, whereas private forest (industrial and non-industrial) is managed by lots of different motivations, preferring to recreation and the aesthetic; as for detail management measures including harvesting and reforestation, fire management and land use change, generally speaking, the public forest management is more unified compared to that of private forest; and it also takes more responsibilities to protect forest and biodiversity, while private forest owners plants a large number of forest. But at the same time, forest parcelization and land divestiture in private forests have brought obstacles to forest timber production and biology conservation, increased landscape fragmentation and lessened inner habitat, so those countries are trying to deal with them by cooperation and combination among all forest ownerships. We hope that their experiences, problems and solutions can help us reform the forest right better to avoid sequencing negative effects in ecology.

## Aspect Dictates Productivity-Species Richness Relationship in Natural Grass Community

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Various forms of productivity-diversity relationship have been reported at almost all scales of observation in ecosystems (Gross et al., 2000; Gillman and Wright, 2006; Cox et al., 2006). Many researchers employed biotic interactions as well as abiotic factors as the mechanisms that generate the different forms. However, the forms are codetermined by both biotic and abiotic factors, and even the latter are much more important due to their great effects on biotic interactions.

Here, we present evidence for aspect-dependent productivity–species richness patterns in a natural *whitesheep grass* (*Bothriochloa ischaemum*) community in Dongzhi tableland area

(2765km<sup>2</sup>) in loess plateau, China, where we observed an unambiguous change of the form along the aspect gradient which stands for different conditions of light and water.

29 samples in *whitesheep grass* community were collected on different aspects and divided into three groups. The relationship between biomass and species richness within each group was tested. Results showed that no significant productivity–diversity relationship was detected when we tested it by all samples ( $R^2= 0.03$ ,  $p=0.40$ ). However, species richness decreased with above-ground net productivity on sunny slope ( $R^2=0.58$ ,  $p=0.011$ ) and increased on shady slope ( $R^2=0.55$ ,  $p=0.014$ ), whereas we found no significant relationship on half sunny and half shady slope ( $R^2= 0.15$ ,  $p=0.30$ ).

Dynamics and competition exclusion of *whitesheep grass* could explain this change. The *whitesheep grass* can markedly contribute to 43% of increasing variation of above-ground biomass ( $R^2 =0.43$ ,  $p=0.04$ ) on sunny slope, and had no marked contribution on half sunny and half shady slope ( $R^2=0.002$ ,  $p=0.91$ ) while a weakly negative contribution was observed on shady slope ( $R^2=0.097$ ,  $p=0.382$ ). Accordingly, variation of *whitesheep grass* can explain 66% of the reduction in species richness on sunny slope, 46% on half sunny and half shady slope, and only 0.8% on shady slope.

We concluded that abiotic factors on different slope directions which can greatly influence the biotic interactions finally resulted in the different forms of productivity–species richness relationship. This conclusion may help to understand the variation of productivity–diversity relationship at all scales where the abiotic factors are much more complex.

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## **Risk Evaluation of Flood Hazard Based on Landscape Ecology: A Case Study of Lower Reaches of the Xiangjiang River in China**

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Floods are the most common natural hazards affecting more people across the globe than all other natural or man-made hazards(Huang et al., 2008). With the combination of rapid population growth and high pressure on space for housing, results in urban growth taking place in areas particularly prone to natural hazards(Braun et al., 2011). Xiangjiang River Basin, China's major grain-producing areas, is no exception to this rule. Accordingly, reliable flood risk evaluation is a critical issue in analysis of the human-socioeconomic-environment

aspects of flood damage reduction projects. To this end, this study aims to provide a RS/GIS (remote sensing/geographical information system)-based technique for distributed flood risk evaluation. Regional flood risk evaluation is often studied on the view of anthropocentrism and take the human is the only disaster-bearing body. One of the commonly used “Multiply” methods, i.e.  $Risk=Hazard \times Vulnerability$  (Ben et al., 2003). In 1990, Hunsaker introduced the principles of landscape structure into the ecological risk assessment (Hunsaker et al., 1990); it provided a new idea for flood risk evaluation. With the different landscape structure, the runoff coefficient of the watersheds takes on diversity (Xu et al., 2007). So, a new calculative model can be established to obtain integrated flood hazard risk ( $R_i$ ) value which was computed by the integrated risk probability ( $P_i$ ), integrated eco-damage ( $E_i$ ), and integrated socioecono-mic vulnerability ( $S_i$ ), i.e.  $R_i=P_i \times E_i \times S_i$ . Local data obtained from the government used to construct this model. Historical rainfall data have occurred from 1971 to 2007, obtained from the China Meteorological Administration. Land-sat TM in 2006 has obtained from the United States Geological Survey. Socioeconomic data have obtained from the *Hunan Statistical Yearbook* (2009). With the support of ERDAS IMAGINE and ArcGIS, the regionalization of flood was drawn, divided general risk assessed results mainly into five grades, that is, the lowest risk region, lower risk region, moderate risk region, higher risk region, and the highest risk region. The assessment results can be used as a reference for making effective flood risk management strategies in study area.

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## Urban Forest Biodiversity in the Context of Cultural Services in China

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Urban forest biodiversity is an important component of urban environment. Furthermore, it is the guarantee of urban environment and sustainable development of economy. There have been 22 forest cities in more than 20 years' development, although the research started late in

China. Study on the structure, function and developing plan of urban forest has been carried out. Several cities have researched deep on urban forest biodiversity and its protection from the aspects of ecological service, economic service and cultural service. Based on the aspects of history of urban forest, the value of urban forest biodiversity and its relationship with urban forest, cultural services of urban forest biodiversity, this paper will mainly introduce the current research status of urban forest biodiversity in China in an attempt to identify the direction of future study.

**Keywords:** Urban Forest, Biodiversity, Cultural Services, China

### **Regional Optimizing Management based on the Landscape-scale Assessment of Steppe NPP in Xilinhote Region of China**

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The ecological crisis derived from NPP decline in grassland region not only endangers the regional stockbreeding development, but also aggravates the contradiction between ecological environment and social economy development. This paper developed a methodology to estimate the grassland management level at large scale based on the change of regional NPP. As a principal indicator for steppe degradation in North China, NPP (Net primary production) of grassland ecosystem in Xilinhote region were simulated in the past twenty years by the improved CASA (Carnegie-Ames-Stanford Approach) model (Potter et al. 1993; Zhu et al. 2006). The results indicate that the average regional NPP gradually dropped down from 1991 to 2000, 2005 due to impacts of climatic change and the grazing manners. During the first ten years, from 1991 to 2000, grassland NPP sharply decreased, and the main transforms were taken place from higher grassland yield in 1991 to lower grassland yield in 2000, especially the largest transferring was from NPP classes (25-50, 50-75, 75-100, 100-125gC/m<sup>2</sup>) in 1991 to NPP class (0-25 gC/m<sup>2</sup>) in 2000. However, after 2000, the degradation trend of NPP has been partly mitigated, and the 25-50gC/m<sup>2</sup> class in 2005 became the main transformed part instead of the 0-25gC/m<sup>2</sup> class in 2000. According to the regional distribution of grassland NPP, four levels of grassland management were measured off and analyzed to illuminate the optimum allocation of grassland resources in the study area. The case study demonstrates that it can synthesize the grassland information to commendably evaluate the grassland management level at regional scale.

**Keywords:** NPP, The typical steppe, The improved CASA Model, Grassland management

**Acknowledgment:** This study was supported by National Natural Science Foundation of China (Contract No. 31060078), by National Public Welfare Project (Contract No. 200809125), by Natural Science Foundation of Inner Mongolia (Contract No. 200804040MS0514), and by the postdoctoral Research Fund of Inner Mongolia University (Contract No. Z20090141).

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## A Simulation Study of Landscape Scale Forest Change under Climate Warming-induced Fire Disturbance in Northeastern China

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Climate change influences forest composition and disturbance regimes directly and indirectly (Dale et al., 2000). The altered forest fires regimes will undoubtedly further affect the composition and spatial pattern of forests, especially in cold temperature zone such as Daxinganling Mountains in Northeastern China (IPCC, 2007; Wang, 2009). For example, fire frequency was predicted to increase by 50% to 100%, and fuel lit probability to increase by 50% to 100%. Warming-induced fire regimes may overshadow direct effects of climate change on species distribution and migration (Flannigan et al., 2000). We used a landscape succession and disturbance model (LANDIS PRO) to study the relative effects of warming-induced fire regime on forest composition and age structure, and compared responses of forest to changed fire regimes. Our preliminary results show that: (1) warming-induced fire regime is likely to significantly change forest composition and age structure of Daxinganling landscapes; (2) changes of fire frequency in the study area are not as significant as fuel lit probability to affect forest landscape, and forest composition, age structure and distribution would be significantly influenced by the combination of fire frequency and fuel lit probability; (3) the amount of forest area would decrease, forest fragmentation would increase, and forests may become younger with increasing fire disturbances whereas, and; (4) ranges of tree species distribution would be significantly influenced, deciduous trees such as *Betula platyphylla* and *Populus suaveolens* would increase their distribution ranges, and coniferous trees (*Picea koraiensis*, *Pinus pumila* and *Larix gmelinii*) would reduce their ranges.

**Keywords:** Forest composition and distribution, Warming-induced fire regime, LANDIS PRO, Daxinganling Mountains

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## Developing Conservation Strategy for Freshwater Ecosystem in North China Plain

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Freshwater ecosystem has received an increasing attention due to its globally continuing decline, but mostly it still protected within terrestrial conservation framework, lacking of specific conservation framework and tool (Linke et al 2008). We therefore explored a freshwater specific conservation strategy demonstrated by a case in North China Plain ( $4.84 \times 10^6 \text{ km}^2$ ), where the freshwater ecosystem is composed by a large area of interbasin floodplains of three large rivers in North China (i.e. Yellowing river, Huaihe River and Haihe river, creating a globally important biodiversity and substantial ecosystem service but under constant human threats from intensive socioeconomic development). Our conservation strategy highlighted the fundamental difference between freshwater and terrestrial ecosystem in that: 1) integrate riverine and nonriverine wetlands into conservation assessment to maintain their interdependence probably undermined by prevailing separate assessment, 2) integrate longitudinal (upstream-downstream), lateral (riverine-floodplain) and vertical (surface water-groundwater) connectivity into conservation targets to address inherent connect nature of freshwater ecosystem (Fig.1); 3) incorporate artificial freshwater targets to accommodate the interbasin conservation needs of ongoing world largest water project in North China Plain, i.e. South-to-North Water Diversion Project. We developed this freshwater specific conservation strategy by innovatively applying approaches well suited for terrestrial ecosystems, e.g. systematic conservation planning and its tool-Marxan (Margules and Pressey, 2000; Margules and Sarkar, 2007). Key outputs included existing conservation gaps, proposed conservation targets and optimal conservation pattern of freshwater ecosystem based on different conservation strategy (Fig.2). Our novel approach and conservation strategy enables managers to set ecologically meaningful spatial conservation priorities for freshwater ecosystem in North China Plain.

**Key words:** freshwater ecosystem; conservation strategy; North China Plain



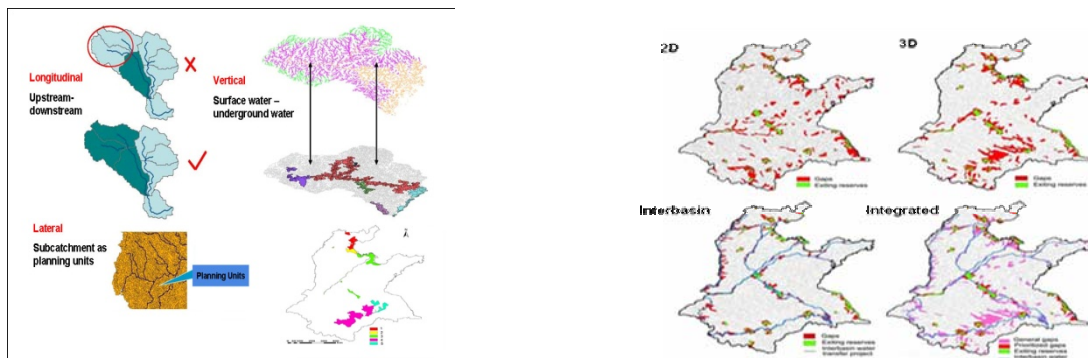


Fig. 1 3D connected nature of freshwater ecosystem. Fig. 2 Optima freshwater conservation pattern for different strategies in North China Plain.

## Climate Change Vulnerability of Representative Endemic and Endangered Species in China

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We assessed the climate change vulnerability of 220 endemic and endangered species in China, as a core part of the project Development of National Biodiversity and Climate Change Strategy and Action Plan (NBCCSAP). Based on the China Species Information System (CSIS, [http://www.baohu.org/csis\\_search/search1.php](http://www.baohu.org/csis_search/search1.php)), we selected representative species as analysis targets, covering various taxa including mammals, birds, reptiles, amphibians, insects, and plants.

We applied nine modes in BIOMOD (a package of R software) (Thuiller et al. 2009) to predict the current and future (i.e. 2020, 2050, and 2080) distribution ranges of these species using five climate variables (i.e. annual minimum temperature, annual maximum temperature, seasonal variance of temperature, annual total precipitation, and seasonal variance of precipitation) based on CGCM2 climate model A2a emission scenario (IPCC 2007) in WorldClim database (Hijmans et al. 2005). The nine models are Generalized Linear Models, Generalized Additive Models, Classification Tree Analysis, Artificial Neural Networks, Mixture Discriminant Analysis, Multivariate Adaptive Regression Splines, Generalized Boosting Models, Random Forest, and Surface Range Envelope. The nine models showed differences in predicted ranges, weights of explanatory variables, and goodness-of-fit (based on ROC curve and Cohen's Kappa index), and model selection for a certain species was based on the model's goodness-of-fit. The Random Forest has the highest model performance for most species, and the Artificial Neural Networks ranks the second.

Different species have diverse range shift potential in the future. In general, species occur in south China would have a northward range shift; species endemic in Tibet Plateau would have smaller ranges. We developed a species conservation priority index using the ratio of range shift, species mobility, conservation status (IUCN 2004), and endemism (Wang and Xie 2009) as parameters, in order to guide national conservation actions. Some endemic reptiles, amphibians, and plants with high potential range shift have the highest conservation priority.

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## Net Anthropogenic Nutrient Accumulation in Beijing, China

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The raising anthropogenic input of nutrient strongly affects the health of terrestrial and aquatic ecosystems (Howarth et al., 2005). We estimated net anthropogenic nitrogen and phosphorus accumulation (NANA and NAPA), as an index of nitrogen (N) or phosphorus (P) pollution potential in the Beijing metropolitan region, China (Han et al., 2011a; 2011b). The NANA estimation was based on an inventory of atmospheric N deposition, N fertilizer use, consumption of human food and animal feed, N fixation, and riverine N import and export. The NAPA was based on an inventory of P fertilizer use, consumption of human food and animal feed, non-food P, and riverine P net flux. We calculated N and P accumulation values for the years 1991, 1997, 2003 and 2007. The average NANA values for the urban and suburban areas from 1991 to 2007 were 24038 kg N km<sup>-2</sup> yr<sup>-1</sup> and 13090 kg N km<sup>-2</sup> yr<sup>-1</sup>, respectively. The average NAPA values for the urban and suburban areas from 1991 to 2007 were 5526 kg P km<sup>-2</sup> yr<sup>-1</sup> and 718 kg P km<sup>-2</sup> yr<sup>-1</sup>, respectively. Both NANA and NAPA were higher in eastern and southern areas than in northern and western areas, and higher in the urban area than in the suburban area. The NANA had a declining trend from 15187kg N km<sup>-2</sup> yr<sup>-1</sup> in 1991 to 11606kg N km<sup>-2</sup> yr<sup>-1</sup> in 2007, but is still 2-5 times as that of developed countries. The NAPA showed an increasing trend from 777 kg P km<sup>-2</sup> yr<sup>-1</sup> in 1991 to 1218 kg P km<sup>-2</sup> yr<sup>-1</sup> in 2003, and then decreased to 1084 kg P km<sup>-2</sup> yr<sup>-1</sup> in 2007. The average NAPA value was about 2 times that reported in developed countries. N input from nitrogenous fertilizer is the largest source of NANA, accounting for 44.4% (6764 kg N km<sup>-2</sup> yr<sup>-1</sup>) of the total N input, followed by atmospheric N deposition and N in human food and animal feed. P input of fertilizer was the largest source of NAPA, accounting for 40.7% (455kg P km<sup>-2</sup> yr<sup>-1</sup>) of the total P input, followed by non-food P and P in human food and animal feed. Both NANA and NAPA were closely related to land use, on average 23140 kg N km<sup>-2</sup> yr<sup>-1</sup> and 5433

kg P km<sup>-2</sup> yr<sup>-1</sup> in densely populated developed land, 17904 kg N km<sup>-2</sup> yr<sup>-1</sup> and 503 kg P km<sup>-2</sup> yr<sup>-1</sup> in agricultural land and 10445 kg N km<sup>-2</sup> yr<sup>-1</sup> and 84 kg P km<sup>-2</sup> yr<sup>-1</sup> in forest land. Human population density was the best single predictor of NANA and NAPA. Our findings provide insights for the potential impact of anthropogenic nutrient inputs on environmental problems, such as nation-wide water quality degradation under the current rapid urban expansion in modern China.

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## Landscape Threshold in Peri-urban Zone: A Non-linear Relationship between Landscape Metrics and Water Environmental Quality

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In China, concern is growing with regard to environmental issues related to the growth of peri-urban zones. We performed a study in a human dominated area of eastern coastal city of China, Lianyungang, a seaport city in Jiangsu Province. Within the context of Lianyungang's peri-urban development, the all of peri-urban regions are divided into two spatial domains: center-adjointed peri-urban zone and non-center-adjointed peri-urban zone). Changes of landscape pattern from 2004 to 2008 in Lianyungang were analyzed by FRAGSTATS with seven metrics in these two zones—total class area (CA), percentage of landscape (PLAND), largest Patch Index (LPI), edge density (ED), area-weighted mean shape index distribution (SHAPE\_AM), patch cohesion index (COHESION), shannon's diversity index (SHDI). The results would reveal the effects and impacts of urban development on the peri-urban regions, including spatial and temporal change of land cover in different scales. Based on the landscape metrics analysis, the paper also attempts to investigate ecological threshold characteristics embedded in the land cover change over time. We choose salt wetland as a typical landscape to explore the relationship between wetland environmental indicators and features of urban built-up fragments (area, isolation, shape), in peri-urban areas. Due to the presence of environmental thresholds, we evaluate the relationship whether might be non-linear between fragmentation and water environmental quality. The thresholds might provide guidelines for urban development policy and water environmental management.

## The Characteristics of soil seed bank in the Wetland in the Downstream Region of Tumen River

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Under the global ecological trend ecological security and ecological recovery are the hot spot research in and around the world. Wetland as a special ecological system under the effect of water and land supplies huge ecological function and economy benefit. The downstream Tumen River locates on the boundary of China, DPRK and Russia as the core status of Northeast Asia ecological network. In 2009, The State Council approved "*Outline of the National Plan for the Development of Tumen River Area of Changchun-Jilin-Tumen Pilot Area*" and an urgent need appeared that is the science base ecological environment conservation and management plan.

This paper conducted researches on typical wetlands' soil seed banks (SSB) in the downstream region of Tumen River and analyzed the composition, diversity and temporal and spatial distribution of SSB in three standard plots through field investigation and germinated seeds. The results showed that there were 19 species in the SSB, with species density 1953~17750/m<sup>2</sup> and ecological dominance 0.63~0.84. The diversity index showed a relatively low value -the highest Shannon-Wiener value is 2.30. Vertical distribution demonstrated significantly obvious condition with 0~5cm having the most species. Furthermore, it still explained the germinating regulation changing over time, which provided reference for vegetation restoration using SSB.

From our study, we got the results of the soil seed stock is significant different from the wetland vegetation downstream Tumen river, so in this area the destroyed vegetation should use transplantation method to restore. In the restoration process, we should think about the transplantation and soil seed while thinking of different vegetation type and vegetation communities, at last we can get the suitable wetland plants. According to our research, we got the environmental vegetation growth curve for balancing the environmental factors to help the soil seed bank successfully applied to the wetland restoration and biodiversity conservation downstream Tumen River.

**Keywords:** Soil seed bank, Wetland, The downstream region of Tumen River, Aboveground vegetations

# The Ecological Corridor Based on Habitat Research on Amur Tiger on Dalongling

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The wild Amur tiger is endangered in China, compared to other conservation strategies protect the tiger habitat is the most important way to keep them. The most threat to tiger is the habitat loss and degrade based on the ecology knowledge of tiger we research on the Amur tiger habitat suitability in the Dalong Ling region, to support the tiger habitat science study. Radio trapper is considered to be the scientific way to collect the species data but it is expensive and time cost. This paper we use the tiger monitoring data and the livestock prey by tiger data, and the tiger habitat environmental information to the habitat model and get the potential tiger habitat and corridor.

We use the Ecological Niche Factor Analysis (ENFA) model which already used by many program compared to other model we just need the exits species data. We use more than ten geography environmental data and the tiger appear dates to the model. At last we get the important factors; they are broadleaves trees, the distance to the river, and the farm land. These factors deputy the 86% character of the habitat. And we also use the expert knowledge model to evaluate the habitat suitability. Finally we draw the tiger habitat suitability map with the GIS.

Expert information supports the drag index to the habitat. On the tiger habitat suitability map we need to connect the patch. Between the patch the drag index give the difficulty evaluate. The GIS space analyst support the cost-distance analyze to this corridor research. This give use the less costs corridor between different habitat patches. They are between Lanjia and Taipinggou, Lishugou and Xiaoliudaogou, and Hedong and Wudaogou. The evaluation and conservation to these corridors are the most important work in the future.

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# The Impacts of Long-term Harvest on Departure of Forest Landscape from the Historical Conditions in Great Hing'an Mountains, Northeast of China

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The managed forest landscape departs greatly from the natural landscape due to the long-term anthropogenic activities. Understanding the difference between natural and current conditions is increasingly important to improve forest ecosystem management. We compare the landscape undergoing rapid change due to timber harvest between 1989 and 2000 in Huzhong Forestry Bureau(HFB) to the neighboring and unaltered landscape in Huzhong National Nature Reserve(HNNR) in Greater Xing'an Mountains to assess the impacts of long-term anthropogenic activities on the forest landscape. Our object are to explore the characteristic structure of unaltered forest landscape and exam how different the managed landscape deviates from the natural one. Landscape changes were evaluated by classification area distribution, transition rates, landscape metrics related to size, density, connectivity and configuration. The results show the reserved landscape was still dominated by the original forest cover of larch(*larix gmelini*), which covered 72.5%, but almost no conversion in classification area distribution and spatial structures occurred during the study period. In contrast, in HFB, the dominative type as matrix was still coniferous forest but decreased to 47.6% in area and fragmented dramatically into more small-size patches in 1989. In 2000, the cover of mixed broadleaves-conifer forests increased to 53.4% as dominant cover type, and it showed us the pattern of only scattered, remnant patches of larch ecosystems among a greater number of the mixed broadleaves-conifer forest types. Meanwhile, the function indicators including forest age, canopy closure and area-unit stocking changed significantly in HFB. The landscape in HNNR was homogeneous with high function indicators involving age of over-mature, unit-area stocking of 120-160m<sup>2</sup>/hm<sup>2</sup> and canopy closure of 0.6-0.8 in both 1989 and 2000. However, landscape in HFB was more heterogeneous than that in HNNR in terms of function classes in 1989. Furthermore, it converted to totally distinctive homogeneous state with low function indicators in 2000. The similarity degree of landscape in HFB with reserved landscape was 70.2% in 1989 and 50.0% in 2000, indicating trend of denaturing from the natural forest. From 1989 to 2000, the reserved landscape pattern were produced by wildfires, but the disturbed landscape deviated from the natural state was created by long-term timber harvesting. This work provides a fund work for creating or applying model to simulate the long-term natural landscape variation range and restoring or enhancing the sustainability in managed landscape to make better management decisions in Greater Xing'an Mountains.

**Keywords:** Forest landscape, Great Hing'an Mountains, Historical conditions, Timber harvest, Function, Transition coefficient

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# Spatial Congruence between Ecosystem Services and Biodiversity in the North China Plain

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As ecosystem services becoming the ad hoc to researchers, their spatial pattern and relationship with biodiversity also have been kept focus on. Meanwhile, more and more studies showed the concern about the extent to which the nature reserves planning program with a relentless focus on protecting biodiversity meets the maintenance and support to ecosystem services (Turner et al., 2007; Carl et al., 2008). However the current research usually emphasizes its study on terrestrial ecosystem. Thus, the methods fail to offer the applicable guidelines to meet the demand in wetland regions. Taking North China Plain as the study area(North China Plain, the Flood plain of lower reaches of Yellow River, Haihe River and Huaihe River with the total area of 4,840,000km<sup>2</sup>, has three large river systems, involving7 provinces. Besides, it is a densely populated region as well as national socioeconomic center in China), based on GIS, we assessed and analyzed the ecosystem services in the North China Plain through lateral and longitudinal dimension (2d), as well as added vertical dimension (3d), and recognized key ecosystem services area. Then the spatial congruence between ecosystem services with biodiversity was tested and analyzed (we carried on the spatial analysis of the current distribution of the nature reserves, and then the adaptability of ecosystem services was evaluated as well). Results showed existing wetland natural reserves have little ability to capture key ecosystem services area, and there are lots of important key ecosystem services gaps (Fig 1.). Furthermore, the spatial congruence between them suggested that 3D is more practical than 2D to key ecosystem services protection (Fig 2.), which is similar to hot area in conservation biology. So the systematic conservation planning theory could be introduced to the ecosystem services protection in the future, integrating them together as conservation target.

**Keywords:** Wetlands ecosystem services, Biodiversity protection, Spatial congruence, Ecosystem services gaps

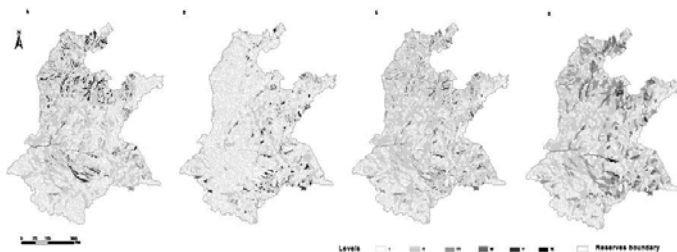


Fig1. The spatial pattern of North China Plain ecosystem service

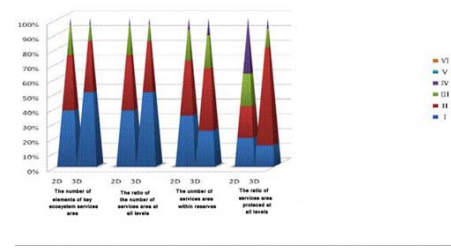


Fig2. Analysis on proportion of biodiversity conservation and ecosystem services

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## Responses of Tree Species to Climate Warming at Different Spatial Scales

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Tree species respond to climate change at multiple scales (Hansen et al., 2001), such as species physiological response (quantified by species establishment coefficient) at fine scale and species distribution (quantified by percent area) at broader spatial scale. At a given spatial scale, species physiological response and distribution can be correlated positively or negatively. The consistency of such correlation relationships at different spatial scales determines whether species responses derived from local scales can be extrapolated to broader spatial scales.

In this study, we used a coupled modeling approach that coupled a plot-level ecosystem process model (LINKAGES) with a spatially explicit landscape model (LANDIS) (He et al., 2002, 2005). We explored species physiological responses and distribution responses to climate warming at the local, zonal and landscape scales respectively, and examined how species physiological response and distribution correlated at each corresponding scale and whether the correlations were consistent among these scales.

Our results indicate that for zonal and warming-sensitive species, the correlations between species physiological response and distribution are consistent at these spatial scales, and therefore the research results of vegetation response to climate warming at the local scale can be extrapolated to the zonal and landscape scale. By contrast, for zonal and warming-insensitive species the correlations among different spatial scales are consistent at some spatial scales but at other scales. Our results also suggest that the results of azonal species at the local scale near their distribution boundaries cannot be extrapolated simply to broader scales due to stronger responses to climate warming in those boundary regions.

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## Seasonal Dynamics of Energy Balance and Evapotranspiration in two Subtropical Mangrove Ecosystems

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Energy exchange between canopy and atmosphere is one of the most important processes in ecosystems, which affects other processes such as water transport, carbon assimilation, etc. Evapotranspiration (ET) also affects the water and heat balance of an ecosystem. Despite of importance roles mangrove forests play in regulating matter exchange in the coastal zones, there are still limited studies on energy balance and ET in mangrove ecosystems. In this study, energy balance and ET variations of two subtropical mangrove ecosystems were investigated over a year period (March 1, 2010 to February 28, 2011) by eddy covariance technique in Yunxiao (23° 55'N, 117° 23'E) of Fujian province and Gaoqiao (21° 34'N, 109° 45'E) of Guangdong province, China. The annual ET was about 848 and 1210 mm for Yunxiao and Gaoqiao, respectively, which accounted for ~85 % of total long-term mean precipitation at the corresponding site. The average daily ET for Yunxiao and Gaoqiao were 3.29 and 5.10 mm d<sup>-1</sup> in summer (June-August), but reduced to 1.36 and 1.76 mm d<sup>-1</sup> in winter (December-February), respectively. The seasonal variation of the energy flux was caused by the changes in the change in net radiation of two sites, which explained 74~83 % of the variation in the sensible heat and latent heat fluxes. In the summer, latent heat dominated the energy flux, and Bowen ratio was fluctuated from 0.3 to 0.5. While in the winter, Bowen ratio increased to 1.2. During the summer daytime, the decoupling coefficient value decreased from 0.7 to 0.4 from morning to afternoon. In the winter, however, the decoupling coefficient of mangrove ecosystem was low at ~0.3. These results suggest that plant physiology plays an important role in regulating ET and energy balance in the summer afternoons and on winter days, while other factors are more important for these processes in other time periods.

## Spatial Variability of Urban Functionality and its Impact on Carbon Balance

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Humanity today is experiencing a dramatic shift to urban life and city has become an increasing source of green house gas (GHG). Through comparing carbon emission from the different social economic activities and carbon sequestration from the five remnant natural

ecosystems (Forest, marine, surface water, wetland, and farmland) in an urban complex ecosystem, this paper quantitatively estimated the input and output of carbon from a city and its different function zones. The results from the case study of Xiamen, a coastal city in southeastern China showed: In 2007, the carbon balance of the city were 9.03, which means the total amount of carbon emission from urban social economic activities was 9.03 times greater than the amount of natural carbon sequestration in Xiamen City. Without considering the indirect carbon emission from the electricity consumption, the balance of Xiamen City was 5.26. Carbon balance showed a significant variation among the six administrative districts of Xiamen City, for their difference in social economic functions and distribution of natural ecosystems. As an old industrial zone, Huli district suffered the highest carbon unbalance. Without considering the indirect carbon emission, Haicang district, a new emerged industrial area, was the worst. Located in the suburban area and possessing large area of natural vegetation cover, Tongan district and Xiangan district had the best carbon balance. In the end, the future development of carbon balance in Xiamen City was discussed, as well as the possible control measures, based on the city socioeconomic development orientation and the overall urban function zoning. We hope the paper can contribute to better understand the carbon cycle within an urban complex ecosystem, providing the scientific basis for rational urban overall planning and function division to establish low-carbon and sustainable urbanization.

## **Valuation of Ecosystem Service in a Seemly Pristine Forest Ecosystem in Northern Taiwan**

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The importance of ecosystem service is widely acknowledged but rarely valued in Taiwan. Valuation of ecosystem service help to build cases for conservation of ecosystems although currently we do not have any accurate measures of the intangible values of ecosystems. In this study, we used travel cost, market water price and cost of soil and water conservation from published data and government reports to estimate the minimum marketable and attributable values of the ecosystem service of Fushan Experimental Forest (FEF) of northern Taiwan. The total travel cost of visitors of 2009 based on the 1999 individual cost (NTD 409) was NTD 36.8 million for a total of 90,000 visitors (Chen et al. 1999). It is important to note that the visitors are only a fraction of those who applied to visit FEF due to 500 and 600 visitors allowed to enter FEF daily for weekdays and weekends, respectively. Most of the watersheds of FEF drain to Fusti Water Reservoir which contributed more than 90% of the water used in Taipei region. Based on the water fee collected by the Taipei Water Company the quantity of water drained from FEF to the reservoir has a market value of NTD 22.83 million. The economic profit of FEF on soil and water conservation is estimated by the maintenance fee for weed control, pavement, clearing of debris of landslides and the subsequent construction on preventing future landslides. Assuming that 10% of the 1000 ha of FEF is converted to roads and other non-forest land uses and the the cost for the maintenance is the same as for the roads, the soil and water conservation value is about 222.22 million. Thus the annual total

marketable and attributable values of ecosystem service provided by FEF is NTD 281.85 million or USD 9.4 million based on the NTD to USD exchange rate of 30 in March 2011. The water price in Taiwan is likely to increase, the travel cost must have increased since 1999 because the oil price increase by more than 40%, similarly the road maintenance cost is likely to increase due to the increase in the cost of labor and materials. Moreover, the market price of water is very low due to government subsidy and there is no substitute for water. Therefore, the number we get could seriously underestimate the actual number but it is a start and open for further elaboration. It is also important to note that the number represents the sum of estimated values but not the net profit. Currently there are approximately 20 researcher and staff, more than 10 part time workers and some 20 volunteers working at FEF to maintain the botanic garden and provide explanatory service to the visitors. What is lacking in the valuation is the intangible values of the FEF. An endemic animal *Muntiacus reevesii* which could only be encountered by extremely lucky people before FEF is established as a nature reserve is now a daily surprise for visitors. The value of the conservation of numerous plants and animals is not included in the valuation. The use of willingness to pay could be a useful tool to get some approximates of the intangible values. Nonetheless our analysis indicates that the marketable value and attributable value of FEF are substantial and can be used to justify the maintenance of its current state even when only economic value is considered.

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## **Dynamic Variation Analysis of Landscape Spatio-temporal Pattern in Desert and Oasis Areas—A Case Study in Linze County, Gansu Province**

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With harsh natural condition and high-intensity impact of human activities, the ecological environment is extremely fragile in desert and oasis areas. Studying the landscape spatio-temporal pattern benefits to assess relationship between ecological environment and human activities correctly, and it is valuable to region ecological environment evaluation and analyzing its development trend. It also provides a reference for making reasonable use of land resource and sustainable development of landscape pattern in arid areas.

With support of RS and GIS techniques, basing on TM images obtained in 1986, 1996 and 2009, taking the desert and oasis areas in the middle of Heihe River Watershed which as a research area, using five common landscape indices (patch area, patch number, landscape fragmental dimension index, landscape contagion index and Simpson diversity index), this paper analyzes the main characteristic and dynamic variation of landscape. The result shows that: In early years, with the patch number increasing, the farmland fragmentation became obvious and a number of farmland split to tiny parts. Then, large patches became as close as

stable but small patches gradually disappeared. Patch number and area of woodland/grassland continued to decrease in the oasis's external and edge. Saline and alkaline land showed an expanded trend, in the first decade, the patch aggregated. After that there are fewer and fewer patches. Patch area shrank but its aggregation enhanced. Fragmentation degree of Gobi and Mountain landscape are stable, there was almost no change during the study period, but total area increased. Desert always expanded from start to end, it presented spatially the intrusion of dunes to vegetation dispersedly in the 1990s. Then, patches expanded and tiny patches formed simultaneously, they connected with each other, their aggregation enhanced. The hallmark of the water area is its increase in fragmentation degree and reduction of patch area.

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## The Effect of Landscape Ecological Structures on the Health Benefits in the Rural Areas

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In recent years, health environment, addressing either on ecological property of landscape or its relationship with human well-being, has been emphasized. Yet, there is still little discussion about integrated structure of landscape. Differing from using all types of land-use as classification of landscape ecological structure types in the past research, we focus on rural land-use and its beneficial effect on perceived health. Nine study sites were chosen from rural areas of Taiwan. The landscape ecological structure indices were then calculated with software such as eCognition 4.0, ArcGIS 9.2, and Patch analysis 4.0 in order to quantify landscape ecological function and naturalness level. These nine study sites were assigned to three groups according to their naturalness. After, we measured participant's psychophysiological reactions and psychological responses to these testing areas. Results of this study showed a strong relationship between psychological reactions and environmental naturalness. In addition, this study also revealed positive relationship between muscle tension reactions while viewing medium naturalness level contrasting to low level in rural areas.

Overall, the results have been consistent with past studies. To conclude, this study may be of importance in summarizing the landscape structure composition of the health environment, providing reference to related domains of research and practical applications.

## **Historical Maps – A Key for Understanding Current Species Diversity Patterns?**

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Fragmentation and destruction of habitats have been recognized as one of the major threats to biodiversity. Although species may react instantly to changes in habitat quality and landscape configuration, those effects are seldom found for species with long life span (Lindborg & Eriksson 2004, Helm et al. 2006). Extinction processes often occur with a time delay and species may survive for long time periods before they go extinct (Hanski & Ovaskainen 2002; Vellend et al. 2006). This relaxation time where declining populations eventually go extinct in fragmented or degraded habitats has been described as an extinction debt (Tilman et al. 1994; Kuussaari et al. 2009).

In order to study and understand delayed responses to fragmentation and land use change, historical data on land use and landscape configuration has become an important tool for ecologists (cf. Kuussaari et al, 2009, Cousins 2009). Here I give an overview of the use of historical maps to calculate historical land use and land use change and impact on current richness of organisms of different longevity.

In general, present-day richness of long-lived plants is better explained by past than current landscape patterns, whereas landscape pattern effects on short-lived insects showed more contradictory results. The relationship between historical landscape pattern and species richness is also explained by differences in landscape matrix, i.e. if a landscape was dominated by open crop field or forest, and when fragmentation of the landscape began.

From a management perspective, these different results indicate that strategies maintaining the status quo of fragmented habitats often are insufficient, due to occurrence of time- delayed extinctions. Thus, using historical maps in conservation management and planning is crucial for mitigating future biodiversity loss.

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## **How Topography-controlled Water Budget Determines the Coexistence of Forest and Steppe in Northern China?**

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The semi-arid forest-steppe ecotone in China is characterized by the co-existence of forest and steppe, with forest patches restricted to shady slopes. How topography regulates available water for forest distribution was answered in this paper.

We calculated evaporation as a function of slope aspect and inclination. Field vegetation records from randomly selected sites were used to test the simulated forest distribution with minimum slope inclination. Seasonal and diurnal changes of surface soil temperature and moisture of shady and sunny slopes were recorded by a U23-001 HOBO Pro v2 data logger. Soil water content was measured during two growing seasons on both sunny and shady slopes with the same forest type at three sites located along the mean annual precipitation (MAP) gradient.

Evaporation decreases with slope inclination on shady slopes but increases with inclination on sunny slopes. The shady slope received 35% of the annual direct solar radiation that was received by the sunny slope when the slope inclination was 25°, and the contrast in annual direct solar radiation between the shady and sunny slopes further widens as slope inclination increases. Steeper shady slopes can support forests in dryer climates, with log-linear regression revealing a minimum slope inclination ( $y$ ) for forest distribution along the MAP ( $x$ ) gradient of  $y = -161.01\log(x) + 433.2$  ( $P < 0.05$ ). The simulated minimum slope inclination for forest growth was larger than the observed minimum inclination, and the difference was higher in wetter conditions. A larger forest area fraction was considered to lead to a reduction in soil temperature and evaporation, as verified by soil temperature and moisture records and soil water content measurements.

The slope-specific forest distribution in the semi-arid region of China can be explained by a topography-controlled water budget. Lower evaporation resulting from lower direct solar radiation on shady slopes allows shady slopes to retain a water supply sufficient for sustaining forests. And the existence of forests on shady slopes further reduces evaporation. Different

tree species coexist at the xeric timberline due to regulation by slope inclination and aspect.

**Keywords:** Forest-steppe coexistence, Expositional forest, East Asian steppe, Water budget, Soil moisture, Slope

## **A Comprehensive Assessment of Wetlands Sustainability in an Urbanized Landscape: A Case Study of Xianlin New City, Nanjing, Jiangsu Province, China**

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Throughout the world wetlands were transformed rapidly and in different ways in urbanization areas. An understanding of these changes of wetland functions by transformations in an urbanized area is required, as they affect landscape functions and they can have far-reaching consequences for biodiversity and natural resources. In recent years there is an emerging attention for wetlands conservation in urban areas in China. The urban wetlands are increasingly involved in conservation. Careful assessment of the function changes for wetland ecosystems transformed by urbanization is essential for the evaluation of the sustainability for wetland systems. We consider three main requirements for wetlands sustainability: (1) wetland changes in landscape scale: the lost number and area; (2) ecological integrity in ecosystem scale: the maintenance of ecosystem functionality; (3) ecological coherence: the appropriate connection between wetlands. This viewpoint emphasizes the sustaining capacity of wetlands as multifunctional ecosystem. The application of these ideas implies the investigation of relationships between both the different functions of wetlands and the dimensions relevant for the evaluation of the sustainability of wetlands. We apply a multidimensional evaluation model to some characteristic wetland landscapes and compare the results with contrasting reference scenarios. The value of each dimension of sustainability is assessed using a semi-quantitative procedure. Results show that:

- (1) Urbanization processes started from 2002 to now and still on going in the Xianlin New City, Nanjing, China, has changed the landscape from a rural area to a new urban area, which resulted 56% wetlands lost in number and 18% lost in area. And the wetland multifunctional characteristics have been changed to simplification.
- (2) The ecological integrity for wetlands are declined greatly due to plant communities degradation and lost in ecosystem scale. The reduced biodiversity is the main threatening factors to wetland functions in the urbanized area.
- (3) The declined landscape connectivity in wetlands by human activity and land use is another important factor to threaten wetland ecological functions.
- (4) This analysis contributes to the discussion of consequences of China policies on the conservation of wetlands in an urbanized landscapes.

**Keywords:** Wetland, Ecological integrity, Ecological coherence, Urbanization

# **Integrating Landscape Ecology and Public Policy for Sustaining Coupled Human and Natural Systems**

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Coupled Human and Natural Systems (CHANS) are integrated systems in which human and natural subsystems interact (Liu et al. 2007a,b). Landscapes are examples of CHANS. They vary over time and across space due to factors such as public policy. Policy changes and landscape dynamics may form complex feedback loops – the former result in changes in landscape structure and function, which may in turn prompt the government to develop new policies (Liu 2010). However, many policies were developed without considering landscape conditions and consequences, and much knowledge in landscape ecology has not been incorporated into policies (Liu and Raven 2010). To sustain CHANS, it is necessary to integrate not only policies that directly affect them, but also those that affect them indirectly. For example, divorce is an increasingly strong force behind global household proliferation (rapid increase in the number of households, Yu and Liu 2007, Liu et al. 2003), which causes cascading effects – more housing units, more conversion of landscapes and other resources for residential use, and more landscape degradation and fragmentation (Liu et al. 2001, Peterson et al. 2008). Policies on divorce and many other societal issues that are seemingly unrelated to landscape ecology have important implications for the landscape ecology community.

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## **Study on Ecological Effect of Green Space in Beijing City, China**

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Urban green space can slow down Urban Heat Island Effect, in order to explore the ecological impact regular pattern of urban green space, the study began from June 2008 to August 2009, 30 selected parks in Beijing as observation points, respectively, in the park, the park at different distances location, for temperature and humidity observations and meteorological factors, analysis of temperature and humidity differences in different monitoring sites.

The results show that: (1) The results of the 30 parks observation tests showed that, the temperature the majority of the inside park below the outside park, proved to be "cool island" effect, the humidity of the outside park is higher than that of inside, to be "wet island" effect. However, there are several parks in the surrounding temperature is higher than the temperature, humidity lower than the ambient temperature. During the summer, the average temperature of the smaller park inside is higher than the surrounding environment of the park; (2) Beijing humidifier cooling of urban green space and park area of the role of the response relationship between the cooling intensity and the size of the park has a certain relationship. By regression analysis, the intensity of humidifier and cool of park has a linear correlation to park area, the levels of the linear correlation was significant.

Different size park of temperature and humidity were analyzed in this study, to the use of ecology, landscape ecology, urban ecology, put forward for the smallest ecological patch area of urban green space in Beijing, and explore the ecological impacts domain, taken as the ecological assessment indicators of urban green space, provide a scientific basis of decision-making for urban planning, land management, the construction of human settlements, and so on.

**Keywords:** Temperature and humidity, Urban green space, Urban heat island, Patch, Influence domain

## **The Increased Vulnerability of China's Agriculture Ecosystem Driven by Land Use and Climate Change and its Adaptation Strategy**

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Arable land area shrinking and food security are highly concerned in China. Human activities played an important role in the drastic change of cropland in recent decades, particularly in semi-arid and arid area in China. We used remote sensing techniques in cropland dynamic monitoring since the late 1980s, and found that cropland area increased, mainly in North China, by 17667 km<sup>2</sup> during 1995-2000, and decreased, mainly in South China, by 6365 km<sup>2</sup>

during 2000-2005. Cropland barycenter turned to low temperature and precipitation region in northeast and northwest China. In the same time, under the background of global warming, the vast area shows increment tendency of temperature in China in recent 30 years. 72.48% area of terrestrial land represents warming and drying, and 27.31% warming and humidifying in China. The results show that China's arable land vulnerability is increased during past 20 years due to land use and climate change, especially in northern China. From late 1980s to 2005, the total net increase of cropland was 23433.60 km<sup>2</sup>, 94% of that was in semi-arid and arid area, and 86% of that in warming and drying area. After combining of the two regions, the results show that cropland area increased by 9011.10 km<sup>2</sup> in sub humid, warming and drying area, 9403.19 km<sup>2</sup> in semi-arid, warming and drying area, and 2789.43 km<sup>2</sup> in Arid, warming and drying area.

In the face of increased vulnerability of China's agriculture ecosystem driven by land use and climate change, study on adaptation strategy should be promoted. Adaptation mechanism and methodology need to be developed to adapt the global and regional climate change, and to mitigate arable land vulnerability. First, we need to promote high-effective intensive farmland water use management pattern. Second, we could carry out ecology protective farmland managerial techniques, including protective cultivation and boundary ecosystem construction in farmland. Third, we could use advanced irrigation technologies, like sprinkler irrigation and drip irrigation. Our results show that the integrated adaptation management pattern and technology can increase crop yield, decrease water consumption, and mitigate arable land vulnerability significantly.

**Keywords:** Land use, Climate change, Vulnerability of agriculture ecosystem, Adaptation strategy

## **Blue Water and Green Water Interactions: Global Water Use under a Changing Climate**

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An accurate estimate of global water uses with high spatial resolution is a key to assessing global water scarcity and to understand human's interference with the ecosystems. In spite of the progress made previously, there are not sufficient studies on spatially explicit assessment of both green and blue water uses, in particular in the context of climate change. In this article, we aim to estimate consumptive green and blue water uses in cropland ecosystems on a global scale with a spatial resolution of 30 arc-minutes. A GIS-based Environmental Policy Integrated Climate (GEPIC) model is used for the estimation. We also use the GEPIC model to study the impacts of climate change on green/blue water uses in the 2030s by considering a few climate scenarios. Previous results show that green water plays an important role in cropland ecosystems, and it accounts for 84% of the total consumptive water use. The importance of green water calls for a better management of green water, in addition to blue water.

## **Discussion the Impact of Road Corridors Effect toward Roadside Ecological Environment**

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This paper is base on the theory of landscape ecology to analyze the impact of road corridors effect toward ecological environment along the line. Road is a disturbance corridor which has all the features of corridor but also has some characteristics which only appear in road corridors. Road corridors affect ecological environment in many aspects. This paper focuses on analyzing the function of road corridors impact in terms of alien species invasion, the increase of corridor coherence and the protection of biodiversity in special areas. In addition, this paper also analyzed as a barriers, how the road corridors affect roadside ecological environment. More over, the paper also analyzed the change of community in ecosystem on the basis of function of road corridors.

**Keywords:** Road corridors, Ecological environment

## **Feasibility of Land-use Change Model Guide Regional Planning – A Case Study in Hun-Taizi River Watershed, China**

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This study addresses land-use and land-cover change (LUCC) in the Hun-Taizi River watershed, China, from 1988 to 2004. Based on remotely sensed images and geographic information systems (GIS) technology, LUCC and landscape pattern changes were investigated. Then, using the famous land use model of Conversion of Land Use and its Effects at Small regional extent (CLUE-S), land use changes were predicted in three scenarios considering land use planning and ecological protection over the next 20 years. Three scenarios were set for changes in future land use: historical trend (HT), urban planning (UP), and ecological protection (EP) scenarios. The predicted result in UP scenario was compared with the planning picture to assessment the feasibility of land use model guide regional planning. Results showed that forest, glebe, paddy, and shrub land were the main land-use categories. Paddy and glebe being converted to urban areas and rural settlements characterize the landscape change from 1988 to 2004. The main land-use categories change over time. Landscape-pattern fragmentation will be worse in HT and UP, though better in EP. The comparing results of predicted map with planning map show that land-use model is powerful tool for regional planning. Land use scenarios can support regional planning and police-making through analyzing future consequences scientifically.

**Acknowledgements:** This project were Supported by the National Natural Science

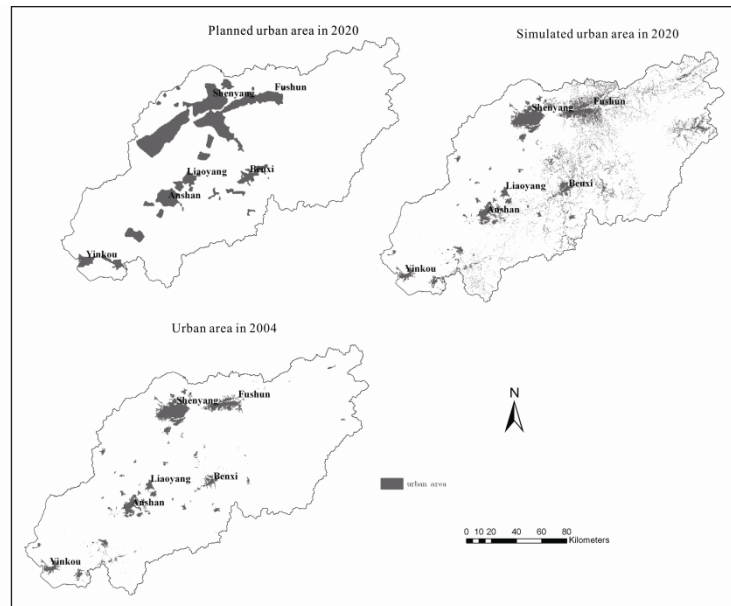


Figure 1 Comparison of planned urban area and simulated results

## The Role of Traditional Knowledge in Forest Resources Conservation in Ethnic Areas —Taking Xiaohuang village in Congjiang County, Guizhou Province as a case

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This paper chooses Xiaohuang which is a Dong community located in Congjiang County, Guizhou Province as a sample-village. Based on analysis of the data from forestry sector and survey, three village-level forest maps of different periods over the past 60 years are made by the local public through Participatory Rural Assessment (PRA). Quantitative analysis on the maps by ArcGIS software shows the change of forest resources from the forest area, forest species composition and age structure. The results are shown as follows: 1) before 1950s, the forest coverage rate was 89.1%, occupying most of the land in Xiaohuang village, and Fengshui woods, water resource conservation forest, fire woods, and distant primeval forest were the four basic forest types with a large amount of trees aged over 100 years old in existence; 2) compared to 1950s, the area of woodland decreased badly with the most land-use of Xiaohuang turned out to be wasteland between 1958 and middle 1980s, and the old trees rarely lived; 3) after the later 1980s, the wood area was increasingly added and the

forest coverage rate recovered to 70.03% in 2007. Current forests consist shelterbelt wood, timber stands forest, economic forests and firewood forest, while old trees has been taken place by those aged below 30 years old. Meanwhile, through literature review, field survey, key informant interview, field survey and the method of weighted average index analysis, major driving factors of the forest change are selected and sorted. The results show that only behind the government policy, Dong customary law, religious and traditional knowledge of forest practices occupy the second most important position.

This traditional ecological knowledge system, which had conducted an abstentious way of forest resources use, have been effective in sustention to ensure the stability and longevity of the agriculture and forestry ecological system. The result of this study also shows that the traditional knowledge has an intimate connection with forest change. The local worship of old trees and custom of reservation of Fengshui forest and water source woodland, had played a significant role in forest resources protection, utilization and management. Under the general circumstances, the forest resources that are well protected and developed always mean that the role of traditional knowledge has been fully played; but when the serious damage of forest resources happens, the role of traditional knowledge is often restricted. Therefore, it is necessary to value the traditional ecological knowledge, and further research and evaluation should be conducted in order to balance the contradiction between development and environmental protection for reference.

**Keywords:** Traditional knowledge, Forest change, Dong community, Congjiang county of Guizhou Province

## **Impact of Road Networks on Conservation at Landscape Scale in Yunnan Province**

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Biodiversity conservation has become a hot issue for promoting sustainable development. The reduction of habitat area and connectivity is currently considered as a major threat to biodiversity conservation. Road networks contribute significantly to a decrease in both the quantity and the quality of such habitat. Understanding the impact of road networks on biodiversity at variable scales is important for mitigating threats to species conservation at multiple levels of management. Taking Lancang River Valley of Yunnan province as a case study area, we conducted this research focusing on both the impacts of road networks on habitat loss, connectivity loss and biodiversity change. Our findings indicate that (1) forest habitat larger than 25 ha decreased in area by 18.3% due to fragmentation from 1997 to 2007; (2) relative forest biomass represented by NDVI decreased by 66.0% resulting from a 98 % conversion of patches from forest to shrub; and (3) connectivity loss was 91.3% within the road-effect zones. We conclude that road network expansion resulted in habitat fragmentation and degradation and landscape connectivity loss. Forest species under the most severe influence of the road networks were those relying on the large forest patches with distance

ranging from 360m to 720m to roads, altitude from 2025m to 2300m, in the southern and western part of the study area. The 12-km long dispersal movement of those species was disturbed more seriously.

**Keywords:** Biodiversity, Road effect zone, Fragmentation, Landscape connectivity

## **Hydrological Impacts of Large-scale Afforestation and Reforestation under a Changing Climate, a Case Study in China**

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Large-scale afforestation and reforestation have been widely implementing since the late 1980s throughout the China as a key way of improving ecological environments while increasing terrestrial carbon sink to mitigate the climate change. However, the hydrologic effects of reforestation and afforestation and the land availability and suitability for reforestation and afforestation are increasingly concerned in China. There is an urgent need to study reforestation hydrology and impacts of climate change on forest-water relationships at multiple scales, which aims at providing a scientific basis for optimizing spatial pattern of reforestation and afforestation under changing climate. In this paper, we analyzed the land suitability for afforestation and reforestation and its potential impacts on regional water balance in China. The results show that most of the suitable lands are located in Southern China. In Western China, however, relatively few land is suitable due to its low Aridity Index (AI<0.65) and high elevation (>3,500 m). In Northern China, as the majority of the lands are used for agriculture the remaining available land for forestation is relatively scarce. For example, the remaining available land in Inner Mongolia is largely unsuitable for afforestation and reforestation due to the limitation of low annual precipitation (Mean annual precipitation<400 mm). At the same time, forestation in Northern China is very likely to be vulnerable to climate change than that in South of China. Land use and land cover changes resulting from adopting afforestation and reforestation programs for mitigating climate change will lead to alterations of hydrological processes in terms of evapotranspiration and runoff. Water yields of both vapor flow and runoff are quantified and mapped under different climate scenarios in this paper. The projection results indicate that the large areas deemed suitable for afforestation and reforestation would exhibit significant increases in ET and/or decreases in runoff. Increase in annual ET is high in south while low in north with significant variations. This demonstrates that it becomes increasingly urgent to assess the impacts of afforestation and reforestation on regional water resources and hydrological processes under a changing climate.

## **Responses of Forest Vegetation and Hydrological Processes to Climate Change in a Large Watershed, Mingjiang River, China**

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In the context of global change, the impacts of climate change, in particular, increasing temperature and changing precipitation on vegetation and hydrological processes at a large river basin scale have been increasingly concerned in recent decades. However, it is very difficult to determine the pure effect of vegetation change, especially vegetation functional activities on hydrological processes because the complex and interactive impacts of climatic change and vegetation change on watershed hydrology. Climatic change is very likely to directly alter the timing and magnitude of hydrological processes, which is, at the same time, indirectly affected by changes in vegetation phenology, growth and productivity due to climate change. The understanding of interactive mechanism of vegetation and hydrological responses to climatic change is of significance to assess and predict impacts of climate change and land use and land cover changes on hydrological processes and water resource at large watershed. Upper Minjiang River (UMR) basin in the southwest of China is a region where climate change is manifested as UMR lies in the transition zone from Sichuan basin to Qinghai-tidbit plateau and land use/land cover change was intensified as the result of heavy forest logging. In this paper, long term NDVI data based on remote sensing are employed to detect vegetation activities and further incorporated into hydrological model to ascertain the long term response of runoff to changing environments in terms of climate change and forest cover change in UMR basin.

## **Take the Concept of Landscape Ecology, Optimize the Land Use Structure to Create a New Landscape---- Examples Zhouning County**

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The land use structure not only determined the landscape form, but also influence the peoples' happiness. So, it is vital important to do the land use structure well. Take Zhouning County for an example to create a new landscape by optimizing the land use structure with the concept of landscape ecology. Now we have the Zhouning County's map of The Second Countrywide Land Survey, we expect to take the concept of landscape ecology—the substrates, the patches and the corridors, to discuss the field of the urban area of zhouning

county, according to the principle of protecting farmland and restricting construction-land. From three scopes—the scope of Zhouning county basin, the scope of the planning urban outline and the scope of the have been built urban area, to allocate how to use different lands. Make buffer zones for the blue corridors and the places of interest, to build green channel and barrier for them. In order to achieve coordinated development between urban and rural areas in the Zhouning county basins, intensive use all the land of the planning urban area, restore the land ecological in the have been built urban area, finally to form a new pattern with beautiful environment, abundant material and unimpeded information flow.

**Keywords:** The land use structure optimization, Landscape ecology, Landscape pattern, Zhouning County urban area

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## **EcoServ: Towards a Community and Web-service-based Modeling System for Quantifying Multiple Ecosystem Services Simultaneously**

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Simultaneously quantifying multiple ecosystem services is required for making informed management and policy decisions. Often, this requirement cannot be met because of the complexity involved in optimizing diverse ecosystem services simultaneously and the lack of adequate modeling systems. Developing such a modeling system has been challenging because it requires participation and collaboration of scientists and practitioners from many different disciplines. In order to address these issues, we are developing an ecosystem services model (EcoServ) following three guiding principles. First, the development of EcoServ is envisioned to be an open-source community effort. It relies heavily on existing



disciplinary models, web services and visualization technologies, and datasets from both ground and satellite observations. EcoServ should be staged on the Internet using open-source data and model sharing technology to accommodate a variety of algorithm developers, data providers, and users. Disciplinary models within EcoServ should be integrated and tested, modified if necessary, for landscape and regional applications. Data-model fusion techniques should be implemented in EcoServ to automatically improve the modeling system and to constrain model simulations using observations from satellites and ground monitoring networks. Second, EcoServ should support monitoring and diagnostic analysis (e.g., how ecosystem services have been affected by historical land use practices and climate?). For example, it should generate performance reports for specific land use practices and policies to satisfy agency reporting requirements and facilitate agency-specific adaptive management and policy goals, using monitoring signals or data from specific areas (for example, lands enrolled in the Conservation Reserve Programs) as input. Third, Ecoserv should be able to forecast changes in diverse ecosystem services in response to proposed policy change or other changes of interest such as climate and land-use (e.g., biofuels) futures.

## **Spatio-temporal Variability of Soil Profiles Nutrients in Karst Peak-Cluster Depression Area of Northwest of Guangxi, China**

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Understanding the content of nutrient in soil profile is crucial for assessing the soil nutrient pools in different scales and realizing the character of nutrient distribution in vertical stratification. However, comparing with non-karst regions, lack of data on soil nutrient distribution in the profiles under different vegetations has identified as one of the major knowledge gaps in soil science. Therefore, this study aimed to partially filled this gap and attract the concentration on soil nutrient in profiles in karst regions.

In order to explore the temporal and spatial variability of soil nutrient and its controlling factors, for each vegetation (grassland, shrubland, plantation forest, original forest), three sample lines were designed, and three or four sampling ditches were dug from foot to top of the slope respectively. Meanwhile, the ditches were excavated layer by layer: 0-10, 10-20, 20-30, 30-50, 50-70, 70-90, below 90 cm. Analysis of variance (ANOVA) was utilized to analyze the differences of nutrient contents for different vegetation types, depths and topographical attributes, respectively. The results showed that for all four vegetation types, soil organic carbon (SOC) and total nitrogen (TN) were decreased with depth deepening, yet there was no significant difference among layers below 20 cm ( $P > 0.05$ ). On the contrary, total phosphorus (TP) and total potassium (TK) were increasing with depth deepening, and there was no significant difference among all the layers ( $P > 0.05$ ). For the physical properties, there was a little change in soil clay content below 30 cm, besides, the extent of clay content among 0-30 cm layers in original forest was larger than the other three, which is due to less

interference in original forest. In the same depth layer, there was significant difference among various vegetation types in total nutrient, such as SOC, TN, TP and TK ( $P < 0.05$ ). Concerning available nutrient, including AN, AP, there was no significant difference below 30 cm among four vegetation types ( $P > 0.05$ ), and the same situation occurred below 20 cm in AK and pH. Concerning the above mentioned, we conjecture that the soil depth affected on available nutrient by vegetation was 20-30 cm, and the total nutrient influenced was up to 50 cm or deeper. In this paper, the distribution of SOC in profile fitted logarithmic curve, and this is helpful to assess carbon storage accurately in karst region.

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## A Sub-pixel Approach for Urban Vegetation Mapping

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Information on the spatial distribution and abundance of vegetation is critical for assessing urban ecological conditions. However, mapping urban vegetation can be difficult due to the complexity of urban landscapes and the spectral similarity between different vegetation types. In this study, we have identified a sub-pixel based approach for urban vegetation mapping from medium-resolution satellite imagery whose large share of mixed pixels has challenged many pixel-based approaches. Our sub-pixel approach is based on the use of spectral mixture analysis (SMA) that has been widely applied to classify urban land use and land cover (e.g., Small 2002; Powell et al. 2007). However, the ability of the sub-pixel classification technique for discriminating vegetation various types is challenged by a number of problems, such as the number of endmembers, spectral confusion between different vegetation types, among others (Myint 2006). Therefore, it is necessary to develop improved strategies for accurate urban vegetation mapping at the sub-pixel level. In this paper, we have explored the usefulness of combining different ancillary information with the sub-pixel analysis to map urban vegetation types with the Atlanta metropolitan area as a case. A spatial stratification strategy is applied to capture the different landscape composition characteristics over the entire study site. Multi-temporal remotely sensed data are used to examine vegetation phenomenological characteristics that help differentiate certain vegetation types. Our initial results have been quite encouraging although some further improvements are needed.

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## **Disentangling the Proximate and Root Causes of Dynamic Forest Cover Changes in Wolong Nature Reserve, China**

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Changes in forest cover are usually driven by a mixture of interacting proximate and root causes that vary in time and space according to specific human-environment conditions. Proximate causes are human activities that directly act on forests such as timber extraction, agricultural expansion, and infrastructure development. Root causes are the underlying socioeconomic, institutional and policy factors that drive human decision-making regarding forest land use. We investigated the dynamics of forest cover in Wolong Nature Reserve, China during six periods (1965, 1974, 1987, 1994, 2001, and 2007). Part of the Southwestern China mountains global biodiversity hotspot and the Sichuan Giant Panda Sanctuary world heritage site, the reserve hosts diverse fauna and flora including the world's largest wild panda population, but has suffered from deforestation throughout the 20<sup>th</sup> century. A historical domestic timber extraction zone was delineated based on information on local human activities. Rates of change of forest cover inside and outside the zone at each period were evaluated. While rates of forest loss from 1965 to 1994 were more than four times higher inside the zone than outside, forest transition started earlier inside (1994-2001) than outside (2001-2007). Key stakeholder and local household interviews were conducted to understand local land-use decisions in different periods that led to the observed forest cover changes. A set of root causes that interact in specific contexts at the local, regional, or global scale, including improved income and energy opportunities, outside policy intervention and changes in social organization, resource access and attitudes, were identified as influential on forest-use decision making. The importance of distinguishing proximate and root causes of land use/cover changes on the long-term sustainability of forest ecosystems is discussed.

**Keywords:** China, Forest cover change, Land use/cover change, Proximate and root causes, Wolong Nature Reserve

## **Indicating Landscape Resilience for Enhancing Adaptive Management: Case study on Grassland Ecosystem in North of China**

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Declining ecosystem production is as a part of ongoing land degradation process, while, the

degradation crisis originated both from stress and changes to natural system and from the increasing vulnerability in adaptive to the changes. In a time of crisis, landscape production is sensitive to the changes, the need for environmental rebuilding, sustain ecosystem services and improve ecological recovery urged for better adaptive options, or in other word for building up a more robust ecological-economical resilience.

This paper starting with a theoretical discussion by providing a theoretical framework to illustrate the interactions of fundamental terms in the study, bridging up the gaps between ecosystem equilibriums and resilience under disturbances, connected ecosystem health with ecosystem functions and structures by developing a list of indicators. Two basic questions we mean to answer in this paper: firstly, is it possible to find a minimum set of indicators to measure the organizational state of ecosystems in responding and adapting to external disturbances? Secondly, what are the ultimate determinates of landscape resilience and their tradeoffs?

Therefore the correlations among candidate measures such us indices of landscape structure, climate, vegetation, and primary production were analyzed to bridging ecosystem production and systematically resilience. Throughout the systematically introduction of key terms and theories, we proposed the production and resilience linear relate hypothechs, thereafter an attempt in grassland ecosystem to put theory into practice on the ecosystem and on the landscape scale. Grassland degradation is considered one of the most severe environmental problems in the north of China, especially in the arid and semi-arid area of pastoral-agricultural Eco-tone located in Inner Mongolia Autonomous Region. The local governments have established year's sustainable management initiatives, which produced more adaption to drought and sand stress.

Based on statistical and remote sensing technique, land use and land cover, together with social-economic data were developed in ARCGIS 10patial analysis tools relationships and tradeoffs were built by SPSS Structural Equation Modeling AMOS 17.0. Thereafter, remarks and discussions on resilience study from an ecosystem production will be drawn.

**Keywords:** Landscape Resilience, Ecosystem services, Ecosystem production, Adaptive management

## **Landscape Pattern Changes in the upper Laodao River Catchment**

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The research on landscape pattern changes is one of the hottest topics in recent decades. There have been many reports on the analysis of landscape pattern changes in the hilly red soil regions in subtropical china, but few of them are at catchment scales. Therefore, in this paper, we examined the land-use/land-cover changes over the last 80 years in the upper Laodao river

catchment in Hunan Province, China, and also explored the driving forces for the land-use/land-cover changes accordingly.

Four land-use/land-cover maps covering the study area (135 km<sup>2</sup>) and spanning the temporal frames of 1933, 1955, 1990 and 2005, and within three administrative districts (AD) (Jinjing, Guanxia and Huinong) were used. Landscape structure metrics analysis was carried out on the raster data with a spatial resolution of 5 m by using the computer program of FRAGSTATS 3.0. The indices used in the analysis were landscape shape index (LSI), largest patch index (LPI), fractal dimension index (FRAC), contagion (CONTAG) and Shannon's diversity index (SHDI). A partial triadic analysis was also made for investigating the spatiotemporal structure of the study area (Ernault *et al.*, 2006). Finally, we unearthed the more important driving forces from 12 environmental factors.

The results showed that from 1933 to 2005 the same landscape pattern has emerged since 1933, even though a major trend was observed, which consisted in presenting a decrease in the forest area resulting from an increase in arable land. Overall, there were 12.7 km<sup>2</sup> of forest lands converted to paddy fields, accounting for 13% of the total forest area in 1933. The landscape indexes analysis demonstrated that the landscape became more heterogeneous from 1933 to 1990, and the patch fragmenting trend showed reasonably stable since 1990. Compared with other ADs, the Jinjing district showed a contrasting trajectory in the temporal trend of LPI, indicating a distinct urbanization there since 1990. In the Guanxia district, there was a different temporal trend in respect to FRAC, suggesting that the district was experiencing a disordered development and thus a comprehensive planning should be concerned. The predominant driving forces for the land-use/land-cover changes were the land terrain and governmental decision-making. The human activities, i.e. the rapid population growth and migration, might also be the important factors leading to the eco-environmental deterioration of the studied catchment.

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## Non-invasive Method Good for Wildlife Biodiversity Monitoring

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The Qinling Mountain is located in Shaanxi Province, China, which goes from the west to the east. It stops the warm air flow from Pacific Ocean and creates a subtropical climate locally which forms a biodiversity refuge. It has a rich biodiversity and is the northern home of giant

pandas accompanied with many other wildlife species, such as golden monkey and tarkin etc.. The global climate change has been thought to produce or have been producing influence on the Qinling ecosystems. There is a high density of giant panda, an animal very hard to spot in the wild. For monitoring the wildlife biodiversity in the Qinling Mountain with easiness and less disturbing to the animals, non-invasive method was applied. We installed 18 infra-red cameras, an effective non-invasive method, in the Guanyingshan Nature Reserve from July 2009. One of the cameras' advantages is that they can work all the time during battery working period. Many scholars have applied this method to research on population density prediction (Silver et al, 2004; Heilbrun et al., 2006).

We have 24 species photographed by cameras during 18 months. The first five species with the highest occurrence are *Budorcas taxicolor*, *Naemorhedus goral*, *Elaphodus cephalophus*, *Chrysolophus pictus* and *Sus scrofa*. In whole year, animal activity can be implied by the value of month relative abundance index with the highest values in June and July, and the lowest values in February and March. The activity pattern was not all the same for the first 5 species but all active during daytime. Species *Capricornis sumatraensis* showed its high capacity of activity during nights. We have photographed also giant panda for three times and *Panthera pardus* for one time. Our current results were based on the camera photo data collected in 18 months, which may not be enough for accurate analysis, and we need more years for wildlife population density predicting.

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## **Biodiversity Conservation in Chinese Agricultural Landscape: A View of Landscape Ecology**

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Looking back at a history of more than 7000 years of agricultural production, Chinese agriculture had succeeded in supporting China's ever-increasing human population without changing the stability of the agro-landscape. The traditional biodiversity-friendly management of agricultural landscapes incorporated various elaborate techniques such as the use of organic manure, traditional integrative farming approaches, crop rotations and intercropping ect, played important role in sustaining the stability of agricultural landscape. Unfortunately, the changes in landscape structure and function caused by ever-increasing intensity of agricultural production in latest decades have caused great decreasing in biodiversity in agricultural landscape. Except the inheritance and development of traditional agricultural landscape management approaches, landscape planning and construction could be the additional

effective measures for biological conservation in agricultural landscape. However, the relationship between landscape pattern and organisms has been weakly understood. Further investigations on the species-landscape relationships at scales including landscape level, between-field level and within-field level as well are all urgently needed. Meanwhile, policies supporting farmers in managing the agricultural landscape for biodiversity conservation and improvements of the rural landscape need to be established.

**Keywords:** Agricultural landscape, Biodiversity, Traditional agriculture, Landscape planning and management

## **Landscape Spatial Perception Evaluation Method and Application Research Based on GIS**

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Landscape spatial perception is the result of interaction between human and landscape in the range of space. From the angle of landscape site volume, study focused on the process of observer obtain landscape environment spatial information. Landscape spatial perception can be achieved for the tendency of landscape types, landscape spatial perception sensitivity and evaluation of the quality of ecological landscape. However, the researches of Landscape spatial perception in current China are still at the starting stage, which are only have few scattered theoretical framework rather than complete set of scientific system. This paper summarizes the development of the Landscape spatial perception theories, expounds the theory of the formation factor, and puts forward research contents and methods on theory of Landscape spatial perception based on the result of former research. Using GIS technology with mathematical methods to quantitatively analyze the impact of spatial awareness, through the way of hierarchy analysis and experts assessment to achieve the goal of the evaluation and classification of visual perception. And prompt the scientific factor came from Chinese traditional geomancy and Fengshui theory a new vitality in landscape ecology and environment construction. Propose the development tendency that application field of Landscape spatial perception so that establish a complete theoretical system, making this theory could apply and develop in visual landscape evaluation and landscape planning.

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# **Environmental Effects on Water Quality Associated with Impervious Surface Area Dynamics in Rapid Urbanization Areas: A Case Study in Shenzhen**

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As we know, urbanization has negative influence on regional ecological environment quality. Urban sustainable development is a hot topic of regional and global sustainable development study. Urban water environment and water resources are closely related to urban development and human survival. The water quality of urban drinking sources and streams has been influenced by urbanization, which confronts us with heavy pressure in their protection, management. Although the influence of human activities on water quality is an indisputable fact in watershed, the mechanism and effects of its influence yet remains unclear. The study of pattern, processes and effects in landscape ecology provides an approach to find out and solve those complicated ecological environmental problems. The impervious surface area (ISA) is an important indicator of both continuous landscape pattern and urban water environment, which acts as bridge in studying urban landscape pattern change and environmental processes, and is a link of urban landscape pattern - process - effect theory in our study.

This study focus on landscape pattern dynamics and water quality change trends, and then connected them through landscape indicators. Taken Shenzhen city as the study area, supported by the urban landscape ecology theory and methods, we chose impervious surface as an entry point, and systematically analyzed the water quality effect of impervious surface dynamic. Detailed methods and conclusions are as follows:

## (1) Using Impervious surface area to quantify the pattern of urban land cover change

Compared with traditional urban landscape types, urban impervious surface is characterized by continuous data and urban landscape gradient. During 1990-2005, the spatial pattern of impervious surface change from dispersion to single center together, multi-center spread, and multi-center aggregation. The change of direction differed from Eastwest to Northwest/Southeast, Northeast/Southwest, and North-South direction, and the overall difference in spatial gradient decreased rapidly, which also decrease the heterogeneity of spatial gradient and increase the spatial autocorrelation of urban land cover. However, in the local level, the spatial pattern of land cover show that the impervious surface component low percentages at four directions between 1990 and 2005. The old town had a low change, but a high change occurred in new urbanizing and industrial areas, with the decreasing of the heterogeneity of local spatial pattern of impervious surface.

## (2) Environmental effects on water quality associated with ISA change

The form, distance, threshold and correlation of stream water quality affected by impervious surface at regional scale have been studied. Based on time series of mean water quality indicators, we applied linear trend analysis to analyze water quality indicators in 8 streams and 6 drinking water source watersheds in recent 15 years. The result indicates that the pollutants of Shenzhen Stream and Dasha Stream are decreasing, and there are no obviously



changes in drinking water resources, while the streams outside the city are deteriorating rapidly. As for the impact of urban impervious surface to water quality, there are mainly occurred at watershed scale and riparian buffer scale. Euclidean Distance and Flowlength Distance are two kinds of riparian buffer forms. The distance of water quality impact of impervious surface buffer ranges from 100m to 200m. DO, S and CGB are affected by Flowlength Distance. The indicators of COD<sub>Mn</sub>, BOD<sub>5</sub>, NH<sub>4</sub>-N, TP, TN, Zn, Pb, CN, VP, Oils, ANC and SO<sub>4</sub><sup>2-</sup> are affected by 100m Euclidean Distance. F (fluoride) is affected by Flowlength Distance of 200m buffer zone. At regional scale, the raparian buffer minimum threshold standards of water quality is 0.279 for China water quality standards of Type Three, 0.349 for China water quality standards of Type Five, and 0.333 for inflection point threshold; and the watershed scale minimum threshold standards of water quality is 0.258 for China water quality standards of Type Three, 0.331 for China water quality standards of Type Five, and 0.369 for inflection point threshold. From 1990 to 2005, water quality indicators are closely related to ISA and range from no obviously correlation to a significant correlation.

In summary, based on theories and methods of urban landscape ecology, this study cooperates urbanization process with water quality change process in a comprehensive quantitative analysis, which not only systematically quantifies the dynamic process of landscape components, but also reveals the degree of association of water quality, form, distance and threshold at regional scale, and yet reveals impact of urban hydrology and non-point source at watershed scale. It is hoped that the results could expand the landscape pattern - process - effect of theory in basic research. It is also hoped that the results could make contributions to watershed management and urban land-use planning.

**Keywords:** Impervious surface, Urbanization dynamics, ISA threshold of water quality indicator

## **Assessing the Impacts of Urban Expansion on Carbon Emissions in China from 1992 to 2008**

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The unprecedented rates of urban population growth over the past century have occurred on <3% of the global terrestrial surface, yet the impact has been global, with about 78% of carbon emissions (Grimm et al., 2008). The major sources of these emissions are transport, industries and the conversion of natural to urban land, as well as cement production for the building sector (Hopkins et al., 2004). Urban expansion changes the characteristics of the vegetation and soils on the territories of the cities, which in turn leads to the change of parameters of the carbon cycle (Hopkins et al., 2004).

Since the 1980s Chinese economic reform has greatly accelerated its urban expansion. From 1981 to 2008, China experienced fast urban expansion with the built-up area increased from

7438 km<sup>2</sup> to 36295 km<sup>2</sup>, about 5 times expansion (National bureau of statistics of China, 2009). Moreover, 300 million more people likely will move to cities, transforming their home landscapes and continuing an already unbelievable juggernaut of urban construction (Grimm et al., 2008). Therefore, the urban expansion has been bringing great impact on carbon emissions in China. Thus, a better understanding of the impacts of urban expansion on carbon emissions is necessary for Chinese decision-makers at various levels to address energy security, climate change mitigation, and local pollution abatement.

The overall aim of this approach is to calculate carbon emissions associated with the land conversion caused by urban expansion in China from 1992 to 2008. Firstly, the urban expansion areas were extracted by using Defense Meteorological Satellite Program's Operational Linescan System (DMSP/OLS) nighttime light imageries. Secondly, the dynamics of carbon emissions resulting from conversion of natural ecosystem into urban land during the process of urban expansion were calculated by using statistic data. As a result, urban expansion is being active sources of carbon through the studied period with the regional dynamics is somewhat more complex in China.

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## **Spatial Pattern of Fire Occurrence and its Future Trend under Global Warming in a Boreal Forest of Northeast China**

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Spatial distribution of fire occurrence can be characterized by its own “ecological niche”, which is bounded by environmental resources (e.g., the distribution of fuels), fire-conducive conditions (e.g., climate/weather, and topography), and ignition agents. In this study, we used spatial point pattern analysis to quantify the spatial controls (biotic, abiotic, and human factors) on influencing patterns of wildfire occurrence and map the spatial distribution of fire occurrences density (numbers of fire occur in a given unit) under current and future climate conditions in a boreal forest landscape of Great Xing'an Mountains in Northeast China, using fire ignition records from 1965 to 2009. The analysis showed that spatial patterns of wildfire occurrence were strongly associated with human access to the natural landscape, with proximity to settlement and roads, and road density found to be the most important factors. High fire occurrence density areas were clustered near the roads and human settlement. Vegetation type was the least important variable in explaining the spatial pattern of fire

occurrence. Our results demonstrated that: (1) human factors had overridden the biophysical factors as the most important driver of the fire occurrence in this severely human affected landscape; (2) Increased fire occurrence density due to climate change would show a highly heterogeneous spatial distribution across the landscape, and would be evident only where proximity to human ignition sources was high; (3) Mean fire occurrence density could increase by 175% in 2100. Results suggested that climate change influences on future fire regimes would be strongly constrained by anthropogenic risk factors. Forecasts of future fire-climate relationships must account for anthropogenic influences on fire ignition probability, such as road density and proximity to settlements.

**Keywords:** Fire, fire ecology, Landscape ecology, Boreal forest, Spatial point pattern analysis, Northeast China

## Realizing CO<sub>2</sub> Emission in China: Pattern and the Process

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Global climate changes have been considered as one of the most urgent issues for human society. Fossil fuel based industrial development has resulted in a rapid increase in atmosphere CO<sub>2</sub> concentration, brought many health concerns to both ecosystem and human beings. China, with its fast economic growth for the last 30 years, has already become the largest country for CO<sub>2</sub> emission in the world. The rapid economic growth in the past three decades has consumed a great amount of fossil fuel, and led to a skyrocketing CO<sub>2</sub> emission increase. Emission reduction and adaption policy is critical for sustainable development in China as well as prosperity of the whole world. However, previous studies were mainly focused on the statistics analysis. There is a need to have a study from spatial-temporal perspectives, so that the industrial evolution of energy consumption and spatial allocation of CO<sub>2</sub> emission across the whole country can be presented.

This paper focuses on the spatial pattern of China CO<sub>2</sub> emission from energy consumption and its evolution during 1995-2008; based on Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories, carbon emissions from energy consumption were accounted in 30 provinces of China (including autonomous regions and municipalities) from 1995 to 2008; by taking Global Moran I index, the variations in spatial autocorrelation of China's carbon emissions from energy consumption in 1995-2008 were analyzed using spatial autocorrelation analysis model.

The research results showed that: (1) CO<sub>2</sub> emissions from energy consumption in 30 provinces, municipalities and autonomous regions of China were increased rapidly between 1995 and 2008, which twice more than those in 1995 on average. There had a considerable increase in CO<sub>2</sub> emissions from energy consumption in Inner Mongolia, Ningxia Fujian, Shandong; these areas are all the energy exporting regions or manufacturing-intensive regions. (2) Significance spatial disparities existed in China's CO<sub>2</sub> emissions from energy consumption,

and the spatial distribution pattern showed a decline trend from east to west. North China and East China witnessed the most intensive carbon emission from energy consumption, which was higher in coastal provinces and cities and lower in Northwest China and the majority of economically underdeveloped areas. (3) China's CO<sub>2</sub> emission from energy consumption indicates a significant spatial autocorrelation, shown as an aggregation pattern in spatial analysis. Additionally, the spatial autocorrelation and significance tended to be increased from 1995 to 2008, indicating that China's CO<sub>2</sub> emission from energy consumption witnessed a growth in the spatial aggregation with more significant regional correlation. China's provincial CO<sub>2</sub> emission from energy consumption illustrates a fast growth associated with spatial cluster, and this process was mainly driven by closer regional relationship resulted from rapid urbanization and transport development. The results implicated: spatial and regional disparities need to be taken into account in policy making relevant regional policies need to be developed focusing on aggregate areas of carbon emission; scenario analysis should combined with the regional disparities respectively based on multi-scale analysis as well as interdisciplinary method. Research outcomes can facilitate policy makers on better understanding the features of CO<sub>2</sub> emission in China and making appropriate strategies for reducing CO<sub>2</sub> emission.

## **The Intersection of Landscape and Metacommunity Ecology in a Tropical Agroecosystem**

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A metacommunity is a set of local communities linked by the dispersal of multiple interacting species (Leibold 2004). Many metacommunity studies seek to characterize how well systems fit into one of four paradigms: species sorting (species tracking environmental gradients; SS), patch dynamics (e.g. competition-colonization tradeoff; PD), mass effects (source-sink dynamics; ME), and neutral (neutral theory; NE). Broadly, these models predict spatial and environmental effects should explain different amounts of variation in local community structure. However, this model-fitting approach is often difficult because 1) large amounts of variation are often unexplained, (Jacobson and Peres-Neto 2009) 2) multiple models can act at different spatial or temporal scales (Declerck et al. 2011), and 3) different subsets of species within the same community can follow different models (Pandit et al. 2009).

I utilize a community of twig-nesting ants (Livingston and Philpott 2010) in a tropical coffee landscape mosaic in Southern Mexico to address these problems. I surveyed community structure and environmental variables at 1352 coffee plants including three low shade sites and three high shade sites within a high shade farm and three sites within an adjacent low shade farm. A variance decomposition and community similarity analysis found no support for SS occurring within farms either among all species or component groups, but strong SS occurred between farms for all species. Light trap and survey data on dispersal ability, coupled with patterns of behavioral and local community dominance, explicit spatial patterns in the distribution of colonies by species, and a survey of the shade tree canopy indicates a

role for ME, PD, priority effects, and spatial aggregation of subdominants in explaining within farm variance. NE was not supported. In conclusion, when used alone both the metacommunity and the landscape ecology perspectives failed to adequately characterize the system. However, a synthetic approach substantially improves the amount of explainable variation and the ability of survey data to identify mechanisms.

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## Designing a Landscape Fragmentation Indicator for Catalonia. Challenges and Results

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The deployment of the European Landscape Convention (ELC) at the regional level requires the development of landscape indicators that allow for the monitoring and improvement of landscape change dynamics. The Landscape Observatory of Catalonia is developing a set of ten landscape indicators focusing on the various dimensions of landscape such as changes in pattern, human perception of changes, economical value and policy developments.

In this presentation we first discuss some of the challenges posed by the translation of landscape ecology principles into practice during the design of a synthetic landscape fragmentation indicator. Most of the challenges derive from the will by the Landscape Observatory to create a simple indicator that, faithful to the ELC approach, is sensitive both to the common landscape ecology definition of fragmentation ‘as the breaking up of a habitat, ecosystem or land-use type into smaller parcels’ (Forman, 1995) and to landscape fragmentation as perceived by citizens. Requirements of simplicity and an interdisciplinary scope has forced designers to carefully choose the scale at which the indicator will be calculated, the landscape dynamics that should be taken into account and the interpretation that landscape managers and decision makers will be able to make from the indicator.

After this discussion, a preliminary version of the landscape fragmentation indicator is presented and its results for the territory of Catalonia are analyzed. With regard to methodology, the best data available nationwide is used and the scale of measurement is set to fit that of human perception of landscape (i.e. human species-specific), with landscape elements contributing to fragmentation being classified into punctual elements, linear elements and elements with area. Each group of elements is regarded as affecting landscape fragmentation differently and a GIS-based procedure is therefore employed to incorporate their characteristics with the weighting deemed suitable. The result of this process is a map of Catalonia illustrating its landscape fragmentation.

Analyzed results correctly classify largely undisturbed mountainous areas and compact urban areas as non-fragmented, whereas areas mixing in a disorganised fashion open areas, developments and infrastructures are assigned higher fragmentation values. This latter case is mainly identified in the Barcelona Metropolitan Area and those areas surrounding some medium-sized cities, along infrastructure corridors and following the course of some river valleys. Therefore, we conclude that the chosen methodological path to design the landscape fragmentation indicator is promising for Catalonia's landscape management. There is, however, plenty of room for improvement, fine tuning and the addition of several other landscape fragmenting elements to influence the results of the indicator or to improve its suitability for different study areas.

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## **Spatial-Temporal Variation of Farmland Soil in Suburban and Rural area of Shanghai, China**

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Understanding spatial and temporal variations of heavy metals in soil is an important precondition for properly monitoring and evaluating eco-environment quality. This study evaluated and analyzed the farmland quality in suburban and rural areas in Shanghai, China during the period of 1985-2005 using the data on Cd, Zn, Cu, Pb, Ni, Cr, Hg, As from the Shanghai Environmental Monitoring Center as input. According to the five-year plan of Shanghai, all the data were averaged every five years. The study years in this paper are divided into "Sixth Five Year Plan" (1985, 6th fyp), "Seventh Five Year Plan" (1986-1990, 7th fyp), "eighth Five year plan" (1991-1995, 8th fyp), "Ninth Five Year Plan" (1996-2000, 9th fyp), "tenth Five Year Plan" (2000-2005, 10th fyp). The Nemerow's synthetical pollution index was calculated to characterize spatial and temporal variations of farmland soil quality every five years. The results showed that Cd, As decreased gradually with time, while most other heavy metals gradually increased at the same time, suggesting that the soil contamination has transferred from pesticide and fertilizer pollution to the heavy metal

pollution in the last two decades, especially for Zn, Cu and Pb. The Nemerow's synthetical pollution index was higher in suburban areas than in rural areas in all five-year-plan periods based on national standards and Shanghai background values except for 1990-1995. Though the pollution was gradually controlled after 1995, heavy metal contamination in farmland soil was still significant compared with Shanghai background values. The spatial pattern of industries and population density and the environment policies influenced the spatial-temporal variation farmland soil quality in Shanghai. Some countermeasures are suggested to relieve pollution in farmland.

## **How Rangeland Ecosystem Dysfunctioning Impacts Pest Outbreaks in the Headstreams of the Three-river of the Tibetan Plateau**

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Rangelands represent the largest ecosystem in the Tibetan Plateau. It covers over half of the plateau total area. The high-altitude rangelands are the cradle of Tibetan culture, which has a history of several thousand years. By providing habitats for Tibetan livestock (yaks, sheep and goats), the rangelands also contribute fundamental living resources for Tibetan nomads. In addition its ecosystems are important for maintaining biodiversity, for the regional water cycle, for soil formation and conservation as well as for carbon sequestration. Globally this unique plateau is also of vital ecological importance for downstream areas, as many of the major rivers in China, South East Asia and India originate in Tibet. Moreover, the rangelands have become increasingly important as a destination for national and international tourism. Over the past 50 years, due to great increments of livestock and human population the rangelands degradation have widely occurred cross the plateau, particularly in the headstreams of the three-river e.g. Yangtze River, Yellow River and Luancang River, consequently, leading to outbreaks of pest *Ochotona* populations and toxicant plants in recent years. Climate change adds to these pressures. It is no doubt that the rangeland ecosystem dysfunctioning threatens the ecological security of the plateau and the survival of its inhabitants. However, our past work in terms of Tibetan rangeland ecosystem functioning mainly focuses on a high level of biological organisations, and less concern about ecosystem dysfunctioning, such as habitat alteration, loss of biodiversity and biological invasion may result in pathogen transmission and toxicant transfers through pest outbreaks within and beyond the ecosystem. This paper aims to contribute to that understanding.

**Keywords:** Tibetan rangeland ecosystem functions, Pest outbreaks, The three-River

# **Influence of Climate, Landscape Structure and Spatial Variables on Beta Diversity of Woody Species in the Yucatan Peninsula at Different Spatial Scales**

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One of the fundamental objectives of ecology, as well as a cause of intense debate during the last few decades, is to unravel the mechanisms or factors that govern beta diversity (measured as species composition variation). Understanding beta diversity and the factors that determine it in ecological communities is important because it allows us to comprehend how species share the habitat, and can help guide and evaluate conservation planning and management, for example in terms of determining the optimal spatial arrangement of conservation areas. However, beta diversity has received far less attention compared with the local (alfa) or regional (gamma) components of diversity. Also, is very important to understand, It is important to understand that spatial scales are acting different variables and their relative importance in each scale.

Different theories about the variation in the species composition such niche and neutral theories, provided contrasting predictions concerning the drivers of beta diversity.

This study aims to characterize relationships between variation in species composition (beta diversity) and climate, landscape structure and configuration, and habitat type considering different spatial scales for a tropical forest in Yucatan Peninsula.

For this, we determined plant species composition (presence-absence) in 640 plots in all forest of Yucatan Peninsula from national forest inventory. A set of explanatory spatial variables was generated from the geographical coordinates of the sampling sites using a principal coordinate of neighbour matrices analysis (PCNM), that represent a spectral decomposition of the spatial relationships. We obtained landscape metrics from vegetation map elaborated for Selva Maya project (TNC) using the program FRAGSTATS and the climate variables from worldclim. We will use the variation partitioning by understand the relative importance of each variable at different spatial scales. Here we hypothesize that the fine scales, the environmental heterogeneity explain the variation in the composition and climate at larger scales play a role in the variation of woody species.

## **Letsmap do Brasil a Web-based Planning Support Tool for Sediment Management in River Basins of Western Central Brazil**

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A central element of a sediment management plan for the Federal District, Western Central Brazil is a planning support tool that enables the user to test the effects of land use changes on landscape processes and functions (LPF) focusing on sediment management (Lorz et al. 2011). For this purpose we developed the web based tool *Letsmap do Brasil* (Lorz et al. 2010). The tool has two principal interacting levels. The upper level contains information on effects of land use on LPF, i.e. runoff control, sediment retention, nitrogen availability, and agronomic value. The parameterized relation between land use and LPF is the core of the system. For each LPF a value specific to land use has been assigned. Values for LPF's were taken from published research, e.g. C factor from USLE (sediment retention) and Curve Number (runoff control), or statistics (agronomic yield). All values were standardized on a scale from 0-100. By changing land use/cover users may act as land planners or managers. By creating their own land use/cover patterns users are enabled to test effects of land use/cover change on LPF's. A second level contains information on landscape properties and potentials (LPP), e.g. potential of runoff control or potential of sediment retention. By linking land use and LPP's a site specific assessment of effects of land use changes on LPF is possible.

*Letsmap do Brasil* is thought to fulfill two purposes. (i) It will support decision making in river basin management and sediment management. (ii) It enables non-experts to participate and trains non-experts in decision processes. Because of its high adaptability, transparency and simple handling *Letsmap do Brasil* might be is a universal tool in river basin management and land use planning.

**Keywords:** Sediment management, Brazil, planning support tool, landscape functions, river basin management

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## Effects on Urban Forests Biodiversity in a Semi-arid Urban Area

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Urban areas are artificial, highly modified environments that include buildings, green areas and urban structure such as streets. In this context, biodiversity and species dispersal interact with landscape structure, especially green spaces, in urban areas. This is more important in semi-arid areas because of the severe environmental conditions (such as temperature and humidity) outside of urban areas. We have evaluated the role of urban forests in promoting

biodiversity by studying the presence of carabid beetles in urban forests of Arak city, an urban area in a semi-arid region of central Iran.

During autumn 2009 we sampled the carabids of 12 forest plots in 10 forest patches. Individuals were captured by 12 pitfall traps in each forest plot. The results confirmed the importance of urban forest as habitat for a diverse range of insects. The results indicate that there are fewer forest specialist species in more urbanized sites and that large forest patches were favoured by specialist species. In relation to landscape connectivity, we found that the species richness was significantly higher in urban forest patches that were more strongly linked to other forest patches or suburban forests.

**Keywords:** Biodiversity, Urban forest, Connectivity, Carabids

## **The Urban Forests Effects on Biodiversity in Semi-arid Urban Area**

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We evaluate the importance of urban woodlands and forests to serve as potential sites for biodiversity conservation in Arak city (Iran) using a field surveys of carabid beetles, ants and spiders.

The aim of project is to: 1) predict biodiversity in urban regions and understand the factors affecting on the biodiversity, 2) evaluate the role of urban forest on the maintenance and conservation of biodiversity and 3) understand the effects of urban forest characteristics associated with urbanization upon the ecological diversity and individual species distributions.

During summer 2009 we sampled 12 forest plots in 10 forest patches. The carabids, ants and dwelling spiders were captured using transects of 12 pitfall traps in each forest plot. The results show that urban forests provide habitats for rich and diverse range of insects and animals. The relative importance of habitat quality on species richness has been illustrated. Our results illustrate that more urbanized sites had significantly fewer forest specialists and more generalist species. Large forest patches were favoured by forest specialist species while generalist species and species frequently associated with forest (forest generalists) dominated the smaller forests. The species richness in the urban forest patches that are more connected to other forest patches or suburban forests are significantly higher than others. Overall urban forests seem have an important role for promoting biodiversity conservation in cities. We suggest that urban planners can have a positive impact on urban biodiversity by slowing the pace of redevelopment and by management of urban forests regarding ecological aspects.

## **Landscape Multifunctionality in the Urban Environment: Evidence from Chicago**

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Landscape multifunctionality offers unique challenges and opportunities in the urban environment, where ecosystems are highly managed and humans live in close proximity. Some of the challenges include limited available land, high property values, and strict zoning regulations. On the positive side, a city is rich with resources that can be reused in the landscape, and the dense human population may intensify the value of functions and provision of ecosystem services. An excellent example of landscape multifunctionality is urban agriculture, which has become an increasingly popular land use option in many cities throughout the US. While the primary and obvious function of these spaces is the production of food, additional ecological and cultural functions are necessary to justify the existence of agriculture on high-value land with many competing uses. Landscape planners, designers, and managers can play an important role in promoting multifunctionality of these spaces and planning for long term success, considering the needs and preferences of local stakeholders (e.g. farmers, consumers, and neighbors).

Chicago, like many other cities, has experienced recent growth in urban agriculture as the demand for fresh, locally grown food has risen. Urban agriculture provides a wide range of functions for Chicago communities including waste management, nutrient cycling, energy conservation, microclimate control, cultural heritage, recreation, and education. My research team has been working to quantify some of these functions and develop tools to assist urban farmers in landscape planning. Spatial analysis in GIS has revealed that urban agriculture is an extensive land use type in Chicago, existing throughout much of the city and contributing to the multifunctionality of this human-dominated ecosystem. Urban agriculture was found in a variety of forms including commercial farms, community farms, allotment gardens, and backyard gardens. The density of urban agriculture sites is related to several different socioeconomic factors, including ethnicity. A study exploring the impact of local habitat type on pollinator abundance and diversity in community gardens demonstrated the importance of area in flower cover for increasing the abundance of bee pollinators. Future research opportunities to support the design of multifunctional urban agriculture: comparing with other types of green space for a range of ecosystem services, evaluating the impacts on community food security, exploring opportunities to improve human health, and planning urban landscapes to expand production and optimize performance across a range of functions.

## **Detection of Land Use and Land Cover Changes Using Remote Sensing and GIS in Bodri Watershed, Central Java, Indonesia**

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Land use and land cover (LULC) changes have important role in driving environmental problems. It is widely accepted that the changes in LULC is a result of complex driving factors interaction. Integrating remote sensing and GIS technologies are very useful to map LULC patterns and its dynamics in certain area (Dewan and Yamaguchi, 2009; Kelarestaghi and Jeluodar, 2009; Reis, 2008). The utilization of these technologies has been applied to Bodri watershed in Central Java, Indonesia. The aims of this study are to map and find LULC changes in the last two decades (1991-2001 and 2001-2009) between 1991 and 2009 in Bodri watershed. Three data sets Landsat image 1991, 2001 and 2009 were applied for this analysis. Image classification for mapping LULC was analyzed by supervised classification through the maximum likelihood method. The six reflective bands (band 1-5 and 7) were used for the classification. LULC changes process were then detected through post classification method which is presented in the transition matrix. In order to analyze LULC according to slope and elevation, the LULC change maps were then overlaid with slope and elevation maps which were derived from digital topographic maps (1:25.000). Images were classified into six LULC legends: forest, tree plantation, dry farming field, paddy field, settlement and water.

It was found that certain changes in LULC occurred over the study period. The results shows that in transition 1991-2001 there were increase in settlement (56.22%), dry farming field (41.77%) and water (32.41), and decrease in forest (-31.85%), tree plantation (-15.19%) and paddy field (-12.23). While, between 2001 and 2009 increase occurred in water (34.17%), tree plantation (12.63%) and settlement (7.47%), and decrease in paddy field (-26.01%), forest (-12.33%) and dry farming field (-1.14%). The changes were mostly taken place in the gentle slope (0-8 %) and the low elevation (0-500 m) areas. These results shows that lowland and gentle slope areas are the most vulnerable and extensive areas to the land use and land cover changes by human and agriculture activities compare to the highland and steep slope areas.

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## **A Holistic Approach to Evaluate Forest Biodiversity Management Strategies and Related Ecosystem Services**

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Throughout Europe forest owners and users, land managers and landscape planners are facing increasing competition for forest products and services under changing environmental, economic and social conditions. This is particularly challenging nowadays because of the “increasing pressures” to intensify wood production and timber exploitation; new methodologies and integrated models to optimise land-use for the allocation and management of existing and new forest lands at the landscape scale are needed. Nevertheless, there are also demands for improving the actions in favour of safeguarding biodiversity, and in a more general way improving forest ecosystems functioning. This twofold requirement of an optimized forest production and an environmental quality improvement represents a true challenge for the years to come. A fast reorganization of the system is needed in order to find the right balance between management within a forest ecosystem services approach at different scales. In particular, we need to consider a valorisation of wood resources and production, thorough knowledge of their vulnerability within an intensification management scenario.

This work provides views and examples on how the holistic approach of landscape ecology can be considered towards the interplay between biodiversity value and the needs of forestry activities. Focusing on biodiversity conservation as a proxy for the ecological dimensions of sustainable forest management the work proposes a series of requirements for the conservation of habitat networks and ecological processes to be met by forest landscape managers.

Vis-a-vis of such stakes, which concepts, methodologies and tools can be validated on strong scientific grounds that can be proposed to the actors charged to implement policies and actions on the ground? Landscape ecology, proposes a comprehensive and integrative approach from the plot level to the landscape level, considering adaptive management and an analysis of ecological thresholds. Spatial conservation prioritization methods are applied to a national-scale conservation planning task. Forest management operations, can be targeted for the maintenance of the quality of the protected areas. The work opens questions regarding the needs for a comprehensive adaptive forest management under changing environmental conditions to improve forest management in a wide range of territories.

## **Landscape-Scale Impacts of Isfahan’s West Freeway on Ghamishloo Wildlife Refuge, Iran**

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The fragmentation of habitat and the creation of barriers caused by transportation infrastructure reduces landscape connectivity and is suspected of being one of the most important factors causing wildlife population declines (Forman et al. 2002). Road networks affect wildlife habitats in two different ways. Firstly, road construction leads to direct habitat loss. Secondly, maintenance and use of road have various effects on and alter habitat quality, such as increasing access to hunters, poachers and tourists. Roads are thought to affect the

persistence of many species by restricting movement between habitat patches. Long-term protection of many natural habitats is threatened due to isolation and segregation, even in protected areas. This study focuses on the impacts of Isfahan's west freeway on Ghamishloo wildlife refuge, I.U.C.N category IV: Habitat/ Species Management Area, through which it passes, in Isfahan Province, Iran. The main goal of this research is to predict the effect of the freeway on the population persistence of *Gazella subgutturosa* and *Ovis orientalis isphahanica* in Ghamishloo wildlife refuge. To quantify landscape patterns, various metrics such as NumP, ED, LPI, AWMPFD and Pland were calculated to examine how landscape patterns (including Number of Patches, Edge Density, Largest Patch Index, Fractal Dimension) influence wild sheep and gazelle populations. In addition, the model of road avoidance behaviour (Road Impact Model) presented by Jaeger et.al. 2005 was used. Model parameters include: road characteristics, road avoidance behaviour of species and sensitivity of the populations to the road's four impacts (habitat loss, road kill, creating barriers to animal movement and population subdivision). The results indicate a significantly negative impact of the freeway on wild sheep and gazelle populations in Ghamishloo wildlife refuge, in particular due to the absence of wildlife crossing structures such as underpasses and overpasses. The results of this presents a concern for the conservation of these vulnerable species.

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## **Diversified Land-use Promotes Plant Functional Redundancy in Farmed Landscapes**

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In agricultural landscapes, the conversion from complex to simplified land-use pattern is a major cause of biodiversity loss (Tschardt et al. 2005). Intensive agricultural land-use can reduce functional diversity beyond changes in species richness alone, potentially imperiling provisioning of ecosystem services (Flynn et al. 2009). By using trait-based approach, this study will examine not only trait-based plant functional diversity in relating to potential ecosystem processes, but also resilient ability of redundant species performing similar function (Walker 1995) along contrast landuse patterns.

Field sampling includes three nested levels of organization along a spatial gradient from simple to complex landscapes: 1) sampling landscape squares (1x1 km) in three landscape

categories from simplified to complex landscapes; 2) totally four types of semi-natural habitats in three landscape categories; and 3) sampling plots in each habitat. We constructed seven functional groups using multiple traits that are of potential effects on ecosystem processes. In each group, taxonomic species were identified, and diversity of within-group regeneration traits was also analyzed.

On landscape-square level we resulted that: 1) functional group richness in diversified landscapes was not significantly higher than that in simple landscapes; 2) mean within-group species richness in complex landscapes was statistically higher than in simple landscapes; 3) diversity index of within-group regeneration traits was increased from simplified to complex landscapes; 4) species distribution within groups were relatively convergent in simple landscapes, while the distribution in complex landscapes was relatively even and divergent; and 5) among different habitat types, although function group types in semi-natural grasslands was similar to other edge types (forest edge, field edges, and riparian edges), within-group species composition between grassland and edge habitats were dissimilar.

The results implied that: 1) simple landscapes do not necessarily contain lower functional diversity (groups of effect traits) than complex ones but that the ecological assembly processes constructing functional components in simple landscapes differ dramatically from complex ones; 2) within-group species distribution indicated that human activities alter community assembly rules – ecological filtering was a main process in simple landscape, while limiting similarity (differentiation) likely occurred in complex landscapes; 3) the differentiation of regeneration traits within functionally redundant species promotes resilient ability to ensure the ecosystem functioning; and 4) semi-natural grassland has a unique value in guarantying ecosystem functioning in agricultural landscapes.

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## **Modelling Population Density Dynamics in Mainland China from 2000 to 2008 by Using DMSP/OLS Nighttime Data and SPOT/VGT Data**

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The spatial distribution of population density is crucial for understanding the relationship among economic growth, environmental protection and resource utilization. In this study, population density dynamics in Mainland China from 2000 to 2008 was modeled by using DMSP/OLS nighttime data and SPOT/VGT data at 1 km × 1 km resolution. Firstly, an new

data-extending approach was developed to overcome the blooming effect in DMSP/OLS nighttime data due to their low radiometric resolution. Then, with the new approach, the DMSP/OLS nighttime data from 2000 to 2008 was extended by using the SPOT/VGT data. After that, the population density in Mainland China from 2000 to 2008 was modeled by using the extended DMSP/OLS nighttime data and the population census data. At last, the spatio-temporal dynamics of the population density in Mainland China from 2000 to 2008 was analyzed.

The results indicate that our new developed data-extending approach is effective to overcome the blooming effect in DMSP/OLS nighttime data. Compared with the original data DMSP/OLS nighttime data, the extended DMSP/OLS nighttime data was better to model the population density in China. In addition, we also found there exist obvious change of population density in China from 2000 to 2008 due to her rapid economic development and vast urbanization.

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## **Evolution of Urban Growth Pattern and its Effects on Regional Landscape Pattern and Ecological Security: Study on the Fast-growing Hangzhou Metropolitan area (HMA), China (1978-2008)**

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In this study, Hangzhou, the capital city of Zhejiang Province in eastern China, was selected as a case study to quantitatively examine the relationship between urban growth pattern, landscape pattern, and regional ecological security. Based on an integrated GIS/RS approach, comprehensive studies of land use and land cover change (LULC), evolution of urban growth pattern, dynamics of landscape structure pattern as well as regional ecological security during 1978-2008 were performed, using time series Landsat TM/ETM+ imagery and regional socioeconomic dataset. The results showed that over the past three decades rapid growth of the Hangzhou Metropolitan Area (HMA) have led to accelerated land use conversion. As revealed by detection of land use changes, extent of the built-up land increased from 319.3 km<sup>2</sup> in 1978 to 862.5 km<sup>2</sup> in 2008. During this period total population grew 46.71%, from



2.89 million in 1978 to 4.99 million in 2008. Since the 1990s the model of urban expansion has shifted from the single-pore to present multi-nuclei pattern. Therefore, rapid increases in both urban expansion and population led to dramatic change in land use and land cover, which were witnessed with sharply decreases in farmlands, water bodies, and bare lands. Consequently, significant increases in patches and fragments were observed. On the other hand, aiming to building up an international famous tourism city with high living quality, great efforts have been officially made to improve local environment. As shown in land use detection, slight but stably increases in forest coverage occurred. This helped mitigate the risk of soil erosion. However, given the ongoing urban agglomeration and rural-urban migration, the other land covers, especially cropland, shrub, and fallow land were rapidly converted to built-up land under the pressure of urban development. Environmentally, as indicated by land resources scarcity, biodiversity loss (indirectly indicated by landscape structure), increasing intensity of urban heat island (UHI), and potential risk in sea level rise due to intensive development along the Hangzhou bay, the fast-growing HMA has experienced significant changes in landscape pattern and degradation in ecological security. Thus, in order to mitigate the adverse effects of human activities and global warming on local scale, ambitious development plans for this city should be deliberate.

**Keywords:** Urban growth pattern, Landscape pattern, Ecological security, Hangzhou, China

## **Response of Ecological Services Value to Land Use Change in the Shule River Basin**

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By the GIS and ecological economy theory , based on the Costanza method and the Chinese land ecological services unit area value , this paper analyzed the variation features of land use change and ecological services value in the Shule River Basin during 1990-2010.Result show that from 1990 to 2010, overall land use characteristics of the Shule River Basin changed slightly, but the internal structure for each kind of land use types changed significantly. Unused land、 Grassland and cultivated land were always major land use types during the 10 years, occupying approximately 98.22% of the total area, respectively. Most of land use changes occurred in cultivated land, built-up land and grassland, the velocity of land use change are 13.60%, 7.97%, 7.68%, respectively. The magnitude of land use exhibited an increasing trend, and meanwhile the ecological services value, from  $344.85 \times 10^8$  yuan to  $485.11 \times 10^8$  yuan ,and also show an increasing trend. Farmland and water area contributed to the overall increasing eco-services change dominantly. The development of eco-economy in the Shule River Basin has been on the verge of lower incoordination. The ecological environment protection should be further enhanced .

**Keywords:** Ecological services value, LUCC, Shule River Basin

# The Construction and Application of Desertification Monitoring Model Based on Albedo-NDVI

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The land desertification is one of the most serious environment - socio-economic problems in the world(Wang Tao, et al. 2003). Accurately monitoring of land status of desertification can provide important scientific basis for research and desertification control, While remote sensing technology can help to access information about different periods of land desertification quickly and accurately (Wang Ranghai, et al. 1998). In this article, we selected a region nearby Gaotai County as the study area, which has typical desertification process and complete desertification type. In support of RS and GIS technology, we used Landsat TM images to construct the monitoring model and apply it to the study area. First, the surface albedo (Liang S, et al. 2000) and vegetation index are calculated. Through statistical regression analysis, we determined the quantitative relationship between albedo and NDVI of different desertification lands, and figured out correlation coefficient between them is 0.7707. On this basis, we constructed the model (Zeng Yongnian, et al. 2006); then, we used decision tree classification to classify the current situation of desertification land and evaluated the quantitative relationship of them by natural breaks (Jenks); finally, we used Quick Bird image to test the classification results and found the overall accuracy of the model can reach 81.64%. Research shows that the index of the model can reflect the desertification land surface cover, water-thermal environmental and its change with a clear biophysical significance. It can make full use of multi-dimensional remote sensing information, reaching a higher monitoring accuracy. Also it can easily achieve the automatic identification of land desertification and quantitative evaluation, which is conducive to monitor the process of desertification quickly and efficiently.

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# Holistic Model for Biocultural Landscape Conservation in Rural Lebanon

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Traditional rural landscapes in Lebanon as elsewhere in the eastern Mediterranean are as much a product of geographical setting and natural processes as they are of cultural modification and adaptations over time. A rich and diverse mosaic of woodland patches, degraded maquis scrubland, terraced perennial cropping of olives trees and vineyards, the rural landscape is characteristically a combination of ‘natural’ and ‘cultural’ ecosystems. Traditional rural landscapes combine agricultural, silvicultural and pastoral uses within an integrated management system. Multifunctional in use, sustainable environmentally, valued culturally, traditional rural landscapes are well adapted to poor the degraded environmental conditions in marginal terrain which are suitable for little else (Makhzoumi, 1997).

In conservation as in development, national policies in Lebanon fail to recognize the specificity of the typically marginal, rural landscapes as bio-cultural resources. Rather, national policies are divided between the Ministries that are concerned either with agricultural productivity or nature conservation. Mediterranean rural landscapes fit neither. Instead they are rich wildlife habitats and productive landscapes, respectively biological and cultural heritage.

This paper proposes a landscape approach to planning and management in rural marginal Lebanon (Makhzoumi, 2000; Makhzoumi and Pungetti, 1999). We shall argue that a landscape approach offers key advantages because it integrates environmental, ecological and cultural values of marginal landscapes and as such address rural needs for health, decent living while protection rural heritage. Drawing on an interdisciplinary project at the IBSAR Centre for Nature Conservation () and Sustainable Future, this paper demonstrates the application of an ecological landscape design framework to investigate the traditional rural landscape in a 150 hectare site in northern Lebanon. A master plan is proposed that combines nature conservation, cultural heritage protection and sustainable development. The approach is community inclusive and place specific rather than top-heavy and generic. Discussing the methodological framework, its application and outcome, the paper concludes that the holistic approach has the potential to address the totality of the traditional landscape, built and open, natural, semi-natural and managed, physical setting and cultural practices.

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# Landscape-Scale Impacts of Isfahan's West Freeway on Ghamishloo Wildlife Refuge, Iran

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The fragmentation of habitat and the creation of barriers caused by transportation infrastructure reduces landscape connectivity and is suspected of being one of the most important factors causing wildlife population declines (Forman et al. 2002). Road networks affect wildlife habitats in two different ways. Firstly, road construction leads to direct habitat loss. Secondly, maintenance and use of road have various effects on and alter habitat quality, such as increasing access to hunters, poachers and tourists. Roads are thought to affect the persistence of many species by restricting movement between habitat patches. Long-term protection of many natural habitats is threatened due to isolation and segregation, even in protected areas. This study focuses on the impacts of Isfahan's west freeway on Ghamishloo wildlife refuge, I.U.C.N category IV: Habitat/ Species Management Area, through which it passes, in Isfahan Province, Iran. The main goal of this research is to predict the effect of the freeway on the population persistence of *Gazella subgutturosa* and *Ovis orientalis isphahanica* in Ghamishloo wildlife refuge. To quantify landscape patterns, various metrics such as NumP, ED, LPI, AWMPFD and Pland were calculated to examine how landscape patterns (including Number of Patches, Edge Density, Largest Patch Index, Fractal Dimension) influence wild sheep and gazelle populations. In addition, the model of road avoidance behaviour (Road Impact Model) presented by Jaeger et al. 2005 was used. Model parameters include: road characteristics, road avoidance behaviour of species and sensitivity of the populations to the road's four impacts (habitat loss, road kill, creating barriers to animal movement and population subdivision). The results indicate a significantly negative impact of the freeway on wild sheep and gazelle populations in Ghamishloo wildlife refuge, in particular due to the absence of wildlife crossing structures such as underpasses and overpasses. The results of this presents a concern for the conservation of these vulnerable species.

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## **Topography and Epistemology: Review and Prospect**

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Topography has been fundamental to the development of ecology, including systems and landscape epistemologies. From the basic differentiation of terrestrial and aquatic environments to further landscape heterogeneity to the spatial structure of energy distributions, topography is important, although it may be overlooked due to its ubiquity. While islands have been important to the development of biogeography, resource heterogeneity to landscape ecology, and hydrogeomorphic gradients to systems ecology, new data at global extent and new tools allow us to potentially integrate these sometimes disparate approaches on a foundation of topography. The science of geomorphometry has been reinvigorated by new data from satellite-based geodesy, but moving these developments into ecology has been piecemeal.

Landscape ecology may be advanced by linking it to concerns in biogeography and systems ecology using geomorphometry. Mountain landscapes, where topography is so obvious, can illustrate how multiscale analyses can take advantage of geomorphometric approaches and data. Such links should enhance the sustainability of montane ecosystem services as reservoirs of biodiversity and as water towers.

## **Landscape Ecology: An Effective Approach to Urban Sustainable Environment and Culture**

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Urban sustainable environment and culture is one of the most pressing and challenging tasks facing humanity today because cities are the primary sources of major environmental problems, the centers of economic and social developments, and home to more than half of the world population. While the ecological, economic, and social dimensions of sustainability are equally important in principle, the ecology of cities is arguably least studied. But this situation has been changing rapidly in recent years. In this paper, the author compares and contrasts different perspectives in urban ecology and examines their relevance to urban sustainable environment and culture. While all perspectives are useful in some ways, the author argues, a landscape ecology perspective that integrates elements of sustainability science seems most comprehensive and effective. This integrative perspective views humans as powerful “ecosystem engineers” or agents that are critically important for developing urban sustainable environment and culture. It focuses on the human landscape scale that is large enough to include key ecological and socioeconomic processes and small enough to allow for

detailed mechanistic studies. The landscape ecology approach also emphasizes the interrelationship between urban landscape patterns and ecological/socioeconomic processes on different scales, and encourages place-based research that integrates ecology with planning, design, and other social sciences.

**Keywords:** Urban ecology, Landscape ecology, Urban sustainability, Landscape planning and design

## Mitigation of Greenhouse Gas Emissions from Abandoned Peat Extraction Areas Using Bioenergy Crops

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We studied the effect of *Phalaris* plantation on GHG emissions from an abandoned peat extraction area in Lavassaare, Estonia. The following sites were chosen for comparative studies: an active peat extraction site (bare peat), a non-fertilized *Phalaris* plot, a fertilized *Phalaris* plot (all on drained Fibric Histosols), a fen meadow (drained Sapric Histosol) and natural raised bog (Fibric Histosol). The measurements of CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O fluxes were carried out using the closed chamber-method once a month from May 2010 to June 2011. White 60 L chambers made of PVC and sealed with by a water-filled ring on the soil surface, were installed in 5 replicates on each site. The gas was sampled 3 times per hour in 100 mL pre-evacuated glass bottles, and in the lab the gas concentrations were measured using the Shimadzu 2015 GC (ECD, FID) gas–chromatographic system combined with a Lofffield autosampler. Measurements of groundwater level, water quality (temperature, pH, conductivity, redox potential, dissolved O<sub>2</sub>) and soil temperature (10, 20, 30 and 40 cm depths) were performed simultaneously. Water samples collected from each site and the drainage ditches were analysed by an accredited laboratory for Ca<sup>2+</sup>, HCO<sub>3</sub><sup>-</sup>, Total N, NH<sub>4</sub><sup>+</sup>-N, NO<sub>2</sub><sup>-</sup>-N, NO<sub>3</sub><sup>-</sup>-N, Total P, PO<sub>4</sub><sup>3-</sup>-P, SO<sub>4</sub><sup>2-</sup> and TOC. Soil samples were collected from each site and analysed for N, P, C and S. Biomass assessments of reed canary grass were carried out just after maximal growth of macrophytes, in early September 2010. Aboveground biomass samples were collected from 1×1m plots. Belowground biomass samples were collected at a depth of 25 cm in 3 replicates adjacent to each chamber using a 10×10 cm auger. Samples were analysed for N, P and C.

Our first results showed high nitrous oxide emissions (up to 6 kg N<sub>2</sub>O-N m<sup>-2</sup> yr<sup>-1</sup>) from the fen meadow and high CH<sub>4</sub> emissions from the natural raised bog (up to 120 kg CH<sub>4</sub>-C m<sup>-2</sup> yr<sup>-1</sup>). The almost zero CH<sub>4</sub> emission from the *Phalaris* plots and bare soils was due to the deeper water table (50-60 cm below ground) and high sulphur concentration in peat (up to 13 g kg<sup>-1</sup>), which probably inhibited methanogenesis. The surprisingly high CO<sub>2</sub> flux from the *Phalaris* plots and the low CO<sub>2</sub> emission from bar peat areas was probably due to (1) the influence of non-harvested grass and the formation of a thick litter layer on the surface (easily decayable C), and (2) higher water level and inhibited mineralization by recalcitrant C of bare peat. N<sub>2</sub>O

flux from *Phalaris* plots was very low ( $<0.1 \text{ kg N}_2\text{O-N m}^{-2} \text{ yr}^{-1}$ ). In September 2011, eddy covariance measurements will be conducted to measure net ecosystem exchange of  $\text{CO}_2$ .

Likewise, other studies show that with proper site selection, new energy crops can be cultivated even on organic soils with low  $\text{N}_2\text{O}$  and  $\text{CH}_4$  emissions. In Finland the mean  $\text{N}_2\text{O}$  emission of reed canary grass cultivated on drained organic soils was only around  $300 \text{ kg CO}_2 \text{ equiv ha}^{-1} \text{ yr}^{-1}$  (Hyvönen et al., 2009).

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## Assessment of Methane and Nitrous Oxide Fluxes in Rural Landscapes

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We estimated  $\text{CH}_4$  and  $\text{N}_2\text{O}$  emissions from the main land-use types in rural landscapes using results from field studies and data from the literature (950 study sites/experiments from the temperate and boreal zone published from 1980 to 2009 in 165 scientific papers indexed by the ISI Web of Science) and assessed the emission potential of  $\text{CH}_4$  and  $\text{N}_2\text{O}$  from rural landscapes in Estonia. Field data were gathered from March 2008 until November 2010 in 24 sites using the closed chamber technique and gas-chromatograph analysis. The study areas were 7 agricultural fields (from intensively used to set-aside), 5 forest sites (three riparian, two paludified) on both automorphic and hydromorphic soils, 6 wetland ecosystems with both natural and altered water regime (including peat extraction areas and bioenergy crop plantations). The cartographic analysis is based on the Estonian soil map (1:200,000, 54 soil type classes), the map of Estonian drainage systems (1:10,000) and the Corine Land Cover Map of Estonia from 2000 (1:100,000). The geometric intersection of the soil map with the digital map of Estonian drainage systems was performed to determine automorphic and hydromorphic soils. This output map was overlaid and intersected by the Corine Land Cover map to define soil types for different land-use units.

Based on this analysis, natural peatlands and marshes appeared to be the most important  $\text{CH}_4$  emitters, whereas  $\text{N}_2\text{O}$  is emitted mainly from drained peatlands and marshes, set aside areas, conventional arable lands, fertilized grasslands and coniferous and mixed forests – all on hydromorphic soils. The estimated median value of annual  $\text{CH}_4\text{-C}$  and  $\text{N}_2\text{O-N}$  fluxes for Estonian rural landscapes are 25,519 and 11,050 t respectively. The Global Warming Potential (GWP) of Estonian rural land-use types ( $42,685 \text{ km}^2$ ) from potential  $\text{CH}_4$  and  $\text{N}_2\text{O}$  fluxes is 5.99 million t of  $\text{CO}_2$  equivalents, of which  $\text{N}_2\text{O}$  is responsible for 86%.

The following principles can be taken into account for the mitigation of GHG fluxes from

rural landscapes: (1) the avoidance of drainage on peatland soils (minimizes N<sub>2</sub>O and CO<sub>2</sub> emissions), (2) the preferred development of organic agriculture (less fertilization decreases emissions from most agricultural areas), (3) the plantation of short-rotation energy forests and energy crops (helps sequester CO<sub>2</sub> and consume CH<sub>4</sub>). In hot spots such as riparian zones and wastewater treatment wetlands, special management (selective cutting of trees in the riparian forest, more efficient pre-treatment of wastewater) can be undertaken. In the short-term perspective, the restoration of drained peatlands may result in high methane emissions.

## **Democratic Participation in Territorial Resilience**

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Nowadays the involvement of public stakeholder in the process of territorial management testifies globally everyone's willingness to get involved in Landscape Modelling. Also it makes tangible crisis of the legitimacy of representative democracies. This willingness shows in non-governmental associations that each society developed in very different ways according to their relation to the environment.

In Japan where the political and economic policies have favored the disintegration of the civic reconciliation structures on the level of spatial problems since 1945, it surges, thus, the new practices of societal implication which is to renew the understanding of their environment in the early 80ties.

Therefore, it is that the Research Center KAMOKEN on Sado Island (佐渡島) where a multidisciplinary team consisting of indigenous people, government officers, and university researchers produces a fully independent research in order to form the basis of a *Local Governance*, and also based on the ecological restoration project of the inside Lake, to provide a veritable response induced by its relation to the environment through a thorough collaboration.

For this, we will have to address the early history of Non-Profitable Organization NPO of environment so as to understand the Japanese specificity as we seize the contribution of these organisations to the reconstruction of the devastated areas after March 11, 2011.



## **How Urbanization Change Urban Forest Soil Chemical and Physical Properties at Different Space Scale**

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We conveyed the urban forest soil conditions concerning soil physical and chemical properties together at different space scale in Beijing, China. The objectives of this study were (1) evaluate the effects of urbanization on urban forest soil properties; (2) identify the main factors which have changed urban forest soil. (3) clear which space scale can be attributed to the urban forest soil properties variation, and what extent they can explain the change of urban soil. Our result showed urbanization have changed soil properties at different space scale, and the variation between chemical properties was more than physical properties. Unlike natural soil, relationship between urban forest soil and vegetation structure was not particularly evident at the plot scale or minor scale. At the local scale associated with different land use, only soil density, soil pH and soil available phosphorus exhibited obvious variation, while other soil characters were scarcely affected by types of land use, especially soil heavy metal pollution status was out of our previous forecast. At the regional scale, applying for different urbanization gradient measurements, the findings indicated that with the increased intensity of urbanization, urban soil nutrient was greater than suburbs, including soil available phosphorus and potassium, soil organic matter, while soil heavy mental pollution increase gradually. Integrate factors we chose from these three space scale, the result of CCA analysis revealed urban soil propertied can be attributed more to the regional space scale, it can explain much more urban soil properties variation. The research enables us to conclude that urbanization has cause tremendous transform at the large space scale. These results will be significant for planning and managing urban forest ecosystem in the future.

**Keywords:** Urbanization, Forest, Soil properties, Space scale

## **Sustainable Use of Wild Vicuñas in Jujuy, Argentina: Ecological, Health and Human Interactions Aspects.**

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Although the South American Camelids have an original distribution along the Andes of South America, vicuñas are restricted to the Altiplano or Puna of Perú, Bolivia, Chile and Argentina.

Vicuñas share their grazing lands with domestic livestock like llamas and non-traditional altiplano species like bovines, sheep and goats. The main threat to their high mountain habitat comes from desertification processes arising from overgrazing mainly by exotic livestock and lack of proper management. On the contrary, camelids are considered low-impact grazers.

Sustainable use of wild species could become a good source of income for local communities that have protected the vicuñas for decades and facilitate an activity which involves low management cost but which is highly compatible with environmental protection and wildlife conservation.

The vicuña bears the highest finest animal fiber in the world and this fiber was valued since pre-hispanics times by ancient cultures which use this resource in a sustainable way by chakus. This method represents a mixture of scientist and local people working together. During the chaku, the people herd the wild vicuñas towards a corral, where adult animals are shorn.

The objective of VICAM Research Group-Vicuñas, Camelids and Environment- includes the holistic approach to sustainable use of wild vicuñas taking into account: the ecology of the species, the culture of the local communities, the revalue of the chaku techniques, the improvement of animal welfare techniques and environmental education.

Several modifications to minimize injuries and mortalities caused by the captures had been included. Time of capture, distance and herding time, captures facilities, restraint time and handling procedures were improved. Multiple animal welfare recommendations were suggested: the duration of the herding and longer restrain times should be minimized. Blindfolding animals for handling and the immediately transfers of the crias to a pre-release corral, were factors that should be regular practices.

Since vicuñas share their sparse grazing with domestic animals, diseases transmission between livestock and wild vicuñas could be possible. Antibodies against several infectious diseases were also checked in captured vicuñas to assess health status of the free-ranging population.

This work illustrated the capture, handling and release of wild vicuñas and presents the physiological and health status of the wild populations studied in Jujuy, Argentina.

## **Protected Landscape in Kosovo and their Role in Sustainable Development**

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Kosovo, although a small country on the map of the globe, is characterized by rich nature, with landscapes, diverse world of plants and animals. Currently the number of nature protected areas in Kosovo is 97 and includes a territory of 47,842.34 ha (4.39% of the territory of Kosovo). Within these areas fall: 11 Nature Reserves, 1 National Park, 82 Nature Monuments, 2 Protected landscape ("Germia" and " Mirusha") and 1 Forest Park.

The canyon of Mirusha is one of most interesting nature areas in Kosovo with 555.81 ha. In this part of the canyon are located 16 exciting waterfalls with lakes that make the most attractive part of the canyon. The area is quite rich with species and associations of flora. A specific of the Mirusha territory flora, is the presence of 14 plant associations, and 5 of them

are to endemic character, whilst the total number of endemic species is 21.

Germia landscape is located in north-east of Kosovo and it covers an area of 1126 ha. Based on geographical position, geological features, and climate conditions the mountainous massive of Germia is quite rich in regard to flora, vegetation and fauna. In researches made so far, 610 species of vascular flora are evidenced. These species are grouped into 83 families, 83 fungi species, 5 endemic species and 12 medical plants. The complexity of Germia natural biotopes provides good conditions for a wide number of animal species. According to the researches, in Germia area are identified: 5 amphibians, 7 reptile, 19 mammal and 30 bird species.

The virgin nature values of Kosovo as well as historical and culture monuments diversity in Kosovo, offers good opportunities for tourism development as is: mountainous tourism, health tourism, excursion tourism etc.

As elsewhere in the world, our natural heritage is under the permanent pressure from unplanned and uncontrolled use of natural resources. Constructions and intervention in Mirusha river embankment as well as other vegetation damages that affect directly the biodiversity are most evident in the area. Lack of a management body for the Mirusha park is also one of the problems for area management. Also due to the forest exploitation are appeared soil erosion and decrease of water flows. Because the Mirusha and Germia represents an important and interesting flora, fauna, tourist and recreational area, it is necessary to undertake proper measures in order to prevent further degradation.

## **Can a Problem-solving Approach Strengthen Landscape Ecology's Contribution to Sustainable Landscape Planning?**

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The need to avert unacceptable and irreversible environmental change is the most urgent challenge facing society. Landscape ecology has the capacity to help address these challenges by providing spatially-explicit solutions to landscape sustainability problems. However, despite a large body of research, the real impact of landscape ecology on sustainable landscape management and planning is still limited. In this paper, we first outline a typology of landscape sustainability problems which serves to guide landscape ecologists in the problem-solving process. We then outline a formal problem-solving approach, whereby

landscape ecologists can better bring about disciplinary integration, a consideration of multiple landscape functions over long time scales, and a focus on decision making. This framework explicitly considers multiple ecological objectives and socio-economic constraints, the spatial allocation of scarce resources to address these objectives, and the timing of the implementation of management actions. It aims to make explicit the problem-solving objectives, management options and the system understanding required to make sustainable landscape planning decisions. We propose that by adopting a more problem-solving approach, landscape ecologists can make a significant contribution towards realising sustainable future landscapes.

## **Modelling the Potential of Large-scale Revegetation to Reduce the Impacts of Climate Change in Semi-arid Australia**

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Climate change is the most urgent environmental, economic and social issue facing the world. The concentration of greenhouse gases has grown rapidly in recent decades, and is expected to continue well into the 21<sup>st</sup> century, increasing the risk of dangerous climate change. The options for significant reduction of emissions are still being debated and as yet there is no global agreement in place. A number of studies show that reforestation in the tropics and sub-tropics could be beneficial to mitigating global warming as well as having other benefits such as carbon sequestration and maintenance of ecological services including biodiversity, clean air and water. Restoring native vegetation at a regional scale also has the potential to reduce the impact of climate extremes. This may be particularly important for eastern Australia, where climate extremes, in particular droughts and heatwaves, have been accentuated by historical land clearing. This oral presentation outlines a project examining the potential role of restoring native woody vegetation in eastern Australia to mitigate climate extremes in a warming climate. It uses the very-high resolution (~10 km) stretched grid CSIRO climate model (CCAM) to explore different options for targeted reforestation in the region.

## **Climate Change Impacts on the Critical Acid Loads and Exceedances of Forest Soils across the Conterminous United States**

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The Federal agencies of the United States (US) are currently developing guidelines for forest soil critical acid loads across the US. A critical acid load is defined as the amount of acid deposition (usually expressed on an annual basis) that an ecosystem can absorb. Traditionally, an ecosystem is considered to be at risk for health impairment when the critical acid load exceeds a level known to impair forest health. The excess over the critical acid load is termed the *exceedance*, and the larger the exceedance, the greater the risk of ecosystem damage. This definition of critical acid load applies to a single, long-term pollutant exposure. These guidelines are often used to establish regulations designed to maintain acidic deposition (e.g., nitrogen and sulfur) inputs below the level shown to exceed an ecosystem's critical acid load. The traditional definition for a critical acid load generally assumes that the ecosystem is in a steady state condition (i.e. no major changes in the factors that regulate the ecosystems ability to absorb acids. Unfortunately, climate change is altering weather patterns and, thus, impacting the factors that regulate critical acid load limits. This paper explores which factors associated with establishing forest soil critical acid load limits will most likely be influenced by climate change, and how these changes might impact forest soil critical acid load limits across the US. Base cation weathering could increase with global warming, along with nitrogen uptake as a function of increased forest growth across New England. We examine the most likely range of climate change and associated impacts on nitrogen uptake, base cation weathering and critical acid loads across the conterminous US. While these results are interesting, they do not account for other negative potential forest health risks associated with climate change such as elevated fire, insect, or disease risk. These factors must be accounted for before a more complete assessment of climate change impacts on critical acid loading is possible.

## **Building Ecological Security Pattern of Ordos Based on Land Use**

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Reasonably building regional ecological security pattern based on land use to improve ecological security level has been the requirement for eco-environmental protection. Taking Ordos, a typical farming-grazing transitional region in the northern part of China, as the study area and on the basis of natural data, socio-economic statistical data and land use/cover data, the ecological security pattern is built using multi-objective optimization model and spatial analysis technologies in the software of ArcGIS. The main conclusions are presented as

follows: (1) The quantitative structure of land use derived from multi-objective optimization model shows that the area of cultivated land, woodland, waterbody and construction land has an upward trend, that the area of grassland approximately maintains the same, and that the unused land reduces significantly. In comparison with the conditions in 2008, both the economic production and ecological security level rise. The water resources consumption and the soil erosion quantity become higher, but they are still not beyond the acceptable level. (2) Considering land suitability, land ecological security, and urban and mineral resources planning, the ecological security pattern in Ordos is built using the spatial analysis technologies. The results are showed as follows. The cultivated land expands, and is distributed along the rivers, lakes and reservoirs where the water conditions are favorable and at the peripheries of towns and villages. Woodland, whose area rises significantly, is mainly distributed in the northern part of Dalad Banner and the eastern part of Jungar Banner. The grassland, the dominant land-cover type, increases slightly, and it covers almost the whole study area except Kubuqi Desert and Mu Us Sandland (sparsely distributed among the two deserts). Unused land lessens in large amounts, and it is mainly distributed in Kubuqi Desert located in Hanggin Banner and Mu Us Sandland situated in Uxin Banner and Otog Banner. The increase in construction land mainly derives from the expansion of key planned towns and mining areas. Then the measures taken to implement and govern security pattern of each land-use types are proposed, which bears great implications to land resources management and ecological security improvement.

**Keywords:** Ordos, Land use, Ecological security pattern, Multi-objective optimization model

## **Effects of Changing DEM Resolution and Environs Size on Landscape Components Interactions**

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The modifiable areal unit problem (MAUP) and “scale effects” are well known in landscape ecology but remain important and actual topics in landscape researches (Jelinski, Wu, 1996; Marceau, 1999). MAUP is revealed in considerable variation of analysis results depending on grain, extent, observations quantity etc. Presented study demonstrates effects of changing resolution of topographic basement and environs size on interactions strength between landscape components.

Independent differentiation factors of vegetation and soils have been calculated from field data using multidimensional scaling technic. The physical interpretations of these factors have been determined by analysis of factor loads. For revealing the influence of grain size on the relationships between landscape components (vegetation/soils and relief) two resolutions of DEM have been used (30 m and 400 m in pixel derived from topographic maps 1:10000 and 1:50000 accordingly). Relief characteristics based on DEM (standard deviation of altitudes, sum of stream lengths, vertical and horizontal curvatures) have been computed for these two resolutions in sliding square with side size from 3 to 15 pixels. Multiple regression analysis

has been used to determine relationships between differentiation factors of mobile landscape components (vegetation and soils) and relief characteristics. Received determination coefficients for different spatial levels demonstrate the changes in landscape components interactions depending on environs size and grain size.

Herbs and trees have the closest relations with relief characteristics at both grain size but the density of these relations is much lower in fine scale (determination coefficient 17-31% in 400 m and 27-46% in 30 m). At 400 m DEM resolution the highest value is characteristic for forest/bog species ratio in environs 1200-2800 m that corresponds to landscape pattern of the region (several relief stages with different drainage level). The factor of anthropogenic disturbance is related with relief in 6 km environs that reflects the difference in economic usage of the territory (agriculture or forestry). Bush, moss, lichens, soils color, layers structure and lithology at 400 m DEM resolution in all environs have no correlations with morphometric characteristics. Differentiation of all these natural features is described by 30 m DEM grain size because of their sensitivity to microrelief and local conditions of moistening and nutrition. In general increase in grain size results in reduction of relations strength between mobile landscape components and relief.

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## A Global Environmental Stratification as Basis for Monitoring and Modelling

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There is growing urgency for integration and coordination of global environmental and biodiversity data required to respond to the 'grand challenges' the planet is facing, including climate change and biodiversity decline. A consistent stratification of land into relatively homogenous strata provides a valuable spatial framework for comparison and analysis of ecological and environmental data across large heterogeneous areas (Metzger *et al.*, 2005; Jongman *et al.*, 2006).

We discuss how statistical stratification can be use to design regional, European and global

biodiversity observation networks. We will draw on insights from the ongoing European Biodiversity Observation Network (EBONE) project, which will provide methodologies and recommendation for biodiversity monitoring in Europe. Furthermore, we will discuss ways of extending these approaches globally supported by the recently developed Global Environmental Stratification (GEnS; Metzger *et al.*, 2011). This dataset distinguishes 125 strata and eighteen zones with a 30 arcsec resolution (approximately 1km<sup>2</sup>). The GEnS has recently been used for modeling of impact of climate change on ecological zones and habitat types within the transboundary Kailash Sacred Landscape in the Himalayas, and is currently being used to design sampling networks and for statistical inference in the context of strategic monitoring of habitats and biodiversity in Portugal.

The GEnS provides a robust spatial analytical framework for the aggregation of local observations, identification of gaps in current monitoring efforts, and systematic design of complementary and new monitoring. It has potential to support global biodiversity monitoring, and has been identified as a focal geospatial data resource for tasks of the Group on Earth Observation Biodiversity Observation Network (GEO BON; Scholes *et al.*, 2008).

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## **Integrated Assessment Modelling of Ecosystem Services, Vulnerability and Adaptation in Europe and Scotland**

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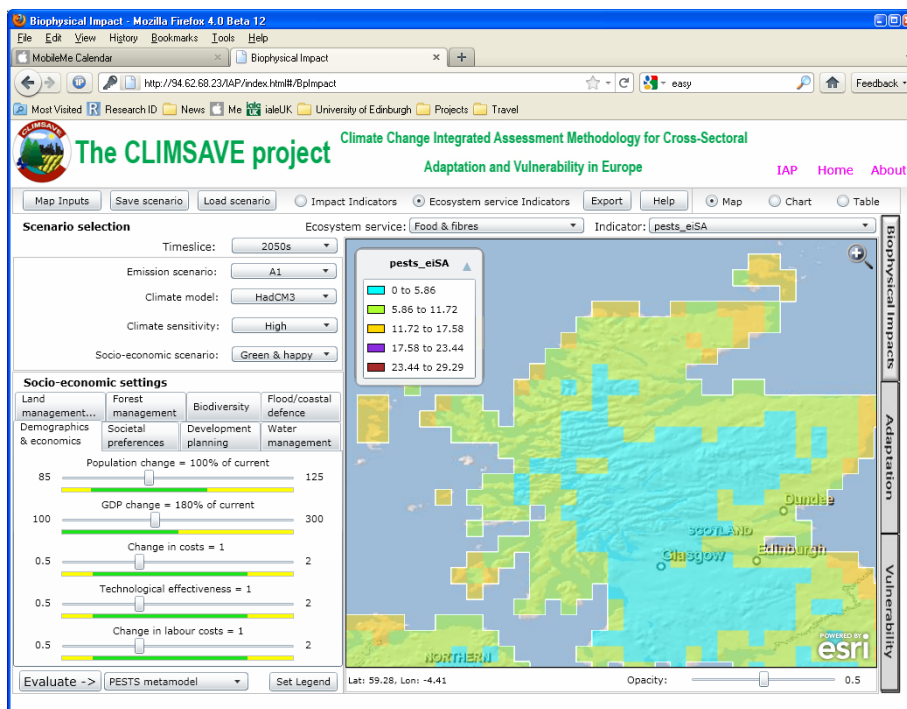
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Climate change will present significant challenges to the way we live and work. Scotland is actively working to limit further climate change by establishing world-leading emissions reduction targets under the Climate Change (Scotland) Act, but mitigation alone will not be sufficient to prevent climate change impacts, and we will therefore need to find pro-active ways to cope with these. The European Union research project CLIMSAVE is using Scotland as a case-study for developing an integrated methodology to assess cross-sectoral climate



change impacts, adaptation and vulnerability. A major product will be an intuitive web-based tool which will address adaptation options for sectors likely to experience climate change impacts. This Integrated Assessment Platform will:

- focus on agriculture, forestry, water, biodiversity, and related ecosystem services
- use a multi-driver multi-sector approach enabling users to assess and compare adaptation options across sectors
- use integrated scenarios describing alternative socio-economic development pathways
- enable users to assess potential climate change by defining their own questions
- explore possible trade-offs and synergies between sectors



*Demo version of the software tool, which will be adapted for Scotland.*

[www.climsave.eu](http://www.climsave.eu)

This is very much work in progress. The first professionally facilitated stakeholder workshops exploring the software tool will be held this Spring, so by the time of the conference it will be possible to demonstrate the tool and discuss initial stakeholder feedback.

## Putting Nature into our Neighbourhoods

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Urban environments support recombinant ecosystems made up of novel mixes of indigenous and exotic plants and animals (Meurk, 2011). Even predominantly indigenous communities will contain combinations of species never before seen in nature. Exotic and non-local or cultivar native species are generally dominant in southern, colonial and/or non-continental

regions. Nevertheless, cities frequently occur on environmentally diverse sites, poorly represented in protected areas, and so are at least potentially important for biodiversity conservation. Moreover, cities are the only places where the majority of the human population experiences nature (Erfurt Declaration), a prerequisite for identity and protectiveness.

The long term goal for urban biodiversity is to facilitate a critical mass of self-reproducing, indigenous species, across a range of scales, capable of generating spontaneous native plant communities, in balance with urban environmental gradients, with a minimum of management effort. Key steps to this are identifying and managing invasive or potentially dominating biosecurity risks; protecting and enhancing degraded remnant natural habitats; planning for sanctuary core habitats at optimal spacings for wildlife and human access or visibility; creating new 'climax' and stable 'sub-climax' communities according to substrate conditions; and progressively inserting seral, indigenous species into managed, open or low growing vegetation such as wastelands, lawns, herbaceous borders and walls, informed by Grime's Stress-Disturbance framework (Meurk, 2004; Swaffield et al., 2009). Sustainability measures can also be applied to reduce consumption of limited resources such as water and energy (matching species to substrate), maximising long term carbon sequestration (indigenous noble trees), and conserving soil carbon.

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## **Sustainability Impact Assessment - Methods Development for the Localization of Policy Impacts**

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The contribution discusses and demonstrates on the basis of actual definitions of environmental impact assessment, strategic environmental assessment and sustainability impact assessment a new approach for sustainability impact assessment (SIA) of European policy impacts in rural areas. The SIA includes the economic, social and environmental indicators dimensions in the context of rural development.

The methods development is part of the EU-FP-7project PRIMA (PRototypical policy Impacts on Multifunctional Activities in rural municipalities). Main aims of the SIA methods

development is the description of a framework for SIA. The framework includes (1) the linkage of policy impacts and scenario developments, (2) methods for stakeholders involvements, (3) the listing of measures applied on the regional scale level for plans and programmes, (4) the listing of events and economic activities applied by stakeholders on the local scale level for projects, (5) scaling up from local via regional to nationwide scale level, (6) indicator descriptions and assessment methods, and (7) methods for integrative assessment tools.

Aim of the approach is the linkage of different spatial indicators for the SIA of policies on different spatial scales. The assessment shall clarify the impacts of policies on rural development by using examples from agriculture, forestry and tourism economic activities. The framework will be useful for the management of urban growth and investigations about structural changes induced by policies and the planning for sustainable environment.

Information about PRIMA: <https://prima.cemagref.fr>

## **Analyzing the Drivers of Changes in Landscape Structure in the Tropical Forest Margins of Cameroon.**

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Distinguishing the different types of land use changes, their drivers and impact on landscape structure is critical to design effective mitigation strategies within the REDD+ context, and maximize the synergies between carbon storage and biodiversity conservation (Koh and Ghazoul 2010). At the tropical forest margin, where selective logging, smallholder agriculture based on shifting cultivation and agro-industrial farming are at work, distinguishing structural processes of deforestation, reforestation and intensification from short term changes intrinsic to the local land management systems (e.g. fallow rotation) requires specific approaches.

This study integrates the analyses of the drivers and spatial structure of land use and land cover change (LULCC) in an area of Southern Cameroon. Patch dynamics are examined through an object-based analysis of LULCC from a time series of remote sensing images. The spatial structure of change is built from the analysis of pattern and class metrics of patches of change. A moving-window approach (Messerli et al. 2009) is then used to delineate larger landscape units, defined as areas within which the pattern of change in landscape structure is homogenous.

Data on land zoning, agricultural systems, and geographical and socio-economics characteristics are then used to analyse the causes of spatial patterns of LULCC, using descriptive statistics (Cassidi et al. 2010) and spatial regressions on landscape units

(Wimberly and Ohmann 2004). Socio-economic data will be reinterpreted spatially to fit these landscape units (Bürge and Turner 2002). This will allow understanding how the main current drivers of land use change in the tropical forest margins of Cameroon – i.e. small-scale agriculture for subsistence and markets, agro-industry development, mining, and new infrastructures – lead to different landscape structures, and designing land management strategies for REDD+ to enhance carbon storage and biodiversity conservation.

## **Prognosis of Climate Change Landscape Impacts in the Carpathian Basin**

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The presentation discusses the potential impacts of climate change on landscapes stability and sensitivity in Hungary and the Carpathian Basin until the year of 2100. The presentation focuses on the main methodological steps to link climate change modeling and the prognosis of potential functional changes induced by changes in climate on a landscape scale. Main topics are the analysis the impacts of the predicted climate on landscape processes and the assumed conflicts between climatic changes and landscape functions.

Starting the discussion with a comparison of different regional climate change models the data from REMO model was chosen for the linkage to the landscape scale. Main climate change impacts in Hungary are explored with special emphasis on the analysis of the extremata (e.g. >30 mm daily precipitation index, dry seasons, heat waves, changes in variability of extremata). On a mapping of landscape units the direct and indirect impacts are analyzed. Main impacts caused by extreme events or caused by slow landscape changes are differentiated. Extreme and slow events are analyzed by simple risk assessment modeling, e.g. for floods, forest fires, groundwater and inland water changes and for soil erosion by water and wind.

The layer of landscape units is the principal GIS basis to link different information (e.g. land use (Corine Landcover), soil, vegetation, digital elevation model, water household, municipalities' statistical data about population census, etc). The results of the model applications are risk assessment maps classified and interpreted on the landscape type scale. The prognosis of landscape changes in the Carpathian Basin gives a first insight to scale down the scarce grained climate change prognosis on a landscape and land use level of regional to local application. The estimated scenarios will link and differentiate the climate and landscape changes to the functional risks for landscape units. This approach will give a basis and new perspectives for the management of changes and the climate change adaptation.

## Ecological Stability Evaluation in Landscape Consolidation Processes

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Ecological stability evaluation in landscape consolidation processes is instrumental to determine demand of ecological arrangements and its incorporation to the landscape consolidation project. This demand is determined already in pre-trial part of landscape consolidation project, because according to Methodical proceedings to carry out landscape consolidation projects (Geisse et al., 2006) it is not necessary to deliberate in landscape consolidation project with ecological arrangements, if coefficient of ecological stability acquired degree 3 and more (that means, this area has from middle to very high ecological stability). The minimum degree of ecological stability after the realization of landscape consolidation project has to be at least medium ecological stability degree. On the other hand it is not allowed to reduce this coefficient under medium degree.

The model landscape consolidation represents a territory of Stola municipality. This sub-mountain area of interest is situated in the north-east part of the Slovak republic with the altitude rising from 820 to 975 m above sea level and covering the area of about 256 hectares. Uniqueness of Stola cadastral area and its importance for landscape and nature protection is expressly proven by fact that more than one half of its area belongs to the oldest national park in Slovakia - National Park High Tatras. Another part of the cadastral area creates buffer zone of the national park. Stola village lies in wide, relatively fordable valley.

Stola agricultural part of landscape is with a dominance of meadows and pasturages. This landscape type (Pado, 2001) has incomparable higher ecological stability than arable landscape with intensive agricultural maintenance. The main landscape elements are determined as: built-up areas (15.04 % of total area), non-forest vegetation continuous areas (2.45 %), permanent grasslands with abundance of woody species (21.16), permanent grasslands without abundance of woody species (12.4 %), forests (41.03 %), non-forest vegetation by the river continuous (4.41 %).

The total value of ecological stability coefficient is 4.94, which means that this cadastral area is markedly stable landscape. Biocorridors, biocenters and interactive elements in Stola cadastral area are connected on all levels – local, regional and supra-regional. This higher ecological stability creates better conditions for species diversity and their populations in zoocoenosis. This creates higher amount of feedbacks and thereafter reinforces total landscape ecological stability.

According to the ecological stability new landscape-ecological optimal functional landscape arrangements proposal is not markedly changed in comparison to recent status, because recent land use does not need strict changes.

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## **Relation between Artificial System and Natural System**

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Cities could be defined as areas where there are roads, buildings and industries, but also as places where humans live. Actually the word “urban” refers to a certain kind of human community with a high density of people, including their dwellings and other constructions (Niemela, 1998). Natural system could be described as the space where plants and animals live. The meaning of natural system is closely linked to the word “Biodiversity”. Biological diversity – or biodiversity- is the term used to define the variety of life on Earth and the natural patterns it forms, encompassing the full range of species, genetic variations and ecosystems in a given place (Newman and Jennings, 2008). We could be defined as the artificial ecosystem or “urban ecosystem”; the natural ecosystem as the “ecological corridor” around and into the cities. The aim of this research is: discovering whether there is cooperation or competition between the artificial system and the natural system. Therefore, a new ecological model was developed in order to analyze the ecological niches through a "habitat suitability map" (for the output of the niche models), than the surrounding urban context. The model was supported by GIS. The case of this study are the Lames (Urban Creek). Urban Creeks are the fundamental biological corridors and related ecological net, connecting internal areas to the coast. Hence, they are key-factors for nature protection and biodiversity increasing on coastal environments. This dissertation involves two steps: the first one is understanding the perception of the landscape, by a human point of view, as “wild” or “homely”; the second one is assessing the ecological conditions through the application of a Fluvial Functionality Index (FFI), proposed since 2000 by Italian Protection Agency.

Methodology of research:

- Study of land use (through GIS) of the area of the channel Asso creek basin.
- Identification of areas covered by reeds (by aerial photo interpretation and a GIS) in the Asso creek basin, presence of *Phragmites australis*.
- Morphological study: inventory of areas suitable for wetland development.
- Identification of a significant Asso creek section to monitor water quality and evaluate indices, such as: Fluvial Functionality Index, Extended Biotic Index..)
- Laboratory analysis of water quality (P, N, BOD, *Escherichia coli*), upstream and downstream of an inlet wetland, to assess, experimentally, its water depuration capacity.
- On the base of this experience, design of a pilot plant (fitodepuration, constructed wetlands) for wastewaters treatment.

## **Conservation of Agricultural Heritage Systems and Practices: the Global GIAHS Initiative and the Chinese Pilot Country**

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Worldwide specific agricultural systems and landscapes have been created, shaped and maintained by generations of farmers and herders based on diverse natural resources using locally adapted management practices. Building on local knowledge and experience these ingenious agricultural systems reflect the evolution of humankind, the diversity of its knowledge and its profound relationship with nature. These systems have resulted not only in outstanding landscapes maintenance and adaptation of globally significant agricultural biodiversity indigenous knowledge systems and resilient ecosystems, but above all, in the sustained provision of multiple goods and services, food and livelihood security and quality of life. However, many of these systems are facing severe threats from various sources including globalization. In 2002 FAO initiated an international partnership initiative: “conservation and adaptive management of Globally Important Agricultural Heritage Systems (GIAHS)”. The global GIAHS initiative aims to establish the basis for the international recognition, dynamic conservation and sustainable management of such systems, agricultural biodiversity and their associated biodiversity knowledge systems, food and livelihood security, landscapes and cultures.

As one of the first pilot countries of GIAHS project, China has thousands of years’ agricultural history and rich agricultural heritage systems. “Qingtian Traditional Rice-fish System” in Zhejiang province, “Hani Rice Terraces System” in Yunnan province and “Wannian Rice Culture System” in Jiangxi Province were selected as pilot systems by FAO in 2005 and 2010. Agro-biodiversity characteristics and multi-values of these systems were studied and dynamic conservation approaches were searched and practiced. The experiences and lessons are useful to other pilot sites and modern agricultural development.

## **Landscape Approaches: Towards Multifunctional Landscapes for REDD+, Adaptation and Ecosystem service (introduction)**

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Current emission reduction mechanisms within the UNFCCC treat forests, agriculture and other land uses in developing countries separately. This creates a number of challenges for addressing emission reductions such as lack of clarity and of harmonization in definitions of what is “forest” and what is “non-forest”; how to address drivers of deforestation and cross sector policy levers for addressing emission reductions. Other conservation and payments for ecosystem services initiatives also tend to approach landscapes from a single function perspective and therefore create a set of challenges for managing landscapes as a whole. This symposium explores a landscape level approach to emissions reductions featuring all land uses in planning, incentives and accounting of emission reductions that takes into account trade-offs with multiple provisioning, regulating and supporting functions. It sets the scene for the discussions on the opportunities of and challenges for developing REDD as an aspect of multifunctional landscapes. The role of multifunctional landscapes in enhancing climate change adaptation is also introduced with examples.

## **Agro-Cultural Landscapes in China: Types and Significances**

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In many countries, specific agricultural systems and landscapes have been created, shaped and maintained by generations of farmers and herders based on diverse species and their interactions and using locally adapted, distinctive and often ingenious combinations of management practices and techniques. These Agro-cultural landscapes are all integrated bio-cultural systems with plenty of biodiversity and cultural diversity. Many traditional, liking rice terraces and vineyards were listed in the World Heritage List. FAO launched an initiative in 2002 and defined Globally Important Agricultural Heritage Systems (GIAHS) as “Remarkable land use systems and landscapes which are rich in globally significant biological diversity evolving from the co-adaptation of a community with its environment and its needs and aspirations for sustainable development.”

“Qingtian Traditional Rice-fish System” in Zhejiang province, “Hani Rice Terraces System” in Yunnan province and “Wannian Rice Culture System” in Jiangxi Province were accepted as GIAHS pilot systems in 2005 and 2010. However, agriculture has flourished in China from time immemorial. One of the legacies of the time honored agricultural development in China has been varied farming practices that adapt well to different natural conditions. In this paper we summarized main agro-cultural landscapes, such as (rice and dry crop) terraces, integrated farming systems (rice-fish system, dike-pond system, agro-forestry), soil and water management, multi-layered home gardens, nomadic pastoral systems, inter-cropping, and so on. Their significances were analyzed viewing from biodiversity conservation, cultural heritage, food and livelihood security, adaptation to climate change, and aesthetic value.

## **A Framework Using Temporal and Spatial Metrics to Planning for Protected Areas**

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Ecological contemporary planning approaches borrow their fundamental concepts and techniques from landscape suitability (Ndubisi, 2002). Landscape suitability considers past, present and some prediction of the future of the environmental characteristics of the areas under study. These can include some data and information about spatial and temporal characteristics of protected area landscapes such as size, shape, temperature and visitation patterns (Miller, 1978; FAO, 1988; McHarg, 1997; Thomas and Middleton, 2003).



Using a case study, this paper will show how practically we use these data and how we can improve the contemporary planning approaches for protected areas in a sustainable manner. In other word, the importance of spatial and temporal characteristics of protected areas will be highlighted. This will also lead to a list of important spatial and temporal characteristics of protected areas.

## **Wetlands - A Significant Global Sink of Carbon?**

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Wetlands offer one of the best natural environments for sequestration and long-term storage of carbon dioxide (CO<sub>2</sub>) from the atmosphere and yet are also natural sources of greenhouse gases (GHG) emissions, especially carbon-based methane (CH<sub>4</sub>). Both of these processes are due to the anaerobic conditions created by shallow standing water and saturated soils that are features of wetlands. When CO<sub>2</sub> sequestration and CH<sub>4</sub> emissions are measured and compared in the same wetland, the wetland is usually determined to be a net source of radiative forcing on climate, based on in current international policy that uses a global warming potential (GWP) of 25 for methane relative to carbon dioxide. Results from a dynamic model illustrate that the ratio of the net removal of CO<sub>2</sub> to the net accumulation of CH<sub>4</sub> in the atmosphere over 100 years of most wetlands become sinks within 200 years. Wetlands can and should be created and restored to provide C sequestration and other ecosystem services without great concern of creating net radiative sources on climate due to methane. The world's wetlands, despite being only about 6% of the terrestrial landscape, may currently be net sinks for a significant portion of the carbon released to the atmosphere by fossil fuel combustion.

## **(De)Stimulation of Ecosystem Services through Management of Urban Structural Changes**

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The Central and Eastern European states have been experiencing deep changes in the spatial structure – a process initiated by the systemic transformation 20 years ago. The changes are particularly visible in the largest urban agglomerations which undergo the process of deindustrialisation and simultaneously become the growth poles, whereas the peripheral areas face stagnation or even extensification of the space use (Łowicki, 2008).

The city of Poznań has been used as an example to present three types of clashes between various forms of urban land investments and the ecological and recreational functions fulfilled by the green areas (Chorażkiewicz, 2010).

In the times of real socialism, urban spatial structure was shaped by political and administrative control and almost unaffected by the market factors. On one hand that marginalized the pressure to develop investments in the areas of natural interest, but on the other hand, the political system did not allow to protest against inaccurate decisions taken by the authorities.

Yet, from the perspective of landscape ecology, the assessment of the effects the transformation had on the spatial planning may be equally ambivalent. Development of the society and democratic spatial planning procedures created formal grounds to take informed spatial decisions based on the balance of social, environmental and economic arguments. In practice, however, it is not uncommon that the factors based on particular, often short-sighted, economic interest play a critical role.

The impact on the level of urban ecosystem services, understood as benefits derived by man from the functions of natural systems, is still disregarded in the process of taking decisions concerning urban spatial planning. The concept of urban ecosystem services emphasizes the utilitarian aspects of ecosystems functioning in the urbanised areas. However, to measure their economic and ethical meaning correctly, it is necessary to combine the achievements of the landscape ecology with the knowledge of economic and social sciences (Mizgajski et al, 2010).

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## **Wetlands Landscape Ecological Classification Based on Object-oriented approach: A Case Study of Southern Hangzhou Bay Area**

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Wetlands landscape ecological classification, as a basis for the studies of wetlands landscape ecology, directly affects the precision and effectiveness of wetland-related research (Cao et al., 2009). Moreover, reducing the disturbance of “Same spectrum different target, same target different spectrum” phenomenon and “salt and pepper” effect, and enhancing the automatization and precision of classification, remain the key issues and the top concerns in this realm of research. In this paper, based on Landsat TM data and the Feature Extraction module of ENVI EX software, object-oriented approach was applied to carry out the remote sensing image classification of wetlands landscape in southern Hangzhou Bay area. And comparisons of object-oriented and traditional pixel-based approach (including Maximum Likelihood, Neural Net and Support Vector Machines) were conducted on the basis of the classification results after then, to systematically analyze the utility of object-oriented classification of wetlands landscape with medium-and low-resolution image. The research shows that, compared with the traditional approach, object-oriented approach effectively reduces the disturbance of the “Same spectrum different target, same target different spectrum” phenomenon and “salt and pepper” effect with the pixel-based approach, thus generating more accurate results for most of the landscape classes (with overall accuracy of 88.80% and Kappa coefficient of 0.8765 in this case), and has a better discriminability for wetlands landscape. It is also found that image segmentation plays an important role in the process of object-oriented classification, and 60% is a reasonable parameter of division scale for the object-oriented classification of medium-and low-resolution image. Furthermore, Feature Extraction module of ENVI EX enable a preview of the result of image segmentation real-time, which is a good approach to image segmentation, one that is more convenient and effective than other comparable softwares. Therefore, the results prove that the object-oriented method is an effective tool for the classification of wetlands landscape with medium-and low-resolution image.

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## **Distribution of Mercury in Some Organs of Anzali Wetland Common Cormorant (*Phalacrocorax carbo*)**

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A study conducted to screen mercury (Hg) level in the common cormorant (*Phalacrocorax Carbo*) of Anzali wetland region (that is located in 49° 25' E and 37° 28'N, in the southwest of the Caspian Sea in Iran) to determine the biological behavior of this element and to assess the exposure of wild fish-eating birds, which are a bio-indicator to this pollutant (mercury).

For this study, fifteen common cormorants were captured by net. The average weight and length of captured birds were 2.09 kg (1.26-2.51 kg) and 82.5 cm (71-88 cm), respectively.

The birds were then stored in polyethylene bags and frozen. After being frozen, the liver, kidneys and muscles, were dismantled and dried in the oven 48 hours. The samples were powdered and prepared for mercury analysis (Sacki et al., 2000) and Mercury was measured by the Mercury Analyzer Leco AMA254. Mercury concentration was measured in liver, kidney and muscle organ.

The mean concentration of mercury respectively was  $8.32 \pm 1.32$ ,  $9.25 \pm 1.71$  and  $2.064 \pm 0.22$  ppm in liver, kidney and muscle. Hg concentration was highest in the kidney and liver ( $p < 0.01$ ). The amount of mercury accumulation obtained was as follows: Liver ~ Kidneys > Muscles. Hg concentration in the liver and muscle increased significantly with growth from juvenile to adult ( $p < 0.05$ ). Comparison of Hg concentration between males and females indicated that Hg concentration in the muscle ( $p < 0.05$ ) and kidney ( $p < 0.01$ ) was significantly different

**Keywords:** Anzali, mercury, Common cormorant, Liver, Kidney, Muscle

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## Evaluating Major Cities in Japan with the CBI Tool

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In 2008, the growing population in city areas had exceeded half of the world's population. Consequently, the role of cities in conservation of natural resources and biodiversity is becoming more important in addition to their increasing potential social capability. Cities are also blessed with ecosystem services provided by ecosystems and biodiversity in and around the city areas. On the occasion of the 10th Conference of Partners (COP10) of the Convention for Biological Diversity at Nagoya, the "Plan of Action for Sub-National Governments, Cities and Other Local Authorities on Biodiversity 2011-2020" was adopted based on Decision IX/28 "Promoting engagement of cities and local authorities" from COP 9. Cities' Biodiversity Index, or CBI, known as the Singapore Index was proposed as a tool for benchmarking the situation regarding biodiversity.

The Singapore Index is the first-ever tool for assessment of biodiversity, which has been discussed and shared among international communities of local governments. We are happy to have this common tool to work with, however, we need to examine its significance by using it in various cities, and various social and natural environments in order to enhance its reliability as a tool for assessment. This paper reports on the results of a quick assessment applied to major cities in Japan to discuss the characteristics of the index in relation to the real challenges that cities are facing.

We took up thirteen government-ordinance-designated cities (including Tokyo's 23 wards) based on the user's manual for the CBI. For the purpose of quick assessment, data were

collected mainly through documents already published by the local governments including those on web sites. The CBI consists of two parts, I: PROFILE OF THE CITY and II: INDICATORS OF THE CITY BIODIVERSITY INDEX. In the latter part, indicators are categorized into three types: Category-1: Native Biodiversity, Category-2: Ecosystem Services, Category-3: Governance and Management.

The results of the assessment showed that scores for Categories-1 and 2 are strongly related to the geographical location and the topographical condition of each city. The scale of assessment and the administrative area of each city seem to directly affect the scores. For example, the significance of the biodiversity and various ecosystem services of those cities without surrounding natural areas but with agricultural areas, or cities with considerable portions of restored green spaces including urban forests and Japanese gardens in built-up areas might be undervalued. As such a 'Densely Inhabited District' (DID) based assessment might have supplemental meaning. Also, standard criteria analyses in relation to the city's profile are greatly needed as a next step in CBI development. As against this, in Category-3 there was little difference among the scores for each city. Valuation methods based only on the existence or lack of existence of specific policies might be insufficient in the case of cities in Japan, because they are already legally obliged to develop master-plans for the environment and greenery. Quantitative evaluation of the administration in terms of the effectiveness or outcomes of these policies is needed to enhance biodiversity in major cities in Japan.

### **Climate Change Vulnerability Assessment for Possible Future Landscapes: Hunter and Central Coasts**

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This study, one of six case studies to support a 'First Pass' National Climate Change Coastal Vulnerability Assessment (NCVA), examined the sea level rise and flood vulnerabilities for the local government areas of Newcastle, Lake Macquarie and Wyong in New South Wales.

The study investigated a number of ecological concerns from species to landscape scale and considered a wide range of social characteristics drawn from the 2006 census as well as surveyed the attitudes of the local population. Analysis of key concepts, such as the costs and benefits of adaption to climate change at multiple scales were incorporated into the biophysical, ecological, social and economic modelling of the present for the study area. These models integrating with past-trend future trajectory analysis allowed a multi-scaled hybrid approach to future analysis that is applicable to landscapes of large regions. The resultant possible future landscapes were analysed and three scenarios were represented as maps and 3D surfaces to demonstrate the areas of ecological, economic and social vulnerability from climate change. By representing this information on both current and possible future landscapes, an area's future sensitivity to the impacts of climate change can be rapidly assessed and incorporated into current day decision making.

## **Seachange and Landscape Change**

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Past policies and landscape changes influence future directions. Human society tooled with powerful machines since the industrial revolution have become the major altering force on landscapes and regions. The affluence of some recent generations in developed countries adds further social expectations for change, particularly urban development in naturally aesthetic places. Rapid large scale change is affecting many rural coastal regions of Australia. Faced with enormous “*Sea Change*” migration many of these regions are heading towards landscapes of “concrete jungles”, less productive land and degraded ecosystems. The enormous challenge is how to accommodate these social needs while protecting our natural areas and agricultural production needs in the long term.

The Alternative Landscape Futures approach presented contributes new tools, knowledge and options to guide long-term policy and planning of regions. Building on Carl Steinitz's methodology and integrating past-trend future trajectory analysis with landscape ecology and design principles, a multi-scaled hybrid approach applicable to landscapes of large regions was developed. Spatial modelling of the essential elements of a very complex debate about regional development and sustainability is used to produce a number of future scenarios that geographically represent potential and plausible changes that might occur or may be applied (through planned design) to regional landscapes in the medium to long term. The outcomes of visual and quantitative analysis and assessment provide a clear understanding of the future consequences of present day decisions.

## **Urban Ecosystems and Sustainable Urban Development – Analyzing Interacting Systems**

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Of major concern today are climatic change and necessary energy systems shift towards increased sustainability. In this context, cities are central as they are vital to the development of human systems, and more and more they dominate the flows of energy and materials on a global scale, now for instance accounting for approximately two-thirds of global primary energy consumption (Keirstead and Schulz 2010). The needs, ideas and abilities of cities' inhabitants cause and direct these flows through their activities, and since half of the world's population now lives in urban areas, the impacts have major significance (e.g. Grimm et al. 2008).

For their metabolism, i.e. flows and storage of energy and materials, cities are highly dependent on ecosystem services of urban and peri-urban landscapes and surrounding regions as well as on global resource webs. The organization of energy- and resource efficient cities will therefore put particular demands on the spatial structure of urban systems, with urban form, land use and transport demands as important components. At the same time, urban and urbanizing landscapes host ecosystem processes that deliver essential ecosystem services, which are intricately linked to resource use, to biodiversity and to livable urban landscapes for citizens, issues of main policy priority today. Thus, ecosystem services will become a main issue of concern as urban regions will change and the pressure on land from competing land use will increase.

The aim of this research is to develop an Urban Sustainability Laboratory (USL) for integrated sustainability assessment of urban policies, plans and programmes as well as large projects. The USL will develop spatially explicit models relating urban form and land use to transport demands (e.g. Waddell et al. 2008) as well as landscape-level ecological and hydrologic models for assessing ecosystem services and biodiversity issues (e.g. Mörtberg et al. 2007). These will be applied in urbanising regions of Sweden, with the Mälardalen region as the first case study. The model interfaces between the interacting urban systems and ecosystems will be further developed in order to find feedbacks and synergies, targeting sustainable development pathways for urban development.

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## Using LIDAR for Biodiversity Monitoring

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Key is the challenge to develop a biodiversity observation system that is transmissible and cost effective. Measuring and reliable reporting of trends and changes in biodiversity requires that data and indicators are collected and analysed in a standard and comparable way. LiDAR as a laser technology is an alternative remote sensing approach that allows to increase the accuracy of biophysical measurements and extend spatial analysis into the third dimension. More countries, such as the Netherlands and Sweden, are now already collecting laser scanner data for their whole country. At the same time, the EBONE project shows that the way forward is to measure habitat diversity as a proxy for biodiversity on the basis of plant life forms including environmental information using a stratified random sampling approach. The objective of our study was to assess to what extent LiDAR can be used to map and monitor plant life forms and associated General Habitat Categories (GHCs) according to EBONE (Bunce et al., 2008) methodology. Pilot studies were implemented in the Netherlands, Sweden, Estonia and Israel. Conclusions are that LiDAR provides accurate height measurements on shrubs and trees, even in early spring when no leaves are present, like in the Netherlands. Unfortunately, not the whole range of plant life forms could be measured with LiDAR. Combination of LiDAR with false-colour aerial photographs and high resolution data such as SPOT provides a powerful tool in combination with e.g. Fusion software, decision tree or ensemble classifiers for the identification of plant life forms and associated GHCs. Regression analysis between field measurements and LiDAR measurements on the height of various plant life forms showed good results. Since the latest generation of LiDAR will have an accuracy of approximately 2 to 3 centimeters, it is assumed that cryptogams and dwarf chamaephytes (below 5 cm) will be still difficult to measure with LiDAR. In general, it has been demonstrated in this study that good characterization of 3d-vegetation objects is possible with LiDAR. Comparison with field surveys of the general habitat categories in the different countries showed uncertainties in the proposed methodology as well as in the used field methods. Central is that cover estimates of woody life forms with LiDAR are more accurate than field measurements, while this advanced technique misses the ability to identify the dominant species, and the required environmental and management qualifiers. Part of this limitation could be counteracted by the use of hyperspectral imagery. However, we propose that future habitat mapping and biodiversity monitoring will integrate field survey and earth observation techniques so that the strength and weakness of each approach will be fully exploited.

## **The Role of Biogeochemical Processes for the Provision of Ecosystem Services**

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The concept of ecosystem services has become a focal approach for ecosystem and landscape assessments and valuations. Ecosystem services are based on ecosystem and landscape structures, processes and functions, which contribute to benefits of human societies. These energetic, hydrological, biogeochemical and eco-physiological systems are aggregated in the concept of ecosystem integrity, which represents the functionality and the state of



self-organization of environmental entities and landscape patterns.

This presentation will analyse the linkages between biodiversity, integrity and ecosystem services on a theoretical and an empirical level to illustrate the significance of biogeochemical processes for the service-based valuation of environmental states.

The theoretical level will be described by a landscape matrix approach: Different land cover units are evaluated due to their capacities to provide ecosystem services and ecosystem integrity variables. The efficiency of the interactions is classified referring to biogeochemical variables such as productivity, storage capacity, cycling or metabolic ratios. The supply of ecosystem services is distinguished considering land cover's capacity for the supply with selected provisioning, regulating and cultural services. The results of these relations are transferred into maps and regional budgets.

The empirical examples will be related to different stages of ecosystem succession and retrogression in a Northern German landscape. The functional features of different wetland ecosystems will be related to their capacity to provide ecosystem services.

Finally, both approaches will be used to derive hypotheses on the long-term development of biogeochemical, functional and structural ecosystem properties in relation to the potential of service provision in different developmental stages of landscapes.

## **Global Outlooks on Cities and Biodiversity- An Introduction**

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Loss of biodiversity, climate change, and the growth of an increasingly urban world population are the main challenges of this century and are all strongly connected. Whilst cities pose major challenges for the protection of biodiversity, the opportunities they can offer have to date received little consideration in the global debate about biodiversity.

A major step recognizing the potential of cities and local authorities to hold the global loss of biodiversity was taken during the 10<sup>th</sup> Conference of the Parties (CBD) of the Convention on Biological Diversity in Nagoya 2010, with the adoption of the "Plan of Action on Cities and Biodiversity 2011-2020". This decision encourages all 193 CBD partners to mobilize and coordinate local actions on biodiversity, to take CBD issues to urban residents, and to bring national strategies and plans into the urban context.

Based on a deeper insight into the characteristics of cities and biodiversity this presentation will introduce the latest scientific and political initiatives (especially the Convention on Biological Diversity) towards sustainable cities. It will present an outlook on the challenges for the future of biodiversity regarding environmental education, research, policy and design in cities.

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## Comparative Studies of Plants and Habitats in Cities - A European Approach

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Plants and habitats of European cities have been described and mapped for a long time. It is now possible to draw conclusions about environmental changes using historical data in comparison with present conditions.

This was the aim for a comparative study of plants and habitats in 16 large European cities which was focusing on the following main topics: natural environment, changes to the environment due to city growth, plant and habitat diversity of pristine, cultural and urban-industrial habitats including lower plants, nature conservation and education.

In this presentation we will highlight some more important results of this natural history of European cities especially:

- Cities as “hot spots” of plant diversity
- Alterations to biodiversity within the rural-to-urban gradient
- Urban opportunists - adaptations of native plants to urban habitats and plant evolution in cities
- Losers and winners – endangered and increasing species and habitats
- Threats to global biodiversity
- Contributions to global biodiversity

The cities the study is comprising are (from north to south of Europe): St. Petersburg, Moscow, Milton Keynes, London, Berlin, Poznan, Warsaw, Brussels, Maastricht, Augsburg, Vienna, Bratislava, Zurich, Bucharest, Sofia, Almeria.

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## **Landscape Approaches to the Management of Threatened Species: Two Case Studies from Tasmania, Australia**

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Applying conservation measures at multiple spatial and temporal scales has been identified as important to ensure long-term viability of forest biodiversity (Lindenmayer and Franklin 2002). Many forest management policy instruments now advocate planning for biodiversity both locally and at the landscape scale using a bioregional approach.

In Tasmania, landscape-scale management of habitats for threatened species is becoming increasingly important as habitat loss and fragmentation continues. Here we present two case studies where landscape level guidelines have been developed and implemented in areas covered by the Tasmanian forest practice system. We highlight the achievements and difficulties encountered with a landscape level approach that is tenure blind and the lessons learnt from our experiences.

### *Case Study One: Maintaining habitat for threatened native fish at the catchment scale*

In catchments known to support threatened native stream or lake fish, one of the management objectives (or desired outcome) is to maintain water quality and flow and thereby maintain habitat quality for the threatened fish species. In order to meet this objective the forest practices code requires that no more than 15% of the basal area of forest within the catchment can be logged in any 10 year period. The implementation of this landscape level threshold appears simple, but is in fact complex. The threshold applies across tenure and is reliant on the availability of data for all timber harvesting practices in the previous 10 years. We highlight the difficulties encountered in applying a threshold limit on timber harvesting using an example where the implementation of the threshold was tested in a legal setting.

### *Case Study Two: Managing the dynamic habitat requirements of a migratory bird at the landscape scale*

The Swift Parrot (*Lathamus discolor*) is a migratory bird that only breeds in Tasmania. Critical breeding-habitat for the species varies in space and time, and many aspects of the species ecology remain poorly known necessitating an adaptive approach to conservation planning across the forest landscape. We discuss the approach taken to develop a landscape-scale objective and planning guideline for the conservation management of swift parrot habitat in areas regulated under the Tasmanian forest practices system. The results of implementation of the planning guideline will also be presented.

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Lindenmayer DB, Franklin JF, 2002. Conserving Forest Biodiversity: a comprehensive multiscaled approach. Island Press, Washington DC.

## **From guiding principles to on-ground practice: Managing holes in the landscape**

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Guiding principles for the conservation of forest biodiversity across the landscape include maintaining connectivity, landscape heterogeneity and stand complexity, and risk-spreading. Measures that contribute to each of these principles include large ecological reserves and landscape-level and stand-level management strategies outside of the formal reserve system. These principles and measures emphasise the importance of adopting multiple strategies at different spatial and temporal scales in off-reserve areas to cater for different species and processes. Translating this risk-spreading approach into on-ground practice for particular habitat elements is often a difficult task.

Tree hollows (i.e. tree cavities) provide critical habitat for an array of fauna. The innovative and multi-scaled approach taken for the management of tree hollows in Tasmania's production forests is used to illustrate the issues associated with adopting theory and applying it to on-ground practice. The formal reserve system contributes to some extent to the conservation of this habitat element at the landscape-scale. However, reliance on this 'set-aside' approach alone can result in intensification of land-use activities outside reserves and subsequent loss of habitat. Although hollow retention is required in harvested areas at the stand-level, research and monitoring has highlighted the need for complimentary mid-scale and additional landscape-level measures to conserve hollow habitat in areas outside of reserves. Planning tools have been developed to help achieve this, including a technical note with clear management objectives and a map of potential hollow availability to assist conservation planning across all land tenures. The latter is based on the results of research that has shown that information on forest structure, as obtained from aerial photographs, can be used to explain a significant proportion of the variability in hollow-bearing tree density.

Our work may be used to develop some general principles to guide more effective implementation of conservation measures for forest biodiversity across the landscape. Clear objectives, strategies and user-friendly planning tools, training and communication programs are all important. In our experience a multi-scaled approach to the conservation of particular habitats in the matrix, such as hollow-bearing trees, will be most successful if it is a collaborative effort between researchers, policy developers, forest managers and practitioners. The ongoing success of such an approach depends on a high level of commitment to monitoring and adaptive management.

## **Landscape Icons and Deep Care of Nature and Biodiversity**

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This presentation examines in three parts the capacity of landscape icons to inspire deep care of nature and biodiversity within cultures and across cultures as well as their feasibility as models to guide policy, planning, and design for biological conservation, ecosystem services, and landscape sustainability. First, I will review the concept of landscape icons. One of the first definitions for landscape icon was proposed by Gobtser (2001), who has done extensive research about urban parks in the United States. In my research, I define landscape icons as particular species, features, and practices that have cultural saliency as images of nature and metaphors. They are deeply embedded in the imaginations of cultures and are associated with specific types of human contact with nature. Many of these icons have historic roots at a time when many cultures were agrarian, and they represent particular ideals associated with an immersive experience of living in rural landscapes (Musacchio in press). Second, I will examine why landscape icons, as powerful symbols of nature, landscape, and culture, act as perceptual guides across generations about how land should ideally be managed over seasons, decades, centuries, and millennia (Musacchio in press). In addition, these icons often inspire deep, collective reverence and care of nature and biodiversity that transcends individual differences within a culture, and sometimes differences across cultures. Some landscape icons are so deeply interwoven in the underpinnings of a culture that they become what Garibaldi and Turner (2004) call a cultural keystone species, and they emphasize without these species, a society would be totally different without them. Finally, I will compare the feasibility of landscape icons as models to guide policy, planning, and design for biological conservation, ecosystem services, and landscape sustainability in a world that is not only more urban but will become warmer. In particular, I will examine whether the power of landscape icons will still be as robust to inspire deep collective reverence and care of nature and biodiversity in new generations who have less connection with agrarian lifestyles and more connection with urban lifestyles.

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# **The Ungreening and Regreening of Minds, Cities, and Regions: Revealing the Hidden Dimension of Landscape Sustainability**

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The aim of this presentation is to explore how the phenomena of the ungreening and regreening of minds, cities, and regions can advance landscape ecological research by revealing the hidden dimension of landscape sustainability. The ungreening of minds, cities, and regions is defined as the broad decoupling of people's psychological, social, and cultural connections to nature and biodiversity in cities and metropolitan region. As cultures have become more highly urbanized, the stress of urbanization has taken its toll on people's contact with nature, which forms the basis of nature and biodiversity appreciation (Musacchio 2011). Numerous scientists have raised concern about the long-term, global impacts on well-being of people and the planet's web of life. The phenomenon of the ungreening of minds, cities, and regions has been called different things by scientists: biodiversity impoverishment (Turner et al. 2004), the extinction of experience (Miller 2005), and nature-deficit disorder (Louv 2005). The full long-term effects and impacts of these phenomena on people's well-being and the planet's web of life are unknown and are scientific mysteries waiting to be discovered. One of the major challenges is addressing how our species' perceptual limitations become an Achilles's heel when dealing with phenomena that are not readily visible to our dominant sense—our eyes—but could be engaging our minds, senses, and bodies in more subtle and almost undetectable ways. As the world becomes more highly urbanized and hard, concrete infrastructure will become the foundation of human experience of urban nature rather than green nature, landscape ecologists will be challenged to transform their science to address this new gray, urban world that will be emerging in the 21<sup>st</sup> century. Landscape ecology could play a key role in helping the broad recoupling of people's psychological, social, and cultural connections to nature and biodiversity, which is called the regreening of minds, cities, and regions. Yet, this situation also raises the long simmering issue within the discipline that the cultural dimension of landscapes must become more central to its epistemology rather than being a specialization at its margins.

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## **Symposium Introduction: Key Concepts and Research Priorities for Landscape Sustainability**

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One of the grand challenges of operationalizing sustainability is to translate and implement sustainability principles in landscape research and practices (Musacchio, 2011). Meeting this challenge requires that we directly address the problem of landscape sustainability through the integration of knowledge from sustainability science and landscape ecology into the planning, design, and governance of cities, regions, and countries and stewardship of natural resources and ecosystem services (see Wu, 2006, 2010; Musacchio, 2011 for more information). This symposium will address three key questions about landscape sustainability:

1. What are the key issues, concepts, and priorities most important to landscape sustainability?
2. How is landscape sustainability influenced by spatial heterogeneity and human(culture)-nature interactions across scales?
3. How can natural and design sciences be better integrated to contribute to landscape sustainability?

These key questions are a beginning point for operationalizing additional topics, principles, concepts, issues, and research questions about landscape sustainability as a bridging concept among sustainability science, landscape ecology, and sustainable design. Well-known scientists from Europe, North America, and the Pacific Rim will reflect on one or more of these questions and provide their perspective about the state of science and practice of landscape ecology in their part of the world; and how landscape sustainability might improve the relevancy and importance of sustainability science into the theory and application of landscape ecology for addressing major environmental challenges.

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## **Reasons for Ecosystem Disappearance in Africa**

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The ecosystem which is the biological interaction of organisms with their environment has faced disappearance in Africa due to unsustainable development. Most African countries rely on agriculture as the main economic activity, which has led to encroachment on forests for agriculture. This has resulted in disappearance of forests in Africa. The disappearance of forests has resulted in climate change with increased temperatures leading to droughts and hence the loss of organisms and consequently loss of ecosystems.

Given that most African countries are developing countries, they are still poor in terms of economy and development and this poverty has increased the disappearance of ecosystem in that most forests have been cleared through timber production, over fishing, poaching. All this is done because of poverty and the human need to earn a living.

All this needs to be rectified in order to conserve ecosystems in Africa through sustainable development.

## **The Role of Oriental White Stork for the Maintenance of Cultural Landscape in Toyooka Basin, Japan**

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Large and conspicuous animals are often used as flagship or umbrella species to promote conservation of regional ecosystem. Being such species, the oriental white stork, *Ciconia boyciana*, is a threatened bird in the Far East and its wild population became extinct in Japan in 1971. The conservation activities were started in 1955 in Toyooka Basin, western Japan, that was the last place for its breeding population, and resulted in pilot release from 2005. The oriental white stork in Japan had been used rural area including paddy landscape as foraging habitat. In this study, we show the foraging habitat of released storks as well as the spreading process of eco-friendly rice farming in Toyooka Basin in order to clarify the role of storks for the maintenance of cultural landscape in the area.

Number of farm households in Toyooka City decreased from 8,370 to 3,678 during 1985-2005. Total area of paddy field was also decreased from 4,577 ha to 3,373 ha during the same period, partly because of aging of farmers and lower price of rice. Therefore, maintenance of paddy field emerged to be important for the conservation of cultural landscape in this region, as well as in other regions in Japan. In the basin, an organic rice farming named “White stork friendly farming method” has introduced in 2003 in order to facilitate restoration



of habitat for storks (Naito and Ikeda, 2007), and increased up to 212 ha by 2009. This farming is composed of several techniques including water management, utilization of organic materials, and management of aquatic animals in order to produce both rice and aquatic animals simultaneously in rice paddy.

Location, habitat environment and behavior of the released storks have been monitored by direct observation of each individual. Based on this monitoring, it turned out that foraging habitat of the storks was considerably composed of rural landscape elements including paddy field, ditch, and wetland, indicating that rice farming is a key to maintain the habitat condition.

Relative foraging time of the released individuals were longer at near location from the organic paddy field and became gradually shorter with the distance, indicating that organic paddy field contributed to creating foraging habitat for storks. From view of farmers, the storks provide an extra value on produced rice as an organic product, giving an incentive to continue the rice farming (Kikuchi, 2010). Therefore, the storks have a role to promote sustainable agriculture and conserve cultural landscape in the region.

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## Nature Restoration Projects in Japan

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The Law for the Promotion of Nature Restoration was enforced in 2003 to promote projects to restore natural environments damaged by past Japanese people activities. Under this law, nature restoration projects were initiated in all over Japan. Many members of the Ecological Society of Japan (ESJ) have collaborated and contributed to the projects by providing advice for developing targets as well as plans and methods of application for ecosystem management. To share the targets, methods, results and challenges of each project and to provide feedback for similar projects in particular ecosystems, The ESJ organized the Committee for Ecosystem Management, the authors are the members, in 2003. This committee examined rules of nature restoration that should be considered before starting a nature restoration project, and the findings were summarized and published the guidelines in 2005. Following these activities, the committee evaluated the results and challenges of the projects that have been conducted in several regions and ecosystems/landscapes of Japan. The outcomes will be provide tips to the public, policy makers and researchers for times when they wish to apply the principles

described in the guidelines to actual tasks.

Most mires in the Yawata basin of northern Hiroshima Prefecture have vanished due to the development of drainage works, with only a few remaining. Kirigatani mire is one of the descent of the underground water level caused by stream alteration. In response to the restoration activities of the public, the Hiroshima Prefectural Government started the restoration project one of the above mention projects in 2003. The first author is the chairman of this project. The goals of the project include restoration of mire using flooding and spring water, conservation of endangered plants and animals, and easy access for tourism and environmental education. Channel improvement, installation of channels and felling of dry land trees were conducted by the prefecture. As a result, the mire is recovering and spawning of salamanders and frogs, newly immigration of aquatic insects and re-flowering of wetland plants have been observed. Establishing financial and institutional bases for ongoing monitoring, as well as, a local community that can support tourism and education, is imperative.

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### **Community Aspects on Forest Ecosystems in the Gunung Gede Pangrango UNESCO Biosphere Reserve, Indonesia**

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Indonesia's forest has high biodiversity in flora and fauna. The government tried to keep the biodiversity through managing the forest in accordance with the existing function and condition (Nakagoshi & Amelgia, 2010). The fact that population is increasing and its affect demand of land and wood consumption. Statistic of Ministry of forestry 2009 recorded a number of disturbances of forest area. The disturbances include land occupation by the community which had reached 52,972,27ha of forest ecosystems. This research have main objectives to assess the level of dependency on forest products (Rizki Amelgia et al., 2009) and to identify which factors are affecting the level dependency of forest products in the

transition zone of Gunung Gede Pangrango UNESCO Biosphere Reserve.

Detail demographic and economic household was collected using the stratified random sampling method from 210 respondents in six villages. Statistic reveal that 361,002 people live around the area (Mulcahy & McCarthy, 2010). The statistic result shows that approximately, 58% of the respondent depend on forest products around 0-20% of their total monthly income and only 10% of the respondents are highly depend on forest products (more than 80% of total monthly income). In average, the community level depends on forest products is 28% of their total income.

From nine of independent variables only five variables such as gender, household size, policy, off-forest income and elevation, are mainly responsible for determining the level of dependency. Statistical proved that off-forest income and elevation of the household have strong effect related to household forest dependency. Meanwhile gender and policy are significant at 5% level and household size at 10% level. Simply, the household with low off-forest income, big number of family and located in remote area more dependent on forest product compared to other household.

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## **Renewal of the Master Plan of Greenery in Hiroshima City**

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Over the first 40 years the greenery campaign was government-led. In 1994, however, when the 12<sup>th</sup> Asian Games were held in Hiroshima City, government-citizen collaboration was successful and a growing interest in greenery was demonstrated. Responding to this, the 3rd Greenery Campaign was launched in 1996 when the New Town Planning Law was established. One objective of the campaign was to achieve the goal of the Green Fiesta Hiroshima 1997. Two major goals of the campaign were to upgrade the amenities of the city with flowers and trees and to improve vegetation quality by government–citizen cooperation.

In response to the increasing recognition of those activities, the Civil Network for Flowers and Greenery of Hiroshima was established.

Succeeding the comprehensive greenery plan in 1986, the Master Plan of Greenery in Hiroshima City with 53 projects was finally established in 2001, and in the same year, the post-third Greenery Campaign was begun. In this master plan, the role of greenery in urban regions is characterized as “existence” and “use”. To define the roles which greenery plays in the city, functions and roles were allocated to five categories: environmental protection, conservation of ecosystem, recreation, disaster prevention, and landscape composition. Better organization and efficiency were incorporated into the guidelines of the greenery policy, and that time environmental and ecosystem conservation has become a major issue. Also, the original aims to increase woody bio-mass and improve amenities, upgrading human health, and providing habitats for wild plants and animals were newly added to the campaign targets. At that time green infrastructures have not yet led to promotion of a new conservation area and ecosystem networks because their structures are not well designed in the sense of landscape ecology.

Under my chairmanship, discussion of renewal of master plan was started in 2010 for the expanded city with 1.17 million and an area of 905 sq. km. In January 2011, the renewed master plan was established. The framework is not changed compared with the former plan, but this time we considered greenery networks in the city. For this improvement, newly jointed area (former Yuki-cho) was added into the inland greenery zone (outer green belt) and promotion of agriculture/Kleingarten, and expansion of a core greenery area including the former baseball stadium of franchised by team “Carp” in downtown of deltaic urban zone.

**Acknowledgements:** The authors wish to thank the Global Environment Leaders (GELs) Programme, Hiroshima University and the Hiroshima City Government for supporting this review paper.

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## **Strategic Education Programme for Designing Low Carbon Societies in Asia**

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Based on the ideas for developing human resources, Hiroshima University is utilizing the

MEXT Special Coordination Funds for Promotion of Science and Technology to establish the Global Environmental Leaders (GELs) Education Programme for Designing a Low Carbon Society from 2008 and the following five years. Our programme promotes the establishment of a unique approach for educating global environmental leaders and developing human resources to meet the needs of societies. The global environmental leader education system is being expanded through 1) the promotion of student support, 2) the global environmental leader special education programme and 3) post-graduation programmes. These systematic efforts are important steps for training experts and re-educating practicing professionals. Through this system, we build a global human resource network based in Hiroshima University. It is consisted with five research programmes, namely 1) urban system design to prevent global warming, 2) wise use of biomass resources, 3) environmental impact assessment, 4) policy and institutional design and 5) development of environmental education.

I am the vice-leader of GELs programme and the head of the second research group: WUBR. Sustainable use and management of ecosystems to preserve sources of carbon sink and further development of alternative energy sources instead of fossil fuels are essential for realization of low carbon society to forestall the acceleration of global warming. However, ongoing degradation of ecosystems continues to be a serious global problem. The rate of deforestation has remained at 14 million ha annually since 1990. Most (78.6%) of this decrease has occurred in tropical rain forests because of large socio-economic dependency on natural resources and lenient management schemes/poorly designed land-use guidelines in the tropics. Ecosystem disturbances brought about by human activities not only decrease the standing carbon stocks in ecosystems but also fragment ecosystems and inhibit the regeneration of ecosystems by decreasing networking among ecosystem remnants. Given this situation, introduction of ecosystem management to stimulate sustainable natural resource usage and carbon sink protection in developing countries is an emergency issue that must be addressed by international community. Among the four research themes of my group, “land-use planning and design for balancing natural resource usage and carbon sink protection” closely related to the principles and applications of landscape ecology. We propose land-use planning and design strategies that balance natural resources usage and carbon sink protection by analyzing the patterns of land-use change from the aspect of realizing a low carbon society. For the education of this research topic, we use recent two textbooks (Hong et al. 2007; 2011).

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## **Landscape Ecology for a Sustainable City**

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Planning a sustainable city must be an adaptive to the ecosystem. Urban biodiversity is important in multiple scales from global to local. Areas where urban occupies is a part of global ecosystem networks. Human settlements have been major courses of biodiversity loss in past thousands years. Many cities have been located on low lands near the mouth of large river, sometimes using costly drainage systems. Natural wetland lost its area by 39% for this 140 years in Japan. On the other hand, forest area has not decreased. Ecosystems in coast, tidal flat and flood plain have been severely damaged. These areas are important for many migratory birds. Urbanization also breaks ecosystem linkage between land and ocean. This causes decrease in coastal fishery. Reduction of specific habitats is better indicator of urban biodiversity than the proportion of natural area in cities. The tsunami disaster in eastern Japan, unfortunately taught us high risk of settlement in the areas protected by embankments. Fitness to the environment is an indicator for sustainable city.

Cities depend on the countryside, forests, and ocean for sources of water, foods and materials. Ecological footprint of Tokyo in 2000 indicates that Tokyo consumes products from area of 180 times of its territory. Longer transportation path needs excess consumption of energy. Concentration of population and products is followed by risk. The maximum size of cities can be considered from the carrying capacity of the region.

Urban biodiversity provides ecosystem services. Loss of vegetation in cities causes “heat island” effects and floods by localized heavy rain. Data shows negative relationship between temperature and proportion of vegetation area in cities. Construction of new power plants is needed by increasing summer temperature in the cities. Absence of predators sometimes causes outbreaks of alien herbivores that damage trees in cities. Proportion of natural habitats including parks planted domestic plants in cities is an indicator in this context.

## **Rewilding Abandoned Landscapes in Europe**

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For millennia, mankind has shaped the landscapes that it occupies, particularly through agriculture. In Europe, the age-old interaction between humans and their habitat shaped the cultural heritage and the perceptions of nature. Yet, since the mid 20th century, European farmland is being abandoned, especially in remote and mountain areas. The loss of the bucolic European landscapes and the resulting opportunities for rewilding is generating controversy for both the scientific community and the public. As a result, rewilding, as an alternative to abandonment, is seldom considered. Here we attempt to provide an objective review of the consequences of farmland on biodiversity. In particular, we ask to what extent farmland abandonment can be considered as an opportunity for rewilding in a European context. We first studied the perceptions of both traditional agriculture and wilderness and how those perceptions can influence land management policies. We then reviewed past, present and future trends of agriculture and the resulting land-uses in order to understand how these impact European landscapes and biodiversity. Finally, we assessed the value and sustainability

of rewilding for human society from both an economy and ecosystem services perspective.

Our review shows the evolution of European agriculture and its impact on both the landscape and the way they are perceived. We also illustrate the extent of past abandonment, its inexorability and the projections for the upcoming decades. It appears that several species, amongst which some large mammals, could benefit from land abandonment and forest regeneration. Moreover, the “wild” landscapes will provide several ecosystem services such as carbon sequestration, soil recovery and recreation. Rewilding is also an interesting economic option especially in comparison to the subsidies dedicated to maintain populations in remote areas by the European Union. We thus believe that rewilding should be considered as a sustainable landscape management option that will benefit several species, including humans.

## **Combining Remote Sensing and Landscape Metrics for Urban Development to monitor Urban Spatial Variation – Examples from Growing and Shrinking Regions**

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Large-scale urban development is likely to be one of the primary sources of environmental change over the next decades, and more of this development will take place in India and China than in any other two countries. Rapid urban growth can have severe consequences for environmental sustainability creating an urgent need for alternative pathways to development. Satellite data and further geo-information data are used for landscape ecological evaluations, e.g. to predict structural diversity in landscape, to derive quantitative data on open space fragmentation and on interlink of biotope structures. Satellite images are just as much used to identify compensational areas for planning of building land in conurbations or to quantify landscape metrics by means of derived medium and high resolution satellite parameters in order to calculate neighbourhood relations of objects.

Within the last two decades landscape structure indices or metrics have been implemented on remote sensing image data for different mapping scales. As original input data topographic maps, aerial photographic data as well as satellite images have been used. Thus the analysis of historical samples represents the base for the comparison of current as well as of future landscape structures and enables predicates to evaluate the dynamics of the landscape.

Nature, in particular in the suburban cultural landscape is described regarding indicators such as structure (line or planar expansion, cutting, island areas, etc.), dynamics (entry of the modification processes) and texture (neighbourhood relations to other land use forms). This is based on the identification and computation of static and dynamic indicators that help providing a synthetic assessment of suburban landscapes. The indicators will also allow the comparison of the environment's condition in different conurbations. The static indicator includes proportion of urban land uses at different points in time, of road network cutting land uses, but also fragmentation of recreational sites within metropolitan areas and of built-up

areas within green spaces in suburban areas. Dynamic urban area indicators refer to typology of changes and the transition from one land-use class to another.

A methodological approach is presented applied to different parts of Europe in growing as well as shrinking urban regions, after which monitoring and evaluation of a landscape diversity in suburban landscapes are feasible on the basis of medium and high resolution satellite data.

## **The Role of Different Ethnic Communities on the Expansion of Terraced Paddy Field in Mountainous Landscapes of Vietnam: A Case Study of Trung Chai commune, Lao Cai province**

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Terraced paddy field is not the most common human land use but admirable cultural heritage that has ever seen on sloping landscapes of the Central Highland and Northern mountain of Vietnam. These regions are characterized by highly bio-cultural diversity with a large number of tropical forests and more than 30 different ethnic groups which have been considered one of the primary driving forces of terraced paddy field expansion. This research was carried out in a case study area of Trung Chai commune belonging to Lao Cai province, of which terraced paddy field had long history, and has expanded in a closed relationship with the evolution of Dzao and H'Mong ethnic groups, especially since early 20<sup>th</sup> century. The methods of using questionnaire, change detecting, and multivariate analysis were chosen as principal techniques of the study. Terraced paddy fields were mapped at different times from early 1950s to present by using aerial photos and satellite images. Three important periods of terraced paddy field expansion were focused. In the period of agricultural co-operative (1954-1970), terraced paddy field was first created in Dzao villages when the Vietnamese Government implemented the State plan resolution II (in 1962) and III (in 1963) on co-operative system. The period of co-operative consolidation (1970-1986) was marked by an event of terraced paddy field extent increased gradually and emerged the major basement for farming cultivation of Dzao as well as H'Mong ethnic groups. Meanwhile, in the Renovation period (since 1986), this type of field reached the highest extent in both of Dzao and H'Mong's villages due to impact of the Agricultural Renovation Policy. A multivariate analysis clarified effects of ethnic community diversity to terraced paddy field changes. Dzao ethnic groups own fields at lower attitude vis-à-vis H'Mong groups', therefore influenced differently to the trend of land use transition over their villages: terraced paddy field in Dzao village was created by a conversion from hilly and bare land, whereas in H'Mong's villages, it formed by conversion mainly from primary and secondary forest. Results of this study showed the nature of culture-nature relationships in this area, namely different ethnic groups play different roles in creating cultural heritages and shaping cultural landscapes by changing their cultivated mode from shifting cultivation to terraced paddy field farming for centuries. Moreover this suggested that the expansion of terraced paddy field could be considered as an important indicator of cultural dimension of mountainous landscapes of Vietnam.



## **Participatory Planning for Zonation of the Cu Lao Cham – Hoi An Biosphere Reserve, Vietnam**

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The paper presents a landscape planning with consultations from local stakeholders to make the zonation of Cu Lao Cham – Hoi An biosphere reserve to link values of biodiversity and culture of the islands. There are three areas in the biosphere reserve. They are core areas for biodiversity conservation following a legal status of the Marine Protected Area (MPA), a buffer area surrounding the core areas with coastal and mangrove habitats to promote tourism development and controlled fishing, and a transition area for economic development with agriculture, fishing services and the world cultural heritage site of Hoi An Citadel. The landscape planning in the case is considered as a spatial planning in both marine and terrestrial environments. It is very difficult because of a lot of conflicts of interests between and among stakeholders. In order to reach a final decision in the zonation, the community participation is identified and divided into six categories, including communication, information, consultation, dialogue, concertation and negotiation in various local meetings and discussions. Based on data collected from field surveys, a matrix of weighting participation from local stakeholders is built to analyze vertical and horizontal interactions. Biodiversity and fishing traditions are considered as key indicators in landscape and seascape planning and management of the biosphere reserve. The biosphere reserve was approved by UNESCO in 2009 and become a demonstration site for initiatives of using biosphere reserves to conserve natural and cultural diversity. The paper also discusses opportunities and challenges in activating local people toward a culture of participation.

## **Patterns and Dynamics of Landcover Changes since the 1930s over Ejina Delta in Heihe River Basin**

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Heihe River Basin is in Northwest China's arid inland, and especially Ejina delta in the low reaches of heihe river, which is historically a hot research area. With the global climate change and the increasing impact of human activities, the quantitative study of the ecological environment change is one of the critical need for inland watershed research. Based on collections of historical maps, remote sensing images and a variety of other sources of data, through methods of digitization, image interpretation, classification, we analysis land cover and land use change of the region since 1930s: mainly for typical vegetation shrinking, increasing desertification and salinization, surface water (including river network, terminal lake) integrity of the destruction and other issues of inland river. With the region's water

resources use and irrigated agriculture and other human activities, we analysis the various driving forces of land cover change, and propose the specific measures of maintaining stability of the ecological environment in arid inland downstream.

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## **Comparative Studies of Wildlife in Cities**

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Comparative studies of the flora and fauna of cities are important to ecologists seeking to understand mechanisms explaining how species respond to urbanization. These studies also critical to planning, conservation, and management efforts that seek to maintain and enhance biodiversity in cities. Comparative studies of animal species focus on patterns among cities in species composition and abundance and compare species guilds or traits, number of species, the percent of the regional fauna captured within a city, the ratio of introduced species to the total number of species within the city. There are important differences in the structure and organization of the world's cities so comparative studies of fauna use environmental, social, and economic variables to characterize and classify cities, approaches that place species and trait data in a broader context. An international working group, "Comparative Ecology of Cities: What Makes an Urban Biota "Urban?", a research group with the National Center for Ecosystem Analysis and Synthesis, is comparing the avifauna from more than 50 cities around the world to understand how urbanization shapes bird communities and populations. Understand similarities and differences in the avifauna of the world's cities is an important part of developing and implementing programs for conserving urban biodiversity.

## **Importance of Landscape Ecology in Developing Countries**

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Crises over land ownership throughout postcolonial Africa have generated international debates and divided world opinion. The case of Zimbabwe has pushed this debate to a new level. “Zimbabwe has demonstrated that disputes over land can turn violent ...,” says International Crisis Group in its publication *Blood and Soil*. While such crises exist all over postcolonial Africa, they are more entrenched in former settler colonies. “Land has been a conflict issue in Zimbabwe, and has the potential to be one in South Africa,” says the ICG. However in Zimbabwe I would like to dwell on importance of wetlands which are fast disappearing due to climate change.

A wetland is an area of land whose soil is saturated with moisture either permanently or seasonally. Such areas may also be covered partially or completely by shallow pools of water. Wetlands include swamps, marshes, and bogs, among others. The water found in wetlands can be saltwater, freshwater, or brackish. The world's largest wetland is the Pantanal which straddles Brazil, Bolivia and Paraguay in South America. Wetlands are considered the most biologically diverse of all ecosystems. Plant life found in wetlands includes mangrove, water lilies, cattails, sedges, tamarack, black spruce, cypress, gum, and many others. Animal life includes many different amphibians, reptiles, birds, insects, and mammals. In many locations, such as the United Kingdom, Iraq, South Africa and the United States, wetlands are the subject of conservation efforts and Biodiversity Action Plans. Wetlands also serve as natural wastewater purification systems-e.g., in Calcutta, India and Arcata, California. Wetlands perform two important functions in relation to climate change. They have mitigation effects through their ability to sink carbon, and adaptation effects through their ability to store and regulate water.

**Mitigation:** Peat swamp forests and soils are being drained, burnt, mined, and overgrazed contributing severely to climate change. As Peatlands form only 3% of all the world's land area, their degradation equal 7% of all fossil fuel carbon dioxide (CO<sub>2</sub>) emissions. As a result of peat drainage, the organic carbon that was built up over thousands of years and is normally under water, is suddenly exposed to the air. It decomposes and turns into carbon dioxide (CO<sub>2</sub>), which is released into the atmosphere. Peat fires cause the same process and in addition create enormous clouds of smoke that cross international borders, such as happen every year in Southeast Asia. Through the building of dams, Wetlands International is halting the drainage of peatlands in Southeast Asia, thereby avoiding enormous CO<sub>2</sub> emissions. Reforestation with native tree species as well as setting up community fire brigades are also part of an integral, very cost effective approach shown in Central Kalimantan and Sumatra, Indonesia. (from: [www.wetlands.org](http://www.wetlands.org))

**Adaptation:** Mangroves, floodplains, highland and other wetlands can reduce the impacts of increased precipitation, storms, glacier melting and even sea level rise. The water regulating and storage functions of these wetlands are crucial in adapting to a changing climate. Therefore, in order to protect people living close or even far downstream from wetlands and their source of livelihoods, we must conserve and restore wetlands. In this way, they can continue to play their critical role (from [www.wetlands.org](http://www.wetlands.org)).

# Landscape Change Analysis in the Mediterranean Region: Coastal Area of Izmir, Turkey

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Landscape change phenomenon resulting from human interactions in the environment has important implications for sustainable resource use, as it generally reflects degradation or irreversible losses of land and water resources. It mainly arises from diverse and ever-increasing demands for space and resources for settlement, agriculture, tourism, industries and transportation (Alphan et al., 2009; Kesgin and Nurlu, 2009). Typically, urban development and agriculture are competing for the same land, and the development of European cities in the recent years has primarily occurred on former agricultural land. For example, throughout the Mediterranean region 3% of farmland was urbanized in the 1990s, and 60% of this land had a good agriculture quality (EEA, 2006). In particular, Turkey has been subjected to land conversions into non-rural uses especially resulted with the loss of prime farmlands due to urbanization (Evrendilek and Doygun, 2000). As a typical Mediterranean province in Turkey, Izmir, which has a great potential of agriculture and increasing land use conflicts due to the rapid population development, the urbanization and the industrialization, were analyzed in the study. Landscape composition, connectivity, patch size and patch number were used to evaluate changes in land cover extent for 25-year period. It is designed to determine ecosystem vulnerability relative to large scale natural and man-induced disturbances using landscape pattern metrics system by using remote sensing and geographic information systems. A time series of Landsat TM and ETM images from 1984 to 2009 were used to gather landscape change. The images were classified using supervised classification according to the CORINE LCC and a post-classification comparison approach was used in change detection. The results showed that rapid urbanization in the study area was the most important factor in altering land cover and landscape composition during past two decades.

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## **A Framework for Assessing Ecosystem Services at a Local Landscape Scale**

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Regularly taking stock or assessing the state of the suite of available ecosystem services, their condition and the trends in their supply improves our understanding and enables us to improve land-use management, development decisions and planning practices into the future. To date, ecosystem service assessments have mostly been undertaken at global and regional scales and have made us aware of the large regional and global shifts in ecosystem service supply. Best practice guidelines developed for assessment at these scales have facilitated policy formulation, but appear limited in their applicability at local planning levels. At the local scale there are a variety of groups and individuals interested in developing a better understanding of the status and trends in condition of the ecosystem services on which they depend or for which they are responsible. These include municipal managers, catchment authorities, agriculture, water supply, forestry, tourism, and conservation agencies and departments, and even individual private land owners. We think that in South Africa (as in many other countries) the potential uptake of ecosystem service assessment has not yet been realised and many other planning and decision making processes (e.g. growth and development strategies) may soon become users of assessments.

To proactively support this processes we have developed a framework for assessing ecosystem services at a local scale based on a decade of learning around ecosystem service assessments in South Africa and internationally. This framework is intended to aid both the people who conduct these assessments, as well as the people who request the assessments in order to ensure that best practices are maintained, developed and shared. Key features of this framework include developing a partnership between the assessment team and the stakeholders involved. This partnership is essential if support, participation and uptake of the final products generated are to take place. Ecosystem service assessments need to be inspired by people who will use the information generated and those who will be affected by or interested in the decisions taken after the assessment. An interdisciplinary approach needs to be followed, with the traditional ecological-economic assessment complemented by a detailed and targeted social assessment. While social assessments take time and are costly, they provide necessary insight into the context and rationale behind resource use decisions, and the implications of these decisions from both institutional and individual perspectives. Our framework consists of four phases, the design, evaluation, planning and communication phases, each of which including the steps involved within each of these phases, are described in detail in this presentation.

## **Bryophytes as Potential Indicators of City Biodiversity**

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Bryophytes are good bioindicators. In this presentation, I will assess the potential use of bryophytes as a city biodiversity index (CBI), on the basis of the results of previous studies.

Bryophytes are small plants and are therefore strongly affected by microclimates. Gignac and Dale (2005) suggested that bryophyte diversity is significantly correlated with microenvironmental diversity. Oishi (2009) used this correlation for evaluating microenvironments, including conditions in the interior of forests, which are important habitats for drought-sensitive species vulnerable to forest fragmentation.

Because bryophytes lack vascular systems, they directly absorb water and nutrients from the atmosphere through leaf surfaces. Hence, bryophytes are very sensitive to atmospheric environments and are good indicators of air pollution (Krommer et al., 2007).

In addition to vascular systems, bryophyte leaves also lack waxy cuticles that protect against desiccation and other damage (e.g., pathogen penetration). This lack of cuticle layer protection causes high accumulation of pollutants such as metals and hydrocarbons from surrounding environments. A recent study reported that NO<sub>x</sub> pollution can also be evaluated by measuring isotope ratios in bryophytes (Solga et al., 2005).

Considering that anthropogenic factors (e.g., forest fragmentation and environmental pollution) seriously affect ecosystems in urban areas, bryophytes seem to be a useful CBI. By combining the bryophyte CBI with other CBIs, we can effectively identify conservation-priority areas and take appropriate measures to conserve biodiversity in urban areas.

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## **The Role of an Individual in Environmental Issues and Exploitation of National Resources: A Case Study in Gwagalada (Community), Federal Capital Territory Abuja Nigeria**

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Nigeria, officially described as the Federal Republic of Nigeria, is a Federal constitutional Republic comprising of 36 States and its Federal Capital Territory, Abuja. Nigeria is located in West Africa on the Gulf of Guinea and has total area of 923,768 km<sup>2</sup>.

Nigeria is classified as an emerging market, is the largest producer of petroleum in the world and the 8<sup>th</sup> largest exporter, and has the 10th largest proven reserves. It is reported to have more gas reserves than oil, and its rapidly approaching middle-income status, with abundant supply of resources, well-developed financial, legal, communications, transport sectors and stock exchange.

This paper look at the various activities of Gwagalada Community in related to the Environmental issues, hazards and exploitation of National Resources. The various positive and negative impacts in the ecological sensitive area, socio economic perturbations, the operational being used in the areas, human/management factors in the region, safeguard jobs and prevents investments flight from the region.

## **Assessment of Ecotourism Potentials of Culture and Natural Landscapes in Old Oyo National Park, Oyo-State, Nigeria**

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Cultural and natural landscapes in Old Oyo National Park (OONP) were assessed with a view to develop their potentials to attract tourists visiting the Park. OONP is one of the eight established National Park with the main objective to preserve the culture, historical and archeological features in the abandoned sites of the then capital city of the ancient Oyo Empire and to conserve and manage representative samples of indigenous flora and fauna of the South west geographical region of Nigeria. Transects laid as observation trails were traversed for several days. Photographic pictures of these features were taken using Digital camera. Global Positioning System (GPS) was used to take coordinate readings of these locations. Gridded digital map of the sites were presented with the use of Global Positioning System Technique. Descriptions of these heritage feature locations specific will assist heritage tourists from any part of the World to locate and identify them. Primary data was collected through administration of structured questionnaires to the tourists, the park management staff and the host communities. Secondary data collected include topographical map of the study area; record of tourist influx and arrests since inception. Data collected were descriptively analysed using SPSS version 15.

**Keywords:** Cultural and Natural Landscapes, Old Oyo National Park, Oyo-Empire, Global Positioning System Technique

## Contributions of Trees in Emerging Nigerian Urban Cityscapes to People's Well-being, Livelihoods and Tradition: A Case Study of Akure City

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The recognition of the contribution of trees planted within settlement areas to the people's well-being, livelihoods and culture has a long time history in the many nations, with an increasing awareness in the recent time. This has pre-informed our present study which investigated the roles of tree species in emerging urban cityscapes in Nigeria using Akure as a case study. The city was stratified into: modern and ancient; commercial and residential; and educational (secondary schools and higher institutions). Detailed tree species enumeration and their importance were carried out within each section. Demographic and developmental information were obtained from government records. According to Yoruba folklore history, Akure is an ancient city, established many centuries ago by a descendant of Oduduwa, the progenitor of the Yoruba race. Upon the creation of Ondo State in 1976, Akure became its capital. Since then, it has grown to become one of the largest cities in south-western Nigeria with a population of 387,087 inhabitants. Tree species encountered within the city totalled 66, with varying dominance in the various sections of Akure. Tree species dominance varied from one section of the city to the other. Within the modern, species with the highest relative dominance (RD) is *Caryota* spp (RD=28.7), followed by *Polyathia longifolia* (RD=23.2) and *Mangifera indica* (RD=10.5) while in the ancient part, *Carica papaya* (RD=14.2), *Mangifera indica* (RD=12.9), *Cocos nucifera* and *Citrus* spp (RD=10.3) dominated. The ancient commercial parts of the city are virtually devoid of trees while the modern commercial part is dominated by *Caryota* spp, *Polyathia longifolia* and *Mangifera indica*. The secondary schools were generally dominated by *Gmelina arborea* (RD=21.4), *Elaeis guinensis* (15.2) and *Mangifera indica* (14.5). The dominant species in some of the higher institutions were *Cocos nucifera* (18.1), *Mangifera indica* (16.3), *Delonix regia* (RD=15.9) and *Gmelina arborea* (12.1). Generally, the uses of the trees in the city include: ornamental/aesthetic (38.6%), food/cash crop (36.6%), timber (10.5%), shade (9.0%), living fence (3.1%), medicinal (2.6%), and cultural purposes (0.8%). However, the importance of trees varied according to the social, economic and educational status of the inhabitants of the city. Within the higher institutions dominated by educated elites, ornamental/aesthetic (51.9%) and shade (16.8%) were the most important uses of the trees while in secondary schools, edible fruits (34.8%) and shade (18.7%) were most important. In the ancient part of the city, dominated by illiterate people, food/cash crop were mostly valued (about 77%). Although food/cash crop was also important within the modern part of city inhabited by rich and educated people, ornamental/aesthetic was the predominant use of trees. Trees were only used for cultural purposes within the ancient part of the city, especially around the old king's palace. Some trees, e.g. *Terminalia catapa*, *Azadirachta indica*, *Mangifera indica*, *Gmelina arborea* etc were used for dual purposes, with the predominant used depending on the section of the city. For example, while *Terminalia catapa* and *Mangifera indica* are predominantly used for food/cash crop by inhabitants of the ancient part of Akure, they are used for shade within the modern part. Although medicine is not currently among the dominant use of trees in any section of the city, there are indications that it will play an important role in the future due to the increasing number of people using trees for medicinal purposes. The results implies that the use of trees in Nigerian emerging city could be for economic, social, and cultural depending on the status of the inhabitants of the city sections. While the poor and uneducated use the trees for economic and cultural purposes, the rich and



educated inhabitants use the trees for social purposes.

**Keywords:** Tree species diversity, Urban centres, Economic, Social, Cultural, Akure, Nigeria

## **Sustainable Landscape Evolution: Exploring the Concept of Socio-ecological Systems**

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A socio-ecological systems thinking has been developed in resilience literature, with reference to sustainable development and governance theory (Lebel et al 2006). I assume that understanding the dynamics of socio-ecological systems may reveal mechanisms in the interaction between the local physical system and the society depending on it. The concept is largely absent from landscape ecological literature, and to our knowledge has never been considered for its potential to become a core concept in landscape ecology.

In this paper we analyse the potential merits of the socio-ecological system concept to develop within landscape ecology. As conceptual models structure scientific thinking and the formulations of research questions, putting a socio-ecological system theory in the heart of landscape ecology may enhance the development of interdisciplinary theory, for example with reference to integration of landscape functions and of pattern-process and process-value approaches (Termorshuizen and Opdam 2009). The relevance of introducing the Socio-ecological system concept can also be found in the shift from top-down government-led decision making towards local level bottom-up governance. Sustainable development assumes that the decision making process is a collaborative attempt of land owners, stakeholders and governments to commonly decide about landscape change. Such processes may be organized systematically and within a planned time frame (“landscape planning”). Increasingly often, however, the process is rather fuzzy structured, with local actors (each with their own view on the future) causing micro-level changes. In such cases, landscape ecology should contribute to an interdisciplinary attempt to understand how such systems respond to information, to incentives and to regulations in order to balance private interests (such as crop growing or house building) against common values (such as biodiversity conservation, water management and landscape identity). Hence, the socio-ecological systems thinking we propose should also bridge the gap between landscape functioning and landscape governance.

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## Understanding the Science-Practice Interface in Landscape Ecology

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In a world with increasing spatial competition among land use functions that often conflict, spatial aspects of landscape change should be paramount in societal deliberation, negotiation and valuation of options for landscape policy and practice. If landscape ecology knowledge penetrates societal awareness and decision making, it will support more sustainable approaches to addressing competing land use functions. Since landscape ecologists have been asserting this potential for decades without satisfactory translation to policy and practice, we argue that investigation of the science-practice interface should be adopted as an explicit field of (our) research. This means specifying questions, developing theories and collecting empirical evidence about the science-practice interface in landscape change. Introducing this symposium, we explore whether characteristics that make certain scientific methods and tools effective in policy assessment differ from characteristics that make methods and tools effective in design and implementation of local landscape change, and we examine the implications for science.

In the context of government-led inquiries, scientific assessments have an explicit, predictable structure: the problem is defined (e.g. decrease of biodiversity), societal goals are specified (e.g. a list of target species), and policy targets (objectives and related metrics) are identified to meet the goals. An integrated science team might use the policy targets to develop and apply a GIS-based assessment tool, which might measure spatial change of the landscape configuration. In an assessment, scientists do not identify societal goals, they respond to goals set by policy-makers. Such applications are well known, and landscape ecology abounds in such assessment tools. However, we know relatively little about how these tools actually affect landscape change. For example, what is the effect of assumptions made in defining the problem, the structure of the tools, the choice of metrics, etc.? This lack of insight precludes landscape ecologists learning how to improve the impact of our knowledge.

In contrast, design and implementation of local landscape change is more directly affected by values and perceptions of local stakeholders, land owners and organizations, and the science-practice interface is less predictably structured. Locally, the problem is debated, and there may be little agreement on common goals, let alone on the best solution. This requires a design oriented approach, supporting a process of common fact finding, identifying values and aspiration levels, coalition building and negotiations about competing values and effective solutions. Scientific tools must inform design while also allowing for creative generation of alternative options rather than a clear “yes or no” answer.

## Visual Quality Analysis of Historical Monuments of Bratislava

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Perception of urban environment, analysis of city's image relate to behaviour of inhabitants and visitors but they also play role in urban analysis necessary for developers, designers, architects and planners. Visual perception and analysis of visual quality are important for urban environment and especially for architectural creations and spatial organization of the city. The third dimension of urban projects has also influenced their architectural design in the context of environmental qualities including vistas, light, composition of objects, and aesthetic aspect of urban environment (Rod, van der Meer 2009). Vistas and their potential are parts of assessment of everyday city street quality for their inhabitants or the visiting rate of historic landmarks. Objective data about structure of urban landscape (3D models) are one of sources for the analysis of attractiveness as well. The concept of analysis of the physical status, morphology or urban environment pursuing the *ex ante* set conditions regarding their configuration and composition is an example of adoption of objectivist paradigm (Lothian 1999) or subjective-objective (normative) approach to assessment of attractiveness of the city image (Hlavata, Otahel 2010).

The aim of paper is visibility and viewshed analysis of some selected historical monuments in Bratislava's city centre: St Martin's Cathedral, St Michael's Gate and the Old Town Hall. Entry data were adapted to a 3D landscape model with raster size of 1.5 m and the terrain was heightened to the level of 165 cm (mean height of observer's eyes) by means of digital terrain model (DTM), 3D model of city and the GIS. Attractiveness of potential view points was assessed in the context of visibility and the viewshed of dominants pursuing the criteria of size (area) of a relevant viewed part and the distance from the particular dominant. Results were computed within the range of 4,000 metres away from dominants and spatially identified in three categories of attractiveness. The most attractive view points were verified and points (spots) of vista were preferred pursuing the principles of aesthetics concerning the viewed images of the city. These issues are especially interesting for visitors of the city and travellers in the context of organization of efficient sightseeing around the decisive monuments of the city.

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# Land Cover and Aquatic Macrophyte Vegetation Changes: Analysis of Terrestrial-lake Ecosystem Interactions in Danube Floodplain Lake (Slovakia)

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Historical remote sensing data can provide a useful baseline to determine long-term ecological changes and clarify the spatial organisation and temporal succession of vegetation communities. To identify land cover changes in wetland and lake ecosystems and to analyse terrestrial-lake ecosystem interactions, we considered aerial photographs and GIS as the most suitable tools. The aim of the study was research the aquatic vegetation of the Čičov Lake in Danube floodplain in relation to the land use of its surroundings. Two methodological approaches, remote sensing and botanical field surveys, were applied to address these questions: how have landscape composition and the structures of the lake buffer zone changed from the mid-20th century and whether these landscape changes were related to the composition of aquatic macrophytes over the last 34 years.

The Čičov Lake, is a relic of the remnant Danube anabranch system, the so-called the Middle Danube inland delta, which is listed in Ramsar Convention. It is situated in a lowland willow-poplar floodplain forest outside the left-flood protection dam of the Danube River in south of Slovakia being cut off in 1903. Up to 1965, a weak hydrological connection existed between the lake and the inundation area, but after flood 1965 it was impaired.

Aerial photographs from 1949, 1970, 1990 and 2006 were analysed to determine land cover changes in wetland and lake ecosystems. Landscape configuration and structure were analysed using eight landscape metrics selected in advance to measure spatio-temporal changes and the fragmentation of the lake ecosystem and its corresponding buffer zone using ArcGIS 9.3 and Fragstat 3.3.

Aquatic macrophytes were sampled in five survey stretches of the lake eleven times during 35 years (from 1973 to 2007) using a five-degree scale as the Plant Mass Estimate (PME). Based on PME data of true aquatic macrophytes, the Mean Mass Total index (MMT) of each species was calculated. The MMT index was used for calculation of Shannon's index species diversity as well as for Principal component analysis (PCA) using the CANOCO 4.5 for Windows package.

Temporal changes in both structural characteristics at the level of aquatic macrophytes and land cover patterns were found (for further details see Otahelova et al. 2011). The results pointed to the effects of the flood and management disturbances (stocking with the herbivorous grass carp) in the past.

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## **Plant Diversity Conservation in Osun Osogbo World Heritage Site, Nigeria**

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The Osun Osogbo is a sacred grove that is listed as a World Heritage Site. The grove is regarded as a place of tourism and is a historical site of Osogbo people; they are renowned, worldwide, for their unique creations of art works of different cadre; painting, carving, beadworks, sacred artworks and even performing arts. The Osun River, the major centre of worship meanders through the whole grove and along its length are nine worship points, which preserves their cultural values.

Floristic data were collected from 12 sample plots (25m x 25m) in the grove using stratified random sampling, within the Core, Buffer and Transition Zone. The core zone had the highest tree density of 123 tree/ha, followed by the buffer and transition zone of 82 tree/ha, 44 tree/ha respectively. 68 tree species were encountered during the study with 44, 14, and 10 species in core and buffer, transition zone respectively. 101 genera of plants were encountered in the core zone followed by the transition and buffer zone of 62 and 38 genera respectively. 67 families of plants were encountered in the core zone, while 27 and 21 families occurred in transition and buffer zone respectively. 6 tree species were common to all sites, and 20, 9 and 7 species were restricted to the core, transition and buffer zone respectively.

Questionnaires were used to collect data on socio-cultural importance, traditional laws forbidding people from cutting the trees, killing of animals and grazing of animals, etc. and methods of conservation and sustainable use of biodiversity. About 270 respondents participated in the study divided in groups: visitors, government workers and traditional groups. The majority addressed that traditional method of conservation are the only means for effectively conserve natural resources, believed in the effectiveness of the functions assigned to Osun grove, and stressed the social purpose of traditional dancers and Votary maid (Arugba Osun). Other cultural components linked to the conservation of the area are shrines and sacred sites. The features function as a place of cult's initiation and other sacrifices, a place for collection of concussion to take care of any sickness, a place for devotees to commune with their gods and goddesses, hunter's abode for sacrifice.

Among the trees species identified in the grove, 10 were vulnerable, one endangered and one critically endangered based on IUCN classification. Therefore, it is necessary to encourage conservation by appropriate funding for development as these are the last areas of existing relicts of natural vegetation in the tropical rainforest areas of Nigeria.

## Wetland Zoning to Delimit Oil Extraction Areas in Tabasco Mexico Based on Environmental Services

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Tabasco is located on the Southern part of Mexico on a flooding plain. The main ecosystems in the area are different types of wetlands among which is the main one register for Mesoamerica “Centla swamps”. They are under constant threat due to an increase of agricultural and urban areas and pollution among other ecological impacts related to modification and control systems of the hydrology and Fish and shrimp farms. This region is also the main producer of oil. The extraction activities performed had causes important ecological impacts that had decreased most of the environmental services. The objective of this research was to construct a proposal defining boundaries for oil extraction areas on the wetland for Tabasco, to reduce impacts. Wetlands were identified and digitalized from SPOT images, using botanical, hydrological, land use and ecological criteria as well as field verification to create a map. The RAMSAR classification was used to identify wetlands types as: wetlands, transition areas and floodable grasslands. In order to propose a zoning for the performance of this activity they were characterized as: 1) Transition areas between land and aquatic systems, 2) Areas with vegetation adapted to floods and 3) Soils flooded permanently or most of the year. Wetland relevance ranking was based on their contribution to environmental services as: 1) Water supply, 2) Flood control, 3) Coastal stabilization and storm protection or 4) Wild life protection. Wetlands were categorized on six different types: **1)** Mangrove and flooded forest, **2a)** a boundary adjacent to wetlands type 1 as a safeguard area and/or patches of natural vegetation with more than 100 has and less than 10% fragmentation, **2b)** Hydrophytic vegetation of more than 100 has, less than 10% fragmentation, and **2c)** Any kind of wetland with less than 100 has, with fragmentation higher than 50%. Transition areas included only one type: **3)** Transition areas are those that present transitions between hydrophytic vegetation to grasslands. There was also only one type of floodable grasslands classified as: **4)** Floodable Grasslands. Taking into account this information as well as soil moist type, six oil extraction management types were defined in relation to the wetlands classification: Wetlands class 1 where only maintenance activities would be allowed on already established oil extraction installations. Wetlands class 2a where to carry out any construction or operation a study must done to limit any influence on mangrove areas and to be able to maintain environmental services. Wetland class 2b, where any construction or operation that interrupts any hydrological flow or causes fragmentation must be avoided. Wetland class 2c an ecological factibility study is required regarding flooding conditions to avoid any disturb to adjacent mangrove areas with development of construction or operation. Wetland class 3: To operate activities here a general diagnosis of the area is required. Wetland class 4. As these areas are altered due to cattle management they are only required to report any special species or fragment that is identified as ecologically important. This zonification on oil extraction sites on Mexico has no precedent and has contributed to promote better conservation strategies on areas where oil extraction is required as a development policy. Wetland protection and conservation is especially important in Tabasco as has been proved to be and alternative adaptation against some impacts related to climate change.

## **From Ecology to Ethics: transformations of European Landscapes**

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The transformations of landscapes in Europe is now one important topic of landscape Ecology. In Italy, like what appened in other countries, two main driving pressures are acting: mountain abandonment (that started more than 50 years ago) and urbanization in flood plain (especially Po River flood plain) and in touristic areas.

Considering the role of urbanization urban regions (Forman, 2008) may be considered one of the new hot topics of landscape ecology. Defining their boundaries may be crucial in order to define different policies for urban regions and surrounding rural areas. We used land use maps to identify the boundary of the urban region of Milan (see Padoa-Schioppa *et al.* 2010), and we compared different approaches and criteria: 1) radius criteria (a radius of 60 km from the centre of the city); 2) “onion” system; 3) contiguity system; 3) density of urban settlement (we consider – using the third nearest neighbour rule – a single urban region as all the area of more than 40% urban elements).

The last approach appears to be the most useful and powerful. We delineated a large region of 3160 km<sup>2</sup> in Lombardy (13% of Lombardy). The results show a clear increase of urban sprawl in the last 10 years. For instance, in 2002 the area of the urban region was 2400 km<sup>2</sup>, indicating an increase of about 30% in six years. Regional parks may play a key role in containing urban sprawl and determining the directions of its expansion. One other interesting result from our study is that the administrative boundaries of districts need to be redrawn following the new urban region.

Our results imply that the urbanization is one of the strongest driving factors for landscape transformations. The numbers we observe (about 10.000 ha every year in few region of North Italy are converted from agricultural use to urban use) are impressive. We suggest that –at least in Europe– landscape ecologist need to consider those numbers not only by an ecological point of view but also by their ethical meaning. As Zev Naveh suggested in his last speech at the world congress of Wageningen an ethical dimension must be rediscovered also in Landscape Ecology. We suppose the first step can be to show and disseminate those numbers among scientists and society making them aware of the irreversible transformations of our landscapes.

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## **Landscape Potential Assessment in River Basing: Riva Creek Case Study**

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Planning landscapes in river basins requires hydroecologic assessments. Examining them as ecosystems enables explaining the basics of how landscapes, watersheds, stream corridors, and streams function. Many common ecosystem functions involve movement of materials (e.g., sediment and debris), energy (e.g., sunlight and biomass), and organisms (e.g., movement of mammals, fish, and macroinvertebrates) between the internal and external environments in relation with water cycle. As an example a stream ecosystem has an input/output relationship with the next higher scale, the stream corridor. This scale, in turn, interacts with the landscape scale, and so on up the hierarchy.

The spatial structures (matrix, patch, corridor, mosaic) defined and used by landscape ecologists can fit into watershed scale properly. The zoning in watershed, drainage system, and hydrologic elements like floodplains, deltas, channel attributes would provide a more robust planning approach particularly when river corridors are on the table.

In this perspective we imported hydroecologic attributes into planning procedure at a case study in Riva basin with the objective of combining natural and cultural elements to build up a planning framework. Riva river basin lies at the outskirts of Istanbul as a portion of larger Marmara Basin. The landscape around the creek is gaining importance as the city sprawls. The landscape subject to our assessment is composed of an alluvial floodplain and the hillslopes surrounding it to compose the basin. The risks based on human activities have been grouped into 3 categories; a) water pollution, b) erosion and sedimentation, and c) torrents and floods.

The basin has been divided into subwatersheds and they have been scored for these 3 categories. The landscape potential evaluation has been based on the risk potential of subwatersheds. The risk potentials of watersheds have been verified with field surveys. The field surveys were composed of measurements of water quality, riparian ecosystem condition (integrity, health, and functionality), and human impacts (roads, bridges, land use, trampling, grazing, etc.). With this approach we had the opportunity to verify our assessment in the field.

The results of the study suggest that hydroecological evaluations should form the background of landscape assessments in riverine environments as almost 60 percent of the watershed was prone to torrent and flood risk while 27.7 percent had a risk of erosion in medium to severe levels in Riva Creek case.

## **A New Method for Urban Vegetation Remotely Sensed Monitoring--Reconstructing the Urban Vegetation Cooling Mechanisms from Multidisciplinary**

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Urban vegetation has numerous ecology services function, especially important for mitigating urban heat island effect in summertime. Recently a lot of research study on the correlation between vegetation cover and urban heat island, based on extracting information from remote sensing data, however most of the study ignored about the real mechanism of vegetation cooling temperature. This paper through explaining the theory of solar radiation energy, plant spectroscopy, ecology, and vegetation remotely sensed, these transdisciplinary, to identify the vegetation cooling effect mechanism, is aimed to eliminate disagreement in this field. In this paper we propose vegetation stress monitoring, through investigating in urban greening's health state management, improving vegetation ecology service function should be a new research point.

**Keywords:** Urban vegetation, Urban heat island, Spectral feature, Stress, Ecology service functions

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## **Conversion of Natural Wetlands into Paddy Rice Fields and its Impact on Water Environment**

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Water quality and quantity are key factors in the sustainability of agricultural development. Sanjiang Plain is an important commodity grain base in China, the total area of which is about  $1.088 \times 10^7$  ha with rich marsh resources and biodiversity. However, as the wetlands have been reclaimed as paddy fields in the last 50 years, irrigation has expanded each year, and water table has declined. Groundwater has been used mainly for irrigation of paddy fields, accounting for 90% of the total. In order to achieve the local government's goal of 5 billion kilograms of grain production per year, water table will decline at a much higher rate, if groundwater is still exploited in the current way. Based on the water balance model, we conclude that groundwater system in the regional aquifer is in negative balance since the period when the wetlands have been reclaimed as paddy fields; as a consequence, water table has declined at least 1m per year in the aquifer underneath the paddy fields. In 1998, when the area of paddy fields was 2.27km<sup>2</sup>, and the grain production was less than 3.5 billion kilograms, water table declined nearly 1m. The fast groundwater decline can't support the sustainable development of agriculture in Sanjiang Plain. Therefore, the major issue to be studied in the region is where or not the irrigation using groundwater can be sustainable, in view of the water table decline as well as water quality constraints. In the last two years, we have collected the hydrological information of the targeted wetland system and analyzed it using isotope techniques. Detailed information of groundwater is obtained, including its flow

field, regime as a consequence of agricultural development. Monitoring data of groundwater system is obtained for the last 5 years or longer. Relationship between groundwater, river water and wetland water is better understood using water chemistry and isotopes of a few well selected typical farms, along the two major rivers: Nongjiang and Bielahonghe located in the northern side of Sanjiang Plain. We have gained a better understanding of the main cause of change in water cycle in the process of conversion from natural wetlands to rice fields. After the field sampling and laboratory testing work, a conceptual model of water flow path in the study area has been established. The sustainability of agricultural development in the study area can be assessed from the two factors: water quality and quantity. After the comprehensive analysis of groundwater regime, water chemistry and isotopes, we conclude that: 1) Groundwater recharge in the studies farms is mainly from precipitation and return water of irrigation. Groundwater decline with inter-annual trends is caused by over extraction of the aquifers. 2) There is hydraulic connection between the different shallow aquifers resulting in similar water chemistry and isotopic compositions. 3) Difference in the groundwater regime of the different farms is caused by the difference in hydrogeological conditions, mainly the permeability and yield, as well as difference in the intensity of paddy farming. 4) The concentrations of NO<sub>3</sub>, Cl and K are very low in the groundwater, which is controlled by the condition of oxidation-reduction in the aquifers. However, the linear relationship of K and NO<sub>3</sub> can still show that the groundwater has been affected by agricultural pollutants. In some areas, the concentration of NO<sub>3</sub> has been increasing gradually, which further confirms the survey results of last year. 5) Hydrogeological variations will dominate the sustainability schemes of the different farms in the region. The distribution of the paddy rice fields could be arranged accordingly so as to avoid continuous decline of groundwater.

## **Analysis of Ecological Structure of Tehran Landscape to Develop Restoration and Enhanced Environmental Quality Strategies**

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Tehran is one of the most polluted metropolises in the world. Sink capacity for absorption and assimilation of pollution is reduced generally in Tehran due to failure in incorporation of ecological aspects in the regional land use development plans. The present condition of air and water related issues in Tehran are largely affected by landscape structural alterations at urban level.

In this research, the focus is to understand relationships between land use patterns and ecological processes particularly those air and water related processes, which are affecting the urban environmental quality.

We propose measures to harmonize urban growth patterns based on the existing opportunities for increasing the sink capacity for air pollution and waste water.

Using Landsat satellite images (dated 1988 & 2002) maps for three classes of green, open and built land cover types were created.

A series of landscape metrics, NP (Number of Patch), MPS( Mean Patch Size), MNND(Minimum Nearest Neighbor Distance), and CAP(Class Area Proportion) were used for the analysis of landscape structure (both configuration and composition) at two different scales.

Based on Variations in environmental conditions and spatial configuration and composition of Tehran landscape, three distinct homogeneous zones and six subzones with different environmental conditions and ecosystem capabilities for urban development are distinguished within the delimited urban region considered.

Final results demonstrate that despite ecological alteration, the remnant patch mosaic network of Tehran may still be restorable. The river valley network provides the basis for development of a conceptual framework referred to in this research as “Refuge Network” in order to integrate all corrective measures at different scales. Natural layouts of river valley networks along with the core open patches of hills may be the basis for implementation of a comprehensive restoration plan based upon the “Aggregate with outlier” model as a spatial design framework at urban level.

**Keywords:** Landscape ecological Metrics, Landscape structural Restoration, Aggregate with outlier model, Refuge Network, Urban environmental quality, Tehran

## **Urban Morphology and Landscape Connectivity in Metropolitan Areas: A Comparative Study in Phoenix, Arizona, USA and Izmir, Turkey**

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Urban sprawl combined with growing population is a major challenge many metropolitan regions are faced with (Ji *et al.*, 2005). As an important ecological consequence, habitat fragmentation is often accompanied by biodiversity decrease and the loss of ecological connectivity. Although the ecological connectivity conservation in urban areas has recently been emphasized, less is known about its relationship to urban form and growth pattern. This study investigates how urban morphology influences regional ecosystem pattern and landscape connectivity. We compared two metropolitan landscapes, Phoenix, Arizona, USA and Izmir, Turkey, both of which are one of the fastest growing regions in their nation context. Both quantitative and descriptive analyses were conducted to understand what has driven current pattern of ecological connectivity in each landscape. A wide range of variables were considered for identifying natural and urban properties. The natural characteristics include typology of urban ecosystems, urban to natural cover ratio, dominant habitat type, urban biodiversity, landscape context, and connectivity conservation efforts, while urban parameters examine urban form, urban extent, urban cover proportion, growth rate, population, urban gradient, major drivers of urbanization, urban density, and mode/approach of urban development. For landscape pattern quantification, twelve landscape metrics found to be useful in urban planning field (Leitão, 2006) were measured using FRAGSTATS (McGarigal

*et al.*, 1995) and compared across natural patches. We developed a buffer-based GIS method to delineate three spatial categories in urban gradient, such as urban, suburban, and rural zones, which was utilized as an analysis framework to evaluate parallels and contrasts between the two regions. The results show that there are little difference in landscape connectivity in the rural zones of Phoenix and Izmir, although Phoenix has a slightly higher connectivity values. On the contrary, the connectivity variance in urbanized areas is significantly dependent on the region. For example, Phoenix urban zones have tremendously lower connectivity than either urban or suburban zones in Izmir. The findings demonstrate that small and compact urban settlements with intense population is likely preferred to conserve landscape connectivity compared to multiple-concentric but amalgamated urban form spreading all over the landscape. This study partly, if not entirely, answers to the critical question on which type of urban model would be desirable in the aspect of landscape connectivity, and concludes with planning implications for making sustainable metropolitan landscapes taking ecological concerns into account.

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## **Historical Maps – Information Source for Landscape Management**

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Archival and historic documents help us to create and formulate type and design of landscape in the past. Old maps represent not only fascinating documents, they also hold valuable information for scientific evaluation of changes in selected territory over time. Many historical maps show situation of land use in those days and give important information about landscape, especially about landscape elements. On the basis of landscape reconstruction with using old maps and documents it is possible to study historic landscape structure, landscape mosaic, land use forms, levels of urbanisation and concrete impacts of landscape management.

Landscape researchers use many various reconstruction methods developed on the basis of landscape evaluation using historical maps, e. g., the extraction method of the attribute data using mathematical morphology and remapping method (Yamada, Chikatsu, 1999), the efficient method for visualization of historical cities using historical maps (Namatame, Chikatsu, 1999), methods for identification of land use changes (Bicik, Chromy, 2006; Boltiziar, 2003; Pauditsova, 2003), methods for determination of land cover changes (Feranec, Otahel,

Cebecauer, 2004), reconstruction methods based on evaluation of varied historical data sources, e.g. historic aerial photos, historic maps (Kakiuchi, Chikatsu, 2009) etc.

Varied types of historic maps (cadastral map, old mining map, historic topography map from 19<sup>th</sup> Century, and aerial photo from 1930) as the information sources about landscape are presented in the contribution. Different ways of data interpretation from old maps and possibilities of their using in landscape planning and management are presented on the selected examples.

**Acknowledgement:** This contribution is the result of the projects: VEGA No. 1/0558/10 Land-use and landscape protection from the point of view of land consolidation like landscape management tool and UK/20/2011 Pasture landscape management in selected area of Cerova vrchovina upland in the past and at the present time.

## **Eco-development in Chinese City Regions – its Potentials and Current Limitations: the Case of Hangzhou**

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In China, rapid urbanization causes huge pressures on the environment. In the EU funded research project PLUREL ([www.plurel.net](http://www.plurel.net), Nilsson et al., 2008) we studied the processes of urbanization in the city of Hangzhou. Emphasis was placed on rural – urban interactions and the peri-urban areas in specific. The aim was to assess current patterns of urban growth and identify suitable strategies to support development of more sustainable land use systems.

The core city of Hangzhou, capital of Zhejiang province, currently has a population of appr. 4 million with an annual average growth rate of appr. 5.2%. A measure of entropy was employed to delimit between the urban core, periurban and rural areas. The urban core area expanded between 1988 and 2004 by 158km<sup>2</sup>, roughly seven times whereas the peri-urban area expanded by 471km<sup>2</sup>, which is about four and a half times. The cover of built up area increased in the rural parts of Hangzhou from 12% to almost 20%. All of this resulted in a dramatic loss of fertile farmland and wetlands.

Three case studies in the peri-urban were selected to explore in more depth the processes of change, its associated environmental and social challenges and the response strategies. The study combined analysis of planning documents, interviews with stakeholders, workshops and field trips.

Environmental and ecological concerns play an increasingly important role in urban development policies and major projects such as the creation of Xixi National Wetland Park.

However, this has been achieved at significant social costs as a larger number of farmers had to leave their land and were relocated into multistory blocks of flats. In other cases, we found that ecological concerns were of less prevalence despite the eco-rhetoric adopted in plans and frequent use of concepts of eco-corridors, urban forests, etc.

It is concluded that in spite of sometimes impressive achievements, ecological concerns need to be taken more seriously and become better integrated into overall urban planning. Strong protection of farmland as a main carrier of the city's future green infrastructure is a particularly urgent issue. This requires recognition of farming as a multifunctional activity which provides food but also important ecosystem services to the city. Special attention also needs to be paid to the development of an efficient transport and an ecologically effective water systems. Assessment of the multifunctional role of the city's green infrastructure would be a first important step to support policy makers with evidence for moving into this direction.

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## **Effects of Sustainable Energy Facilities on the Landscape**

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Sustainable energy is the provision of energy that meets the needs of the present without compromising the ability of future generations to meet their needs. As the sustainable energy sources are most often regarded hydroelectricity, solar energy, wind energy, geothermal energy and biomass energy. The impacts of increased sustainable production and consumption are considerably less than increased supply and consumption of conventionally produced energy. That is without the discussion, but we have to take into account also negative effects of new renewable production energy facilities, mainly on the landscape and its characteristics. They could be also considered as a limit of future settlements' development. A localization of them as a factor which influences settlements' development could be evaluated from two points of view. It can be perceived as a facility reducing the amount of „green gas emissions“, but also as a separate construction in the landscape.

Two slightly differentiated concepts can be identified in the discussion on energy transition. At first, all kinds of energy based on *renewable resources* found their way into the scientific debate and public discussion. Only with the rising concern on a socially fair, environmentally friendly and economically feasible future, the focus has shifted and included sustainable energy sources. This is primarily due to the fact, that some of the renewable technologies, although reducing greenhouse gas emissions, do harm the environment as well as humans. (van Etteger et al., 2007)

The capacity for sustainable energy production is affected by geographical location, climate

as well as geology and therefore limited. This perception is based on ecological understanding. But according to Kozova and Pauditsova (2010) landscape suitability must be assessed not only in ecological terms, but also on social and cultural carrying capacity. Environmental Impact Assessments from simple methods such as checklists to complex predictive models, can also evaluate landscape suitability.

The aim of paper is to point on specific aspects of environmental impact assessment of sustainable energy facilities with the emphasis on the role of „landscape“ and „landscape-ecological evaluation“ in Slovakia. On the basis of dozens evaluated activities assessed in last 10 years as the specific aspects were determined: choice of locality - „brown fields“ versus „green areas“, increased emphasis on cumulative impacts evaluation, clear suggestions strengthening of proposed activities including their visualisation, visibility evaluation and public animosity to proposed activity.

The contribution is prepared as a result of VEGA project 2/0017/09.

## **Designing a Sustainable City: Perils of not Taking a Landscape Ecological Approach to Designing for Sustainability.**

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As the world faces increasing threats of global environmental crisis, there is intensifying pressure to make our lives more sustainable, and recognition of this is being demonstrated by planners talking about building sustainable future cities in which we can live. But what do we really mean by a sustainable city? Are planners more concerned with selling design concepts that appear to address hot topics like reducing carbon emissions, and less concerned with worrying about sustaining the underlying patterns and processes that ensure sustainable landscape functioning of the landscape on which the city is built? As a case study, this paper looks at recent development plans for the Greater Darwin area, Northern Territory, Australia. To date, landscapes surrounding Darwin have been relatively undisturbed, but population prediction figures indicate that Darwin will continue to grow at one of the highest rates in Australia, i.e. an increase of about 34% by 2021 is predicted, which if true, means considerable urban expansion is required. One of the major elements of the proposed development plans is the creation of the new sustainable city of Weddell. The site of Weddell is about 30 km south of Darwin and approximately 15 km from the satellite city of Palmerston and lies on an important part of the Darwin Harbour catchment. Darwin Harbour is currently renowned for its ecological significance. Amongst other things the site of Weddell has been identified to contain important hydrological features that have been shown to significantly reduce the amount of sediment runoff from the landscape into the harbour. Without careful design to preserve the integrity of these important hydrological features, and therefore maintenance of a landscape structure that preserves important landscape processes, what is supposed to be a sustainable 21<sup>st</sup> century city could seriously

impact on the sustainability of the natural resources in and around Darwin Harbour. This paper therefore demonstrates that design for sustainability should not just be about reducing carbon emissions but also ensuring that a new city is created to maintain continued functioning of the ecological and hydrological systems on which the city sits. The authors suggest that a landscape ecological approach is crucial in order to guide the design of a new sustainable city, and that design which ignores the important elements of taking a holistic landscape ecological approach to planning will be to the peril of future landscape sustainability.

## **Ecotones as Indicators of Landscape Changes in the last 230 Years - Case Study Trkmanka Catchment, Czech republic**

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Edges or boundaries of particular landscape areas form contact lines that, according to many authors, can form transition communities of varying widths, species and characteristics in dependency of the edge effect (fluctuations in light exposure, temperatures, wind speeds and moisture). The ecotone, a transition, boundary or edge community, is formed in the boundary area between two or more adjacent community types (Hansen, di Castri 1992; Forman, Godron 1993).

The research on ecotones in the Trkmanka catchment area was carried out using spatial analyses of historical maps of landscape utilisation in the years 1764, 1836, 1876, 1920, 1953, 1995, 2001, and 2008 and determination of landscape indices using geoinformation technologies. The research into ecotones enabled a better understanding of the causal relationships between particular landscape elements, landscape utilisation categories and ecotones. The geoinformation research brought the findings on the trends in developments and the identification of stable areas. In the Trkmanka catchment area the most prevalent land is arable land. Forests, vineyards and grassland occupy much smaller area. However, they support and increase an ecological value of a landscape and its stability. The water resources in the area were analysed as well, although their area is currently very small. In addition to analyses of stable areas, the landscape metric indices, coefficients of ecological stability, persistence of areas and change indices were determined. The initial state was the reconstruction map from the second military mapping (1836–1838). Persistence values were given for all intervals (1836–1876, 1836–1920, 1836–1953, etc.).

When studying cultural landscape in particular time horizons, ecotones were viewed as boundaries between specific landscape utilisation units, but when studying “natural” landscape at the level of potential vegetation, they were viewed as boundaries between potential natural vegetation units (i.e. convergent and divergent boundaries). The existence and typology of an ecotone community is a manifestation of non-living elements of nature, of human impact and of other living organisms. Their interactions vary considerably when



comparing their impact in the current landscape with its vegetation and in a potential landscape with its potential vegetation not being influenced by anthropogenic activities.

The research confirmed that ecotones are important landscape structures and that they reflect both the quality of the natural environment and the intensity of the human impact. Ecotones may serve as one of the distinctive indicators of the impact humans have on landscape.

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## **Assessing Ecological Effects of Land Use Pattern Change: a Case Study in Lijiang County of China**

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Land use / land cover change (LUCC) is gaining recognitions as one of the key components and driving forces of global environmental change. Ecological effect of LUCC is regarded as the very reason for the importance of LUCC to global environmental change. And ecosystem services assessment of associated land use types are always applied to evaluating the integrated ecological effects of LUCC. However, all the studies failed to discuss the ecological effects of land use change in spatial patterns, but explored the change of ecosystem services associated with area ratio change of land use types. In this case study in Lijiang County of China, a new model was developed to assess integrated ecological effects of land use change in quantitative structure and spatial patterns. In details, ecological value of each land use type was assessed according to global average value of ecosystem services, and the coefficients of spatial neighboring effects on ecosystem services for each land use type were developed to quantify ecological effects of land use pattern change. The results showed that, along with slow but significant increase of grassland, bare land and forest land, decrease of crop land and glacier or snow-capped land, and patch fragmentation and regularization of land use patterns in Lijiang County during 1986-2006, there were distinct positive ecological effects. And land use patterns in Lijiang County were proved to be positive to ecosystem services in the study period, through calculating the coefficients of spatial neighboring effects.

**Keywords:** Land Use Pattern Change, Integrated Ecological Effects, Coefficient of Spatial Neighboring Effects, Ecosystem Services, Lijiang, China

## Global Species Monitoring for Quantitative Models and Scenarios

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The progress towards reducing biodiversity loss was assessed recently (Butchart et al. 2010). Many of the biodiversity state indicators show declining trends, but it is worrying that the spatial coverage and the taxonomic coverage of the datasets from which the indicators are derived are very limited (Pereira et al. 2010a). These data limitations are well apparent in current quantitative models for biodiversity change in the 21st century. Many of the models are derived from static patterns of biodiversity distribution and therefore the future dynamics of biodiversity loss as consequence of land-use change, climate change and other drivers remains uncertain (Pereira et al. 2010b). Here we argue that we need to develop a global observation system of biodiversity change to provide timely feedback to decision-makers on the impacts of policies and pressures on biodiversity, and to validate and improve existing models for biodiversity scenarios (Araujo et al. 2005). The Group on Earth Observations Biodiversity Observation Network (GEO BON) aims at filling this gap. GEO BON is building on existing biodiversity monitoring initiatives to develop a collaborative network of institutions, scientists and volunteers working towards expanding existing biodiversity observation capacities. For terrestrial species, emphasis is being placed on the development of pilot monitoring programs in biodiversity data gap regions, such as Sub-Saharan Africa, South East Asia, and tropical Americas. These programs will harmonize biodiversity monitoring schemes and focus on three indicator groups: vertebrates (particularly birds and large mammals), vascular plants (particularly endangered plants), and butterflies. These programs could produce spatial time-series observations of species populations by the end of the decade, in time for assessing the new 2020 targets of the Convention on Biological Diversity. These datasets of biodiversity dynamics, integrated with other spatial datasets being developed by GEO, can contribute towards developing a new generation of quantitative and process-based biodiversity scenarios and assist policy analysis in the Intergovernmental Platform on Biodiversity and Ecosystem Services.

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## Linking Biological and Cultural Diversity from Local to Global Levels

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Recognizing the inextricable link between biological and cultural diversity, the United Nations Education Science and Cultural Organization (UNESCO) and the Secretariat of the Convention on Biological Diversity (SCBD) joined forces to understand and address the interactions between biological and cultural diversity and common challenges posed by contemporary processing affecting the current diversity trends. The SCBD-UNESCO Joint Programme on Biological and Cultural Diversity was endorsed by UNESCO's constituencies and welcomed by the 10<sup>th</sup> meeting of the Parties to the CBD (CBD COP 10) held in October 2010 in Nagoya, Japan (Decision X/20). The CBD COP 10 recognized the Joint Programme as a 'useful co-ordination mechanism to advance the implementation of the Convention and deepen global awareness of the inter-linkages between cultural and biological diversity'. State Parties and other relevant stakeholders were invited to 'contribute to and support the implementation of this joint programme'.

In addition to linking grassroots and community initiatives with local, national, regional and global policy processes, one of the key goals of this international Programme is to advance knowledge on the ways in which cultures have shaped and continue to shape biodiversity in sustainable way to be able to identify and implement management and policy approaches to sustain our planet's diversity. As demonstrations of sustainable interactions between people and their environment, many examples of cultural landscapes and sacred sites offer promising possibilities to elaborate such approaches on the appropriate spatial and temporal scales (UNESCO, 2006). Because of their critical ecological, but also cultural, historical and institutional dimensions, cultural and sacred landscapes can thus be viewed as sustainability units well adapted for the exploration of the mutually beneficial interactions between biological and cultural diversity which are vital for enhancing environmental integrity and human well-being (UNESCO, 2008).

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# Territories of Detached Housing Model New Forms of Sustainable Landscape

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Due to numerous thermic transformations and energy regulations in France, a several number of changes concerning the detached housing models are about to occur, modifying landscape's aspects. The aim of our abstract is to study the evolution of housing prototypes and to reveal the questions that will appear in the next decade.

It is important to reduce energy losses but what is essential is to change constructing principles in order to adapt to the site, taking into account ecological and social matters. Based on models of three main constructors (*constructeurs*) in France (*I.G.C.* in Gironde, *Trecobat* in Britain, *Maisons CTVL* in Loiret) during the last three decades, we are going to examine with landscape architects, ecologists and thermic engineers the evolution of detached house.

The way to implant detached houses following the exposition rules and the environmental sensibilities will put in question the traditional organisation of the parcel and its governance. To do so, it is essential to have in mind past reflexions and use historical evidence: anticipate new constructing ways towards a sustainable housing model should take into account the ecosystem and its biodiversity, topography, landscape ecological infrastructure and hydroscares.

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## **Design and Implementation of Multifunctional Greenways in Southern Sweden**

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Greenways are linear landscape elements that consist of or are aligned by vegetation and can provide multiple functions as recreation possibilities, biodiversity conservation or environmental functions (e.g. decreasing nutrient run-off). Greenways can either be established in areas with already existing (semi-natural) vegetation, as for example along river- corridors or newly created in areas lacking green infrastructure. In areas with intensive agriculture and little semi-natural vegetation present, new establishment of greenways can be a suitable measure to enhance the multifunctionality of the landscape. This is especially the case in peri-urban areas where there is an increased demand for recreation possibilities due to an increasing urbanized population.

This project has analysed existing greenways in the southernmost part of Sweden (Scania) regarding different aspects of biodiversity (vegetation, butterflies, bumblebees and birds) and their suitability for recreation. We concluded that the existing greenways - mostly established by municipalities – do not benefit biodiversity sufficiently. From a recreational view point certain aspects could be optimized especially regarding co-existence of different user-groups and their different interests.

Based on these analyses we have developed design solutions for greenways that improve biodiversity and recreation amongst others by decreasing conflicts between different user groups (walkers, equestrians). Possible implementation processes have been discussed with local and regional authorities as well as other stakeholders. It is suggested that several implementation possibilities should be encouraged as establishment initiated by interest groups, by municipalities, regional authorities and within agri-environmental schemes.

## **Monitoring the Changing High Mountain Landscapes of the Central Caucasus**

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The high mountain regions of the Central Caucasus, the highest and most popular for recreation part of the Caucasus, are distinguished by dynamic landscape structure, resulting from active natural processes and human activities. The last decades are especially notable for catastrophic processes of large volume such as avalanches and debris flows and for increasing of anthropogenic effect, mainly of uncontrolled recreation. The changes of landscape structure

have been analyzed on the base of long-term field landscape research, repeated studies on the model plots, information of historical maps, satellite (TERRA (ASTER), EROS, LANDSAT) aerial images (since 1946) and photos (since 1928), phytoindication and lichenometry.

Several periods with different landscape changes reflecting climatic fluctuations and anthropogenic impact since the middle of the XIX century with particular attention to the last decades have been revealed. The most dynamic landscape structure is typical for the periglacial areas and zones affected by avalanches and debris-flows. Reduction of the glacio-nival landscapes with the most intense deglaciation in the 70<sup>th</sup>-80<sup>th</sup> of the XIX century, in the 30<sup>th</sup>-60<sup>th</sup> of the XX century and during the last decades have been noticed. During the last 80 years (from 1928) the front of glaciers in Adylsy valley retreated on 350-400 m. Expansion of meadow and forest landscapes due to their formation on modern moraines, fluvio-glacial and nival-gravitation deposits, mainly in the bottoms of valleys and in the glacial cirques is a result of the glacial retreat. The unique “on-glacier” geosystems with vegetation and sometimes with primitive soils on the surface moraines of some glaciers are the specific evidence of climatic changes and glacier retreat nowadays. The velocity of periglacial landscape formation is correlated with type and size of concrete glaciers, character of glacier valley, activity of natural processers, position in altitudinal belt, granulometric composition of deposits and climatic features.

The intensification of landscape changes as a result of active debris flows in combination with snow avalanches including extreme events during past decades comes to light in all study valleys of the Central Caucasus. The areas affected by debris flows and avalanches are characterized by different landscape structure and time of landscape succession changing in the periods of climatic fluctuations.

The different landscape changes were enhanced or relaxed in the periods of different intracentury climatic fluctuations. Thus the trend of aridization was exacerbated in the 40-ies and from the end of the 70-ies to the middle of 80-ies of the XX century. In humid and cold periods (the end of 50-ies -middle of the 70-ies) the expansion of subalpine meadows and appearance of more mezophytic species of plants in all zones were revealed.

Last decade is also characterized by intensive anthropogenic impact especially of recreation construction and expansion of settlements. Maps of landscape dynamics under natural processers and anthropogenic effect are compiled for some model areas. The studies were supported by RFFR grant 10-05-00774.

## **Modern State of Landscapes of Russian Northeastern Black Sea Coast**

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The northeastern Black Sea coast is the unique place in Russia with original subtropical landscapes. The aim of this investigation is to study structure, evolution and modern state of

background and anthropogenic modified landscapes of the Abrau Peninsula. It's one of the conservation sites on the Russian Black Sea coast. But the ecological situation is aggravated here nowadays due to the construction of pine-line and oil terminal near Novorossiysk and the increasing of uncontrolled recreation within the narrow coastal zone.

Landscape mapping and profiling with regular step of investigation of 20-25 m was made during the field studies. Large-scale landscape and vegetation maps (1:25000) with some detailed schemes on model areas within the coastal zone have been compiled on the basis of fieldwork and remote sensing analysis. Natural and anthropogenic modified landscapes with different types of changes under anthropogenic pressure have been shown on these maps. Emphasis has been placed on the ecological state of unique Mediterranean ecosystems – pine-tree forests, pistachio-tree and juniper open-lands.

About 70 vascular plant species, found at Abrau Peninsula are included into the Red Data Book of Russian Federation. The forests of *Juniperous excelsa* are the most species-rich (up to 70% of species), they presented by the different types of communities, facilitated by the wide ecological amplitude of the natural conditions of the lower part of the southern macro slopes. Thus, proportion of Mediterranean species in the pistachio-juniper light forests is about 50%, sometimes more. It is these communities with numerous species of shrubs, grasses and forbs are the most rich and diverse, where the various geographical and ecological cenotic elements combine. The common biodiversity is also higher in the coastal zone.

Fauna of this region is particularly rich in rare and endemic species, most of which are listed in the Red Data Book of Krasnodarsky Krai (2007), Russian Federation (2001), and some (2 species) are in the International Red Data Book of the IUCN (tortoise *Testudo graeca* (L.) and snake *Elaphe longissima* (Laurenti)).

The reduction of forests, including relict and endemic species, expansion of shrubs, secondary forests and meadows; reduction of biomass, productivity, floristic composition of vegetation were revealed as a result of the anthropogenic effect. It was turned out that near 60% of pine-tree (*Pinus pithyusa*) forests exist in the fourth and fifth stages of recreation degradation. Expansion of soil disturbances – the sod absence, the appearance of surface rocky covers; formation of new erosion and anthropogenic landforms, reduction of vineyards and appearance of pine-tree stand on their places are also typical for the study region. The ecological situation of coastal landscapes is aggravated also due to the periodic influence of active nature processes such as water-spouts, heavy showers, hurricanes and so on and require the strict measures of nature conservation.

## **Landscape Indication of Avalanche and Debris Flow Activity in the Caucasus Mountains of Russia**

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The high mountain regions of the Caucasus are characterized by active nature processes that result in landscape changes, decrease of ecological potential and sustainable development of the areas. Landscape structure in the zones of snow avalanche release and debris flow effect have been studied as indicator of their activity in the different valleys of the Caucasus on the basis of long-term landscape mapping, phytoindication and lichenometry, interpretation of remote sensing data and repeated studies on the model plots. The functional-dynamic approach has been used in this study regarding avalanche and debris flow geosystems as specific vector geosystems. The interrelations between nature components (relief, soils, plants and etc) in landscapes of different ages have been investigated using methods of mathematic statistic. An analysis of more than 30 parameters of elementary landscapes of different age (relief, surface and soil stoniness, granulometric composition of deposits and soils, thickness of the soil profile and separated layers, characteristics of vegetation, etc.) showed that we must consider a complex of parameters to determine the time of debris-flow deposit stabilization and debris-flow activity.

Several types of debris flow fans were revealed due to the characteristics of their landscape structure and dynamics reflecting the activity of debris flows of different type and volume. The areas affected by debris flows are characterized by metachronic landscape structure and different rates of landscape successions. Features and velocity of landscape succession in different nature and anthropogenic conditions have been distinguished with more detail research at the initiation stages. Common and individual features of plant and soil formation in these stages have been revealed in various altitudinal belts and regions and used as indicators of the time of avalanche and debris flow events. Less change in the landscape successions were determined for the debris deposits of 9-10 years old as well as decreasing of plant diversity on the deposits of 5-7 years old.

Several types of landscape spatial patterns were marked out for the zones of formation, transit and release of avalanches of different type and magnitude, for example, fan-shaped for avalanche debris fans. The most informative characteristics of avalanche release are snow paths, specific forms of relief and deposits, character of trees (forest type, density, height, deformation of trunks), changes in phenologic phases of plants.

The landscape structure of the valleys usually is more complicated due to the cumulative effect of debris flows and avalanches. Special large-scale maps and middle-scale map of landscape dynamics under effect of avalanches and debris flows were compiled for the model regions. The studies were supported by RFFR grant 10-05-00774.

## **Monitoring Fragmentation of Peat Swamp Forest in Sarawak, Malaysia Using Multitemporal Landsat images**

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Tropical wetlands play an important role in regulating global climate through carbon



sequestration. Tropical peatland in particular can absorb 80% more carbon than wetland in temperate zone (Millennium Ecosystem Assessment, 2005). Sarawak is the largest state in Malaysia located in the northwestern part of Borneo Island. Almost 70% of the total of 1.54 million hectares of peat swamp forest in Malaysia is located in Sarawak (UNDP/GEF, 2006). However, a postclassification comparison of land covers of 1990 and 2009 revealed rapid deforestation of peat swamp forest (Tsuyuki et al., *in press*). Fragmentation, as a contextual aspect of deforestation, has not been investigated in the rapid changing landscape of Sarawak. This paper examines the fragmentation of peat swamp forest in Sarawak between 1990 and 2009 at a 10-year interval. Nine Landsat (resolution: 30m) scenes were needed to provide full coverage of Sarawak. Landsat5 TM images were used for 1990 while Landsat7 ETM+ provided the images for 2000 and 2010. Two additional sets of ETM+ images were used to fill the missing lines in the ETM+ images for 2010. The satellite images for each time series were classified into eight land cover classes using supervised classification. The classification's results show significant changes in peat swamp forest, bareland and oil palm plantation within the change period. Peat swamp forest had plummeted by about 50% in less than two decades. Multitemporal landscape indices such as number of patches and mean patch size show the onset of fragmentation for peat swamp forest. Mean nearest neighbor distance and largest patch index provide evidence that the patches of peat swamp forest have low connectivity, isolated and disappearing from the state. Without significant change in land use policy, fragmentation will continue to threaten the peat swamp forest to the brink of disappearance in the landscape.

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## **Strategy for Climate Change Mitigation at Sub-national Level: A GIS-based Approach for Assessing Hot Spots of Dipterocarps in Sarawak, Malaysia**

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Tropical deforestation and degradation contribute enormously to carbon emissions. As most of tropical carbon is attributed to dipterocarps, setting aside lowland rain forests from agricultural and logging activities becomes a plausible climate change mitigation strategy for implementing Reducing Emissions from Deforestation and Forest Degradation-Plus (REDD+). This paper presents a GIS-based approach for identifying hot spots of dipterocarp occurrences for conservation area planning at a sub-national level of Sarawak. Sarawak is the centre of diversity for the Dipterocarps (Ashton 2004). Influence of environmental factors on plant diversity in Borneo has been examined based on field data, which is often very scarce and costly to collect (e.g. Sliks et al., 2009). Our approach is based on combined use of herbarium, satellite and GIS data. Dipterocarp herbarium records were input as point data for all 247 species in Sarawak. GIS data of eight environmental factors was constructed. The environmental characteristics of all the species were extracted for correlation and binary logistic regression analyses. Species Occurrence Maps (SOMs) were generated for all the species based on the regression models. The species occurrence density map (SODM) for each genus was generated based on the SOMs. The species occurrence density maps were analyzed with a land cover map from Landsat7-ETM+ images (Tsuyuki et al., *in press*) and protected areas for identifying hotspots for conservation in Sarawak. Slope influences most of the dipterocarp species occurrences in Sarawak. Soil pH, number of rainy days, mean annual rainfall influence about half of the species. About one-third of dipterocarps are influenced by the remaining factors. The logistic regression analysis revealed that more than 85% of the species occurrence can be weakly predicted with the environmental factors. Moderate prediction for about 60% of the dipterocarps was possible. The resulted SODMs show that hot spots of most genera of dipterocarps are located inland of Sarawak. And existing protected forest areas are limited in southwestern and northern parts of Sarawak.

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## Tracing Potentially Valuable Biotopes with the Aid of Historical Data – A Case Study from Fragmented Islands in Southwestern Finland

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Recent loss of biodiversity is a widespread concern that partly derives from abrupt changes of land use practices. In the archipelago area of southwestern Finland, semi-natural grasslands are one of the most species-rich biotopes in the country, but vast majority of them has quite recently overgrown due to structural changes of livelihoods, rationalization of agriculture and abandonment of agricultural land. Restoration of these grassland areas is perhaps the most important means of fighting against this trend but site characteristics such as soil properties, topographic attributes, dormant seed bank and especially underlying land use trajectories of these biotopes may play an important role in success of the management actions. As restoration is rather expensive and labor intensive, decisions on the location of restoration sites and management actions are limited. It requires sufficient amount of site specific information to target the resources, which emerge from combination of contemporary and past knowledge of these key biotopes and their development.

This study indicates how research on historical land cover and land use changes provides with important information to trace latent biodiversity values of overgrown grassland biotopes and find best alternatives for restoration actions. The approach is innovative with respect to management planning where often only the most recent image data and field observations are used as the basis of management decisions. Landscape change trajectories are analyzed mainly using old general parceling maps from 18<sup>th</sup> and 19<sup>th</sup> centuries and newer aerial images of several dates, but historical registers and taxation documents as well as recent biological inventories are utilized as supplementary data sources to support the analysis. Overlaying numerous layers of classified land cover data will lead to excessive amount of distinct change trajectories, but by means of appropriate grouping they may be refined into meaningful categories. In terms of potential grassland biodiversity, the most promising sites are those having long and unbroken continuum of semi-intensive management by *e.g.* cattle grazing without extensive period of overgrowth that have not been heavily fertilized, cultivated or ploughed at any stage of trajectory.

There are many pitfalls in performing a long-term trajectory analysis and there is no straightforward way of dealing with numerous and heterogeneous data sources. However, despite of problems, the analysis will give substantial amount of additional information to spot potentially valuable biotopes not easily detectable by conventional methods. One important measure is permanency of certain land cover or land use types that may prove to be determinant information for restoration management.

## **Agricultural Landscape Dynamics in Metropolitan Areas - Strategic Approach Based on Simultaneous Evolution Scenarios**

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Economic and social transformations in the last decades in Eastern European Countries occurs in metropolitan areas through new models of spatial distribution of activities and also new models of mobility and population and labor location, both at urban and territorial level (in influence areas of settlements). All this new development tendencies characterizing the metropolitan area in transitional cities (and Bucharest as particular case study) leave their marks on agricultural landscape. Extra-urban development modifies the adjacent landscape (agricultural, rural and cultural) and generates new landscape patterns, modeled by the interaction between the rural and urban space.

At national transitional level the local government concern to protect and value the "common landscape" was almost inexistent and the main goal was focused only on the protected natural and build areas. In this context, dynamic of metropolitan landscape in Bucharest City case was typologically different in the last century related to development of the city and urban and rural policy (but without a continuous approach in sense of protection and valuation). One of the landscapes considered to be "common" but with economic, social, cultural and esthetic potential (modified and deeply transformed by urban extension processes and without any adequate policy in the last decades) is the agricultural landscape in the metropolitan area of Bucharest. In the absence of urban policies the landscape suffers irreversible transformations (fragmentation, segregation, alienation) generating loss of specificity and uniqueness. Any decision at urban level is spatially concretized and generates new models of urban growth with implications on adjacent urban-rural landscape.

In the last decades and mostly for transitional cities (like Bucharest) the classical urban growth models overlap and interpenetrate - concentric, segmented, polycentric, satellite (Brunn, 1983). The research considers that the new development patterns (as variations or deviations of traditional models) can lead to a development prognosis based on the understanding of generator mechanisms. That development prognosis takes into account multiple development scenarios (alternative scenarios), and based on it, the research intends to constitute an intervention model adapted to territorial reality (from process to model). The main goal of the research is to substantiate an adequate metropolitan strategic approach in order to preserve, integrate and value the agricultural landscape of Bucharest's metropolitan area.

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## **Sacred Species and Sites for Biocultural Landscape and Diversity Conservation**

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The link between biological and cultural diversity has been increasingly acknowledged in recent studies, and conservation strategies have been accordingly encouraged to move towards a more ethical and spiritual account of nature. The conservation of biocultural landscape and biocultural diversity has become therefore fundamental to support these cutting-edge strategies.

The 3S Initiative on Sacred Species and Sites contributes to the advances in biocultural landscape and diversity conservation, improving recognition and understanding of the ecological, cultural and spiritual values of species, sites, landscapes and their ecosystems, linked to the cultures which have managed them. The goals are to demonstrate ways in which biocultural landscapes can contribute to conservation biology and to the maintenance of indigenous knowledge (McIvor and Pungetti, 2008), to support the link between cultural and ecological diversity, and finally to promote the integration of intangible values into policy, planning and management (Pungetti, 2008).

A range of scholars, practitioners and spiritual leaders from around the world have collaborated with the Cambridge Centre for Landscape and People (CCLP) in the 3S Initiative, providing new insights into biocultural diversity conservation. Sacred landscapes, sites, plants and animals from around the world have been explored to demonstrate the links between traditional spiritual beliefs and practices, landscape ecology and the conservation of nature (Pungetti et al., 2011).

The results of these studies are illustrated in this talk, outlining the advances in biocultural and sacred landscape, as well as in ancient and indigenous knowledge, and offering new insights for nature conservation, planning and management.

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## **Land Ecological Safety and Utilization on the Lower Reach Beaches of the Yellow River in Kaifeng City**

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In this article, Yellow River beach land in the Kaifeng area is used as a case study to explore land utilization issues. Based on the latest SPOT2.5 images for 2007 and ArcGIS and ERDAS remote sensing image processing software, along with field surveys, the Yellow River channel boundary and beach land use within Kaifeng City are mapped in detail. Then, employing the TM images of annual highest flood peaks between 1992 and 2007, and data from the hydrological observation stations along the Yellow River, the river channel flood fringe line for this typical 15-year period is outlined for flow levels up to 8000m<sup>3</sup>/s. In conjunction, the submerged Yellow River beach areas within Kaifeng City under different regularly occurring flood flows are drawn up, overlaid by background data.

## **Chinese Fire Distribution Pattern in Ten Years**

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Fires are a prominent global phenomenon, which not only destroy natural vegetation, but also pose enormous danger to wildlife as well as to human life and property. Spatial and temporal distribution pattern of fire is very important to know the energy release, and protect environment and resources. In the past, people usually study on the pattern of forest or grass fires according to the number, burned area and on fire time by using the forestry statistic report data in China. Because the forestry statistical report data usually doesn't include the information of longitude and latitude of forest or grass fires. At the same times, there are many farming fires which didn't included in the report in China every year. So, the analysis results just show the pattern of forest or grass fires from number, area and burning time by using the forestry statistical report data. They couldn't show the spatial and temporal distribution pattern of fire in China. To get the spatial and temporal distribution pattern of fires in nearly ten yeas in China, the 1km spatial resolution fire production data from MODerate resolution Imaging Spectroradiaomete (MODIS), NOAA-AVHRR and FY orbit satellite images had been selected. The statistic analysis and GIS spatial analysis method had been used. The results showed there are three high density fire regions in China. One is Daxing'anling forest region, where had taken place many large forest fires during Apr. 15 to June 1 or Sep. 20 to Oct. 20 in past ten years. One is Guangdong province in south of China, most of fires belong to farming fire during Nov. 1 to Mar. 30. The other is Yunnan province,

which in southwest of China, there are many small forest fires during Nov. 1 to March 15 next year.

**Keywords:** Fires, Spatial and temporal distribution pattern, Satellite techniques, GIS

## **The Study of Landscape Visual Impact Assessment in Mountain Tourism Area**

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With the breadth and depth of tourism resources development, the study of landscape protection and landscape planning has increasingly been focused on. Many researchers began to study the landscape ecology, landscape perception and landscape visual (Faludi A, 1987; McHarg Ian L, 1992; Kaplan R, 1985; Steiner F et al., 1988; Zube EH, 1984). This paper uses geographic information technology and virtual reality technology, takes small-scale mountain tourism area for example, proposes a method of the cumulative viewshed analysis to study the landscape visual impact assessment of only mountain lake in National Forest Park, Guangdong Nankun Mountain——Qixian Lake and the surrounding natural landscape based on temporal database of the landscape resources distribution. In the study, it compares the difference about the waters and the surrounding visual landscape sensitivity of wet and dry season, then gets assessment of landscape visual sensitivity of lake and the surrounding. It overlays all the sight spots around the lake to analyze the sensitivity on this basis and then gets the result of eight sight spots: Gold Top, Riyue Island, Lanfen, Gujing Waterfalls, Qixian lake power plants, Bamboo leaves softly, Meilong Waterfalls, Tombs are the highest sensitivity points of water-related attractions, and calculates the distribution and area of the lake landscape from these points. Then, based on the cumulative viewshed analysis of these sight spots on the lake to get evaluation of visual sensitivity of water landscape. The result of lake and surrounding landscape visual impact assessment will provide scientific basis and evidence for water area planning and development, optimization of the lake travelling route and promoting the protection and restoration of the surrounding landscape, so as to promote the use of mountain tourism resources reasonable and sustainable.

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# **Multi-functionality of Landscapes Derives the Structural Matrix of Urban Mosaic: An Anthropocentric Approach to Ecological Assessment**

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Landscape functions are quite diverse and indeed complex. Where land performs multiple functions it affords a far greater range of social, environmental and economic benefits than might otherwise be delivered. Therefore, understanding the multi-functionality should be central to the ecological network approach to land-use planning and landscape sustainability. The development of a multifunctional landscape usually includes consideration of biophysical features important for conservation of biodiversity and ecological processes (Lovell and Johnston, 2009). However, the functional characteristics are often observed as under-investigated and the weaker link (Qureshi et al., 2010). Consequently, the existing fragmented knowledge of the relationships between the structure (land-use/cover) and functions (e.g. ecosystem services) of landscape has been insufficient for policy makers and scientific community. It had been difficult to realistically instigate long-term plans towards the inclusion of these concepts as a meaningful component of sustainable urban development. The study of the ecological structures and functional characteristics of heterogeneous landscapes can contribute to the achievement of greater sustainability. Therefore, this study investigates the hypothesis that the functions of land parcels in urban systems can be very complex, and higher the complexity of land-use in an area, the greater will be the multitude of functions associated with it. Societal response to the urban dynamics is the key to transect the gradients of ecological structures and functional characteristics of heterogeneous landscape.

The landscape metrics had been the triumph in planning, evaluation, monitoring, management, conservation and design of the multifunctional landscape (Leitão and Ahern, 2002); therefore served as central tenet for investigating structural patterns in this study. Given the trends towards ever-increasing urbanisation, it is vital that ways are found to fully represent the functionality of all urban landscapes. It can be exemplified best by the Human perceptions of the landscape and its change due to the influence of economic, social, aesthetic and ethical factors. The appreciation and relative preferences for visual quality among distinct landscapes leads to the notion of societal acceptance for varying urban forms and their intended functions. Of all the spatial metrics of the landscape, diversity and heterogeneity are perhaps the easiest to relate to human perception of the environment. It was revealed that the higher homogeneity and structural cohesiveness in the landscape is much more appreciated than fragmentation. The study was based on cases along impact gradients in moderately to heavily-disturbed (i.e. informal and unregulated) urban structures across megacity Karachi, Pakistan. Multi-scale investigations over distinct urban structures, forming a variety of ecosystems in the cities, are necessary in the future.

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# **Investigation of Walking tracks in Natural Recreational Areas Using GPS and GIS to Providing High Quality Experience for Tourism - Case Study in the West and East of Ziyarat Basin, Jahannama Protected Area**

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Considering the increasing number of visitors in natural recreational areas, understanding visitors' preferences and needs is required for managing and providing high quality recreational opportunities. Walking tracks are a primary recreation resource facility on which recreation activities are performed. They are supposed to provide safe access to non-roaded areas, support recreational opportunities such as walking, hiking and wildlife observation, and protect natural resources by concentrating visitor traffic on resistant treads. However, increasing recreational use, coupled with poorly designed and/or maintained trails, has led to a variety of resource impacts. Trail managers require objective information on walking tracks and their conditions to monitor trends, direct trail maintenance efforts, and evaluate the need for visitor management and resource protection actions (Marion et al., 2001). Guide maps and information about walking track conditions, characteristics and facilities provide an opportunity for visitors with different interests, desire and abilities (Arias., 2007). Specific geographical location and diversity of natural phenomena has caused Iran is known as the world's fifth country with natural variability. Though, there are many outstanding natural recreational areas in Iran and high level of natural recreation demand for them, there is not enough and appropriate infrastructure for walking. So, planning, managing, monitoring and last but not least developing the tracks are necessary. The aim of this study is finding the best opportunity for walking tracks development in east and west of Ziyarat basin natural recreational area. In doing so, a field survey using GPS receivers was conducted to collect all required information regarding environmental conditions and characteristics and exciting recreational facilities on the study area. The data was analyzed in ArcGis9.3 to provide final map of study area. The results show that "Alidigah walking track" in west of basin and "Zeble walking track" in the east are the most difficult and longest tracks and "Sooteh walking track" in west and "Shamsak walking track" in east are the easiest and shortest tracks. There also investigated that there is no facilities such as signage, rubbish bins and toilets along these tracks in the areas under study. This study reveals importance and necessity of developing of walking tracks as a guide for visitors to select appropriate walks in terms of their ability and desire and for future planning, development and management of walking tracks in national and forest parks, protected areas and other natural recreational destinations in Iran.

**Keywords:** Walking tracks, Visitors, Natural recreational areas, Management

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## **Impact of Forest Fragmentation on Floral Species Richness of Sal Forests of Bangladesh**

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Massive habitat destruction occurred in the Sal forests of Bangladesh during the last four decades. The recurrent anthropogenic disturbances in the Sal forests have rendered the system inhospitable for the regeneration and growth of wild plant associates, causing a net loss in plant diversity. No single part of the Sal forests can be found as undisturbed natural forest. In Central Bangladesh we examined floral species richness in forest fragments of 5>, 5-10 and >10 ha areas. The flora was grouped into matured tree, sapling, established seedling, small seedling, shrubs, herbs, mushrooms and climbers. The floral species richness decreased with the decrease of fragment size. The Sal associates were more vulnerable to smaller fragments. Species similarity was higher among fragments of similar sizes. Species rank/abundance curves showed that species of larger fragments in all life forms tended to decline in smaller fragments. The life-form composition and structure of floral pool in smaller fragments are converting to species-poor community. Losses of natural Sal associates threaten the maintenance of Sal forest biodiversity.

## **Changing Paradigms in a Changing Climate: Adaptive Innovation towards Forest Management Institutions to Manage Tropical Forest in South and Southeast Asia**

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Some communities in the tropics traditionally protect natural habitats for their cultural and material sources, for example, in a form of sacred sites and as a communal forest. These natural habitats play an important role in biodiversity conservation which maintain through indigenous institutions that do not require involvement of conservation organizations or government bodies. These indigenous institutions regulate through customary laws and belief systems led by community elders and traditional religious leaders. Evidence from our three research sites in south and south east Asia i.e., Matiranga in eastern Bangladesh, central Maluku in eastern Indonesia, and Palawan in the Philippines are presented here to highlight on these accounts. We used different methods i.e., participatory rural appraisal, personal observations, focus groups discussion and content analysis to elicit knowledge of the

communities on how they conserve and manage their forests. Our result indicates that existing indigenous forest management institutions which are closely related to local people's belief systems served as enabling agents to manage forests. These belief systems play an important role in monitoring of forest uses, and community leaders use to impose sanctions on the transgressors. As a conclusion, reinforcing these indigenous institutions is one of the forest management alternatives to mitigate future deforestation and degradation in the tropics. Indigenous management institutions can be strengthened by 1) backing their culture and conservation activities through giving recognition at government level, 2) establishing sustainable livelihood sources for communities living around the forests that can mitigate the overexploitation.

**Keywords:** Communities, Institution, Tropical forest management

## **Increasing Tree Cover in Degrading Landscapes: 'Integration' and 'Intensification' of Smallholder Forest Culture in the Alutilla Valley, Matiranga, Bangladesh**

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Research was conducted in Alutilla valley, eastern Bangladesh to identify the nature of existing agroforestry systems, and to suggest the potential agroforestry models that could ameliorate currently degrading forest resources. Using participatory diagnostics and a structured quarterly survey of 160 households in two villages the results presented here are qualitative with a supplementary quantitative analysis to assess the economic potential of agroforestry systems using cost-benefit analysis. There are different patterns of agroforestry exist in the study site, but all of them have two common principles i.e., 'integration with agriculture' and 'multi-functionality'. Based on economic analysis and its ecological functions, we have suggested two agroforestry models can be adopted by the farmers in the study site. The first is multi-strata agroforestry, based on a fruit and timber tree canopy with vegetables and tuber species in the understorey; this system can be practiced in the shifting cultivation fields close or adjacent to settlements. The second is fruit and timber tree-based conservation agroforestry to manage large-scale biologically depleted landscapes.

**Keywords:** Deforestation, Agroforestry, Forest management

## Understanding Urban Dynamics through Spatial Metrics

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Urbanisation reflects the regional development (planned or unplanned) in response to economic, social, political and physical geography of an area. Dynamic urban change processes, especially the tremendous expansion of urban areas affect the natural and human systems at multiple scales. The rapid and often uncontrolled growth of the urbanising cities brings about numerous changes in the structure and functioning of landscape (Solon, 2009). Urban sprawl, a consequence of socioeconomic development under certain circumstances, has increasingly become a major issue facing many metropolitan areas (Ji, 2006). Bangalore is one among the fastest urbanising cities in Asia, undergoing redevelopment for economic purposes and is witnessing tremendous pressure on the infrastructure, civic amenities, public services, etc. (Ramachandra and Kumar, 2008). The growing migrant population, increasing number of Information Technology and Bio-Technology firms, and real estate projects are demanding more resources within the city, forcing it to expand both horizontally and vertically leading to serious problems like scarcity of food, informal settlements, environmental pollutions, destruction of ecological structures, unemployment etc. The unprecedented growth and urban sprawl are often unnoticed by the planners, as they are unable to visualise this type of growth patterns. Since patterns are fundamental to many of the spatial-temporal relationships that we seek to discover, it is important to understand the factors and trend that influence the growth of the urbanising landscape. Therefore, characterising and understanding the changing patterns of urban growth is critical, given that urbanisation continues to be one of the major global environmental changes in foreseeable future.

Earth observation, satellites provide information over a considerable range of spatial and temporal resolution for mapping land cover (LC) to understand the spatial and temporal aspects of landscapes. These data are classified to derive metrics that are quantitative measures for spatial pattern, which are helpful in understanding the landscape dynamics and linking the agents of change. Here, we analyse temporal remote sensing data of diverse spatial and spectral resolutions for Greater Bangalore. The city was divided into 8 zones to analyse the landscape metrics using classified data from 1973 to 2010. The study reveals that there has been a 584% urban growth with a 66% decline in water bodies and 74% decrease in vegetation cover. The city was more compact in 1973 and began to disperse in all directions with decrease in the ratio of open space and increase in the number of urban patches as well as urban density. Most large urban patches have developed in west, south-west and southern regions of the city corresponding to the policy decision of setting up small scale industries, Information Technology-Bio-Technology firms and consequent housing projects.

**Keywords:** Urbanisation, Landscape, Spatial metrics, Urban planning, Remote sensing

## **Rethinking Urban Ecology: Creating Eco-responsive Settlements**

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The emergence of new design issues related to urban ecology, like those of ecological degradation, energy supply or climate change, calls for designers to find new ways of rethinking the design of settlements.

First, we need a design approach that is removed from the traditional idea that the world is divided into human and natural elements that are somehow inherently different; and replace this dichotomy with an approach that would enable designers to bring human settlements and other natural systems together. Second, for creating settlements that remain workable in the face of radical changes, we need to think beyond the conventional design culture's almost exclusive focus on space, making it hard for planners to consider the time implications of their work. We need to develop a way of thinking about settlement design that brings time and space together.

Generating and holding ideals are not enough. Ideals must be linked through appropriate design ideas to the spatial fabric of the built environment itself. This presentation focusses on the practical design implications of these new ways of thinking.

We draw on ideas from the field of urban morphology, wherein settlement structures are understood as being built up from a series of 'layers' or 'levels'; each with its own inherent characteristics in terms of space and time. At the most pragmatic level, it focuses attention directly on spatial structures like streets, buildings, underlying landscape and plots which can then be used as a springboard to develop a creative transcultural design culture, for rethinking urban ecology and for the design of eco-responsive settlements in more effective ways.

## **Integrated Social-Ecological Network Analysis of User-managed, Pollinator-inhabited GreenER Roofs and Walls Enhancing Urban Resilience and Ecosystem Services**

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Identification of the benefits of green roofs and walls have largely focused on their engineering functions such as storm water retention, climate mitigation, and/or the aesthetic value of their plant life. By incorporating an understanding of ecological processes into the design and construction of green roofs and walls, the provision of habitats and/or foraging grounds for pollinators, seed dispersers, or particular red-listed species is also possible. Taken individually, such habitats and foraging grounds would be isolated habitats, at risk for

population extinction. However, a network of green roofs and walls, designed with an ecological understanding of species movements in and between fragmented habitats, could maintain viable species populations providing expanded ecosystem services in a wider urban landscape, especially when existing surrounding ground level habitats and foraging areas are incorporated into this ecological network. By further incorporating social networks - active citizen involvement and management - in the use and maintenance of this fragmented ecological network, additional ecosystem services connected with educational, social, cultural, recreational, and health benefits are also possible. These linked social-ecological networks would be an inherent part of a larger green infrastructure that could for example enhance urban resilience by providing increased capacity for climate change mitigation.

The provision of these expanded greenER roof and wall ecosystem services can be studied by examining the interaction of user and management social networks with the ecological networks on which they impinge, and vice-versa, as integrated social-ecological networks. Such work builds upon studies that have begun to use a network perspective in understanding the resilience of social-ecological systems as well as a particular study sketching a typology of four approaches to integrated social-ecological network analysis: (1) Analytical integration of separately examined social and ecological networks; (2) Analysis of the social network with ecological elements as node attributes, or vice versa ; (3) Integrated social-ecological network analysis removing social and ecological distinctions between network nodes and flows between nodes; and (4) Translating interactions between social and ecological entities into two-mode networks, possibly complemented by one-mode social and/or ecological networks.

Application of these approaches to such a user groups and greenroof pollinators social ecological network in-the-making will be presented.

## **The Social-Ecological Ranking Matrix and Mapping of Social-Ecological Values in Stockholm: Implications for Urban Transition Planning**

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Theories linking complex systems of people and nature – social-ecological systems – are well-developed in resilience research, but empirical data linking the social and the ecological is not as widely available.

Stockholm has uniquely pioneered surveys of recreational use of open spaces (sociotopes), and of the distribution of ecological habitats (biotopes). We present a framework and method for ranking and spatially linking the elements of these separate social and ecological maps, using a two-factor index to create a unified, understandable social-ecological map identifying areas of low-low, low-high, high-low, and high-high social-ecological rankings.

Social-ecological maps can improve our understanding of ecosystem services -*”a heuristic device for making human-ecology interaction more visible in decision making”* – and are important for mapping their spatial distribution. We could determine, for example, where and how social corridors could improve accessibility to cultural ecosystem services, and for whom. We could also understand whether areas of high or low ecological ranking tend to be associated with particular kinds and levels of social ranking, and how these areas are spatially clustered. We could then correlate these findings with other spatial socioeconomic and institutional factors such as income, crime, or property rights.

Such analyses can provide input to policymakers navigating sustainable urban development paths. For example, identifying actions in areas of low social and ecological ranking could, after comparison with areas of high social and/or ecological ranking, involve transitions along ecological – e.g. restoration – or social – e.g. stakeholder involvement – pathways, or both. Identifying these pathways could involve key stakeholders in a participatory, scenario planning process that envisions possible futures and concrete steps for realizing them. The whole process could serve as an urban development model for most cities in Sweden and in other countries

## **Risk Management as a Tool to Handle Uncertainty in Climate Change - A Case Study from the Hardangervidda National Park, Norway -**

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Climate change is considered a major threat to biodiversity. Many ecosystems will experience substantial changes with dramatic effects on species distribution and biotic interaction. Species unable to move or adapt in response to climate change will face local or global extinction. Conservation management in the face of such extensive transformation is a challenging task.

Even though adaptation of conservation management is a pressing need, there is still little knowledge about ecological consequences of climate change on species, habitat and landscape level. Projections of climatic change are accompanied with major uncertainties. The potential interactions of climate related changes with other environmental impacts are adding to this problem. The development of robust conservation strategies in the face of these uncertainties is a major challenge for the climate proofing process.

To tackle this problem a framework for climate proofing of conservation management based on risk management was developed. The framework was applied for the Hardangervidda

National Park in southern Norway. The alpine arctic plateau of the Hardangervidda harbours Europe's largest population of wild barren ground reindeer (*Rangifer tarandus tarandus*) and is of particular importance for the preservation of this species. The location and its conditions make it especially sensitive to the negative effects of climate change.

As migratory animal using different tundra ecosystems through the period of a year wild barren ground reindeer inhabit large areas. Hence, effects of climate change and their impact on reindeer populations need to be assessed on landscape level. By means of a past to present analysis of the last four decades (1964-2004) several climate and non-climate related driving forces with major impacts on the population could be identified. It could be shown that the population and its environment are a Complex Adaptive System where driving forces constantly interact.

Regional scenarios of climate change were used to identify the most likely effects on the driving forces for the population until 2050. The risk management approach was especially useful to join the scenario based impact assessment and the past to present analysis. The classification of future changes into different types of risks allowed the identification of suitable measures and no-regret strategies for conservation management in a changing climate.

A guideline for the climate proofing of conservation management was outlined. The application of risk management can efficiently help conservation managers today to make decisions under major uncertainties about climate impacts of the future.

## **Responses of Pristine and Intensively Managed Catchments: A Synthesis of Long-term Hydrologic and Biogeochemical Datasets**

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Our analyses of long-term monitoring of intensely managed and forested catchments reveal that increasing human impacts have led to shifts in the dominance of key processes controlling exported solute loads. We analyzed and interpreted long-term monitoring data from two large basins – the Mississippi River Basin (MARB) and the Baltic Sea Drainage Basin (BSDB) – and several small catchments within Long-term Ecological Research (LTER) sites located in the U.S. and Puerto Rico. Data from other river basins (e.g., UK, China, Canada, and Australia) were also used for complementary analyses. Persistent anthropogenic forcing has: (1) severely modified "natural" hydrologic fluxes (e.g., flashy hydrographs, increased base-flow; flood frequency) from intensification of croplands and urbanization, (2) overwhelmed the internal biogeochemical heterogeneities through build up of legacy nutrient stores in croplands, and (3) shifted the relative dominance of hydrologic and biogeochemical processes in controlling exported solute loads. In managed catchments, these changes have led to "functional hydrologic homogeneity", in spite of apparent spatial heterogeneity in



catchment hydrologic attributes, and chemostatic responses (temporal invariance of solute concentrations) for export of nutrients (TN and TP) as well as geogenic solutes. Biogeochemical stationarity emerges when the rates of solute inputs (mobilization of legacy sources or anthropological inputs or atmospheric deposition) closely match rates of losses through degradation and uptake. In the absence of such ubiquitous legacy sources in catchments, the biochemical responses for certain solutes (e.g., pesticides, biogenic solutes at LTER sites) were non-stationary. Such catchment simplifications from persistent anthropogenic impacts enable parsimonious models to provide robust predictions of hydrologic and biogeochemical responses observed in intensively managed croplands. We developed both numerical models and stochastic analytical models for predicting catchment hydrologic and biogeochemical responses. We also compared these predictions with predictions of more complex models, and evaluated them with patterns discerned from long-term datasets. Practical implications of our synthesis to watershed management need to be better understood are: (1) legacy nutrient sources, built up from intensive land management, will persist for several decades, suggesting that nutrient loads exported from catchments may not decrease significantly even if no further nutrient additions are made; (2) export and in-stream processing of nutrients at multiple scales can be readily predicted, given only the discharge dynamics, using the procedures we developed for estimating effective catchment model parameters; and (3) the role of socio-economic and socio-ecological factors that drive catchment trajectories (expansion, intensification, and restoration) need to be better understood.

## **Dietary Response to Landscape and Food Resource Variations: Consequences for Parasite and Toxicant Transfers**

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Over the last decade, there have been a growing number of experimental and observational studies suggesting that changes in biodiversity have the potential to affect the transmission and emergence of pathogens in animal and plant populations (Keesing et al. 2010). Landscape diversity, trophic structure and diversity of food webs (nb. of trophic levels, degree of dietary specialisation, etc.) have been proposed as factors modulating pathogen dynamics, although mechanisms are still largely matter of investigation. Many toxicants (trace metals, organic pollutants) are also transmitted along food chains *via* predation and herbivory. Surprisingly, no study has explored the role of biodiversity and food web trophic structure on the patterns of toxicant transmission. Toxicants and pathogens fluxes in food webs vary according to seasonal and inter-annual changes in predation and herbivory interactions, themselves depending on the population structure (age, etc.) and dynamics of various species within the community. However, those aspects still remain poorly documented. The cestode parasite *Echinococcus multilocularis* (*Em*) is transmitted in wildlife from small mammal intermediate hosts (mainly rodents) to carnivore definitive hosts (mainly the red fox) *via* predation. In Eastern France, landscape changes on mid-altitude plateaus have increased the area and connectivity of grasslands, favouring regular and spatially asynchronous population outbreaks of two grassland rodent species. In the lowland plain, grassland rodent population densities

are much lower and stable. This offers a range of situations with contrasting intermediate host densities both in time and space. The fox dietary response to rodent intermediate host density variation was species-specific: no response for the Common vole *Microtus arvalis* and a type-III like (sigmoid) response for the Water vole *Arvicola terrestris*. The fox contamination response followed a type II-like shape (asymptotic) for both rodent species. This shows (i) that predation patterns cannot be predictive of pathogen transmission patterns, and (ii) the relevance of considering non-linearity in such systems (Raoul et al. 2010). In a smelter-impacted area in Northern France, Fritsch et al. (in press) provide evidence of landscape-specific metals (Cd, Pb) transfer patterns to small mammals. We plan to investigate how small mammal diet is affected by resource diversity (landscape, vegetation and invertebrate) and how this might impact pollutant transfer. Recent high-throughput DNA pyrosequencing now allow a precise and massive determination of DNA sequences extracted from small mammal stomach content and faeces. Preliminary results will be presented.

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## **Reducing Emissions from Deforestation and Forest Degradation (REDD+) Program in Protected Areas, Indonesia**

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Climate change is become the international cause of the moment. Aproximately from 15-20 percent of the global green house gas (GHG) emissions come from deforestation and forest degradation. Addressing this problem, United Nations Framework Convention on Climate Change (UNFCCC) establishes an international mechanism using market or financial incentives in order to reduce CO<sub>2</sub> emissions from deforestation and forest degradation which is called as REDD. Since Indonesia's major emissions are related to deforestation, land degradation, inappropriate land uses, and land conversion, therefore REDD has become an eminent priority for Indonesia. During readiness phase, 2009-2012, Indonesia needs to prepare methodological and policies to support REDD+ in Indonesia.

This study aims to recognize the readiness of REDD+ programme in Indonesia and what issues need to be developed and strengthened towards full implementation post 2012. Literature review, web-based sources and existing data were used to compile data. Through

identifying and analyzing all elements which have been established by the Ministry of Forestry of Indonesia, including institution, regulation/policy, strategy and capacity building, we attempt to know how far the Indonesia preparedness and what remain issues need to be developed and strengthened.

Since 2007, Indonesia has been executing many actions to succeed REDD+ implementation as well as institution, regulation/policy, strategy and capacity building, however, still there are many remains issues need to be developed and strengthened, such as development of capacity building, REL/RL establishment, development of MRV system, finalizing National REDD+ Strategy and National Standard for Carbon Accounting Methodology, scaling up REDD+ project level activities into district/provincial level and involving the private sector. Therefore, it is important to conduct a research to recognize the stakeholders awareness and REDD+ literacy in Indonesia, focusing on central and local government. Due to the REDD+ related projects has been carrying out many activities, such as, workshop, seminar, national consultation meeting, consequently stakeholders awareness and REDD+ literacy in Indonesia is enhanced.

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### **Success and failure affecting sustainable fisheries in Marine Protected Areas (MPAs) in Sarangani Bay, Mindanao, Philippines**

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Marine Reserves or Marine Protected Areas (MPA) or marine reserves have been claimed and are widely advocated as one of the most important tools for the protection and management of coastal, marine and fishery resources (Pietri et al., 2009; Pollnac et al., 2001). MPAs or marine reserves, as defined by Alcala (2001) are areas of marine environment protected from various forms of human or extracted exploitation, especially fishing or completely banning the collection of any organism in the area. The marine areas outside the MPAs are referred to as non-reserves or fished areas, where fishers are allowed to fish using traditional, non-destructive fishing gear.

This study was conducted in four MPAs in Sarangani Province, Philippines: Glan Padidu

Marine Sanctuary, Kapatan Marine Reserve, Tuka Marine Park and Kamanga Marine Ecotourism Park and Sanctuary. The ecological health of the coral reef such as coral cover and species diversity in each MPA was taken from the secondary data sources. Interviews of the fishermen around the established MPAs were conducted to determine their productivity before and after the establishment of MPA based on the catch per unit effort (CPUE). MPA management was assessed based on the interview of the MPA board members. Data show that all four MPAs investigated have fair coral cover. Result of the study revealed that after a certain period of time of the establishment and well management of these MPAs, the CPUE of the fishermen fishing around these protected areas has increased. However, failure in MPA management of Glan Padidu Marine Sanctuary and Kapatan Marine Reserve resulted to damage of the coral reef and decreased fish catch. Management problem of the Kamanga Marine Ecotourism Park and Sanctuary did not help increase the CPUE of the fishermen.

### **Acknowledgement**

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## **The Hydrological Effects of Alien Invasion and Subsequent Restoration: A Case Study of the Kromme River System, South Africa**

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The coastal city of Port Elizabeth in the Eastern Cape of South Africa is in the midst of a water crisis and is searching for ways to augment its water supply, and achieve water security. Port Elizabeth currently obtains roughly forty percent of its water from the Kromme River Catchment. Farmers have occupied the Kromme River Catchment since the eighteenth century. According to the first aerial photographs taken in 1942, the catchment had already been transformed to a degree. However it was not until after the 1940's, driven by growing economic pressures, that unsustainable farming practices increased. Activities altering the catchment included over-grazing, alteration of flood plains for crop production, planting of alien trees (mainly *Acacia mearnsii*), canalization of the river, straightening of the river,

building infrastructure through and alongside the river, mechanical damage to the wetlands (ploughing) and the removal of palmetto (*Prionium serratum*). In 1996, Working for Water commenced restoration in the Kromme River Catchment. Since then restoration has comprised two approaches; firstly the construction of gabions to prevent further erosion from headcuts, and secondly the clearing of *A. mearnsii* from the river bed and flood plains. If it can be shown that the continuing land degradation in the Kromme River Catchment is reducing the quantity and quality of water that could be available for human consumption, the municipality may focus more efforts on restoring the catchment. This study aims to investigate the impact of restoration on several ecosystem services, including provisioning (water flow) and regulating (water purification, assurance of supply, erosion control, flood attenuation) services. This will be done by investigating the effects of future land-use scenarios on the hydrology of the catchment using the ACRU (Agricultural Catchments Research Unit) Model. The ACRU Model is a physical-conceptual model that requires detailed data input on a daily time-step. The central hypothesis is that the restoration of natural capital in the Kromme River Catchment has and will improve river flow, yield, water quality, erosion control and flood attenuation. Preliminary results suggest that the complete eradication of *A. mearnsii* from the Kromme Catchment would make significant volumes of water available for downstream users –including the municipality of the city of Port Elizabeth. Furthermore, the removal of palmetto from wetlands and the use of the resultant cleared areas for agriculture appear to have degraded the water quality over time by increasing sediment loads and levels of harmful chemicals and bacteria.

## **Legacy Phosphorus in Agricultural Watersheds: Implications to Restoration of Wetlands and Aquatic Systems**

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Wetlands and aquatic systems such as lakes are often the final recipients of nutrients discharged from adjacent terrestrial ecosystems. Since many freshwater systems are phosphorus (P) limited, loading of this nutrient is of particular concern to environmental managers. Nonpoint sources of P dominate eutrophication processes of many wetlands and aquatic ecosystems. Thus, in many situations, alternative land use management practices in the watershed are implemented in an effort to reduce the overall load to receiving water bodies. The key questions often asked are: (i) will wetlands and aquatic systems respond to P load reduction? ; (ii) if so, how long will it take for these systems to recover and reach its background condition?; (iii) what biogeochemical processes regulate the mobilization of internally stored phosphorus; and (iv) are there any economically feasible management options to hasten the recovery process? Once the external P loads are reduced, the internal memory of P can extend the time required for a wetland or an aquatic system to recover from eutrophic status to more background levels. The lag time for recovery should be considered in developing management strategies to restore wetlands and aquatic systems. This presentation will include a discussion on a range of biogeochemical and hydrodynamic processes regulating the mobilization of P stored within the system.

# **The Spatial Effects of Rapid Urban Sprawl on Urban Forest Carbon Stocks: A Case Study of Xiamen, China**

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Research on the effects of urban sprawl on carbon storage within urban forests is of great significance to improve urban environment quality, urban sustainable development and land use planning and management. We used remote sensing technology, geographical information systems and forestry resource inventory data to investigate vegetation carbon density in Xiamen, China. We compared the carbon density of different forest compartments during different urbanization periods in three zones (urban core, suburb and exurb). We classified four types of forest compartment: (1) forest compartments that are connected with construction land; (2) forest compartments that are connected with farmland; (3) forest compartments that are connected with both construction land and farmland and (4) close forest compartments. Dynamic changes of carbon storage by different plant types were estimated by combining forestry resource inventory data and Landsat data. The forestry resource inventory data were collected from 39,723 sample plots in four years of forest management planning inventory (1972, 1988, 1996 and 2006), and we focus on changes during the period of rapid urban growth (1988–1996) and stable urban growth (1996–2006). The Landsat data were derived from three TM images. The results revealed that the effects of urban sprawl on an urban forest compartment are mainly dependent on its distance from the urban core during urban sprawl. There was a tendency for the effect to decline with increasing distance away from the urban core, towards the exurb. In the urban core, people are inclined to protect nearby forest and to use forests that are at a further distance away. In the suburbs, people tend to first use and then protect nearby forest, and to protect forest further away. In the exurbs, which are seldom influenced by urban expansion, people are inclined to protect forests at various distances. Based on our findings, we suggest that as cities further expand, there will be a tendency for the carbon density of urban forest to initially decline and then to rise.

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# Migratory Water Birds and Landscape-level Analysis of Their Habitats in a Cultural Landscape in Korea

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The species richness of migratory water birds are declining and many species are in danger in western coastal regions of Korea due to loss and degradation of critical wintering and feeding habitats caused by large-scale reclamation and development projects. Human-modified landscapes, particularly rice paddy, man-made reservoirs and tidal flats have been frequently used by migratory water birds in Korea, but the relationship between water birds and the structure and configuration of rice paddy and tidal flats at the landscape level is poorly understand. In this study, 5-years nationwide census data of migratory wintering birds were acquired and analyzed the effects of landscape-level analysis of rice paddy and tidal flats on the avian species and their habitats. The total richness of migratory water birds was strongly associated with the larger proportion of tidal flats and many small patches of rice paddy. The generalized additive models showed that landscapes with larger proportion of tidal flats in conjunction with rice paddy were the statistically significant predictors of habitats with higher species richness, abundance and diversity. The abundance of water birds, however, was significantly higher in few large patches than many small patches of rice paddy and tidal flats. Moreover, migratory water birds displayed a much stronger response to landscape-level indices on rice paddy than tidal flats, indicating the importance of landscape context of rice paddy in maintaining migratory birds in coastal region of Korea. This research provides natural resource managers and land use planners with a hierarchical process to reserve design and management to conserve the highest richness and abundance of migratory avian species within coastal regions. First of all, conservation efforts should preferentially focus on the retention of larger remnants of tidal flat surrounding rice paddy. The number of species and individuals of migratory birds prefer to use continuous large patches of tidal flats and rice paddy. Second, where possible, rice paddy should be included in wintering habitats to provide foraging sites for some kinds of geese and ducks. Third, conservation efforts on tidal flat and rice paddy should be focused at maintaining appropriate landscape structure and complexity. For example, few larger patches of tidal flats and many smaller patches of rice paddy are vital components to support species richness and abundance of migratory water birds in Korea.

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## **Consideration of Anthropogenic Land Use Changes in Regional Climate Modelling**

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Land use changes are expected to be significant for the hydrological cycle on regional scales. Therefore the future global climate change simulations for the intergovernmental panel on climate change fifth climate change assessment report (IPCC-AR5) incorporates land cover change scenarios. The consideration of observed land use changes in a regional climate model requires numerous parameterizations of vegetation behaviour that will be demonstrated with an extension to the regional model REMO (REMO-iMOVE).

In regard to atmospheric conditions, two of the probably strongest interventions into agricultural land use are afforestation and irrigation.

As an example how human influence feeds back to the atmosphere and leads to the enhancement or reduction of the original climate change signal, sensitivity studies about the role of afforestation for Hungary are presented. For the period 2071-2100, the focus is put on probability and severity of extreme dry events.

On an even larger scale irrigation in India will be shown to play an important role for the development of the South Asian summer monsoon. Ignoring irrigation in regional climate modeling results for the Indus river basin in a 30% loss of the 400 km<sup>3</sup> annual precipitation amount for evapotranspiration. This loss in turn leads to an overestimation of the Pakistan heat low equivalent to a too strong South Asian summer monsoon and suppressing cyclones over central India.

Even less extreme scenarios of land use changes have an effect on the regional climate, as will be shown with regional climate model simulations for the Mediterranean taking into account the observed land use changes over the last 50 years.

## **Forests, Landscapes and People – Human Exploitation or Symbiotic Relationships?**

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Trees have played a crucial role in the development of human culture. As outstanding landscape elements, they are at the same time inevitably connected to the forming of cultural landscapes. In the current discussion of landscape ecology and landscape planning, however, the importance of trees is often neglected. Based on the history and cultural development of



European landscapes, we wish to point out how the presence of trees and forests is closely interwoven with the values and functions which they have in our lives. These values and functions have changed in parallel with societal needs, technical development and even philosophical trends. They comprise more than just the productive part of forests, but are also connected to the spiritual, cultural, protective and symbolic understanding of forests.

Through history, we can observe an alienation from nature and an increasing exploitation of the natural resources provided by trees. This started with the early development of civilization, based on the use of fire and axe, and accelerated during the Industrial Revolution, driven by initially wood-fired furnaces. Human over-exploitation of forest resources was and still is the major reason for losses of forest cover all over the world. At the same time, the need for wood as well as other non-wood forest products has resulted in the protection of forests, and it has a major influence on the presence and spatial location of trees and forests in cultural landscapes. Today, the interest in trees and timber is increasing again, e.g., as carbon neutral building material. In addition, non-wood forest products have come into focus, e.g., the recreational potential and the protection of biodiversity or groundwater quality. With the lessons learned from the past, we should start to work towards a symbiotic relationship between people and forests and try to develop sustainable socio-ecological landscape systems for the future (Ritter and Dauksta 2011).

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### **Tradeoffs in Landscapes at the Tropical Forest Margin in Cameroon**

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Biodiversity –Carbon tradeoffs have grown in importance as part of a global debate on Reducing Emissions from Deforestation and forest Degradation – REDD+ especially in forest rich developing countries.

Measurements of trees biodiversity and terrestrial carbon stock were conducted in different forest and small-holder cropping systems in South and Centre regions in Cameroon, at the North Western margin of Central African forest. GPS tracking data of field perimeters were used to model the structure and composition of land units in the shifting cultivation landscapes. Multi temporal land cover maps were produced using medium high resolution images (Landsat ETM and Aster) to assess changes in landscape structure related to trajectories of change in the agricultural mosaic and the application of the national forest zoning plan. A set of biodiversity-carbon curves was developed for the range of land uses at the forest margin and showed deviation from the 1:1 trend, depending on the functional

groups considered. In fallow and agroforest systems depended on length of rotation and management types, in particular the preservation of on-farm trees during forest clearing and across fallow cycles. Key biodiversity-carbon links identified were used to scale up to landscape level analysis developing scenarios based on the Remote Sensing maps and to assess different sets of land use changes eligible under REDD+ schemes and their impact on biodiversity. The links between the natural resource base, management systems, and socio-economic drivers of land use change must be understood in order to efficiently manage the biodiversity-carbon and profitability tradeoffs under hypothetical REDD+ schemes.

## **Evaluating the Effects of Pattern on Process in Geospatial Data Describing Wildland Fuels for the United States**

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The Landscape Fire and Resource Management Planning Tools Project, also known as LANDFIRE is a federal program in the United States producing consistent, integrated, and comprehensive geospatial data describing vegetation, surface and canopy wildland fuels, and historical fire regimes across all lands. LANDFIRE applies consistent methodologies to develop comprehensive and integrated data for both landscape management and wildfire management organizations. In September 2009, LANDFIRE delivered the last of 24 data products at a 30m resolution for all lands in the United States. For detailed information about LANDFIRE data products, documentation, and program status please see <http://www.landfire.gov>.

Wildland fire and landscape managers use LANDFIRE data products to predict the effects of vegetation and fuel management on fire behavior, to plan for hazardous fuel reduction projects, to support tactical and strategic fire planning; to support resource management activities such as landscape restoration and habitat assessment; to predict emissions from wildfires; and to support national-level carbon assessments for the United States. Wildland fuels from LANDFIRE were developed to serve as input to fire behavior and fire effects models that are used for evaluating the characteristics of specific fires and for conducting regional assessments for long-term planning.

Because wildland fuels are highly variable and complex across landscapes, most fire modeling applications use classifications of fuel that represent fuel units with a specific set of fuel composition and structure. These classifications are developed to provide a representative fire behavior for combinations of vegetation composition and structure. LANDFIRE mapped fuels using 2 fuels classifications one with 13 classes and one with 40 classes.

Working in the area of operations of the Northern Rockies Coordination Center (<http://gacc.nifc.gov/nrcc>) we analyzed the effects on fire behavior of aggregating fuels maps into clusters with a range of minimum patch sizes. We hypothesized that the granularity of

wildland fuels would affect fire characteristics such as extent, intensity, and probability of conversion from surface fire to canopy fire. At a moderate granularity, we expected to see a change from topography and fuel-influenced fire characteristics to fires where characteristics are dominated by weather conditions.

## **Habitat Suitability Models as a Tool for Designing Wildlife Corridors**

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Increasing landscape fragmentation due to barrier effect of transport infrastructure leads to loss of habitat connectivity, which is key factor for prosperous migration of large mammals. Presented project is dealing with ecological requirements of migration of target species, regarding landscape structure and barrier permeability. The scientific knowledge about migration of large mammals is going to be used for designing and practical implementation of migration corridors within landscape planning.

Habitat suitability modeling based on assessment of statistical relationships between data of species occurrence and environmental variables is increasingly used to predict spatial patterns of potential distribution of target species. Outputs of these models (maps of potential species distribution) provides helpful tool for spatial planning and conservation of migration network. Several suitability models, which have been developed, are based on different statistical approaches and data availability. In case of large mammals in the Czech Republic, where only „presence-data“ were available, two different method were used:

1. Mahalanobis Typicality is derived from Mahalanobis distance algorithm which expresses the likelihood that a set of environmental variables at specific location is typical to a known location of the species (Eastman 2006).
2. Environmental Niche Factor Analysis (ENFA) compares, in the multidimensional space of ecological variables, the distribution of the localities where the focal species was observed to a reference set describing the whole study area (Hirzel et al. 2002).

Outputs of both methods were compared and analysed in order to define “core areas” of species actual or potential distribution, to delineate so called ”step-stones” and for designing network of wildlife corridors network.

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## Conservation of Local Biodiversity in the Context of Climate Change: A Moving Target

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Throughout the world, local conservation organizations secure ownership or use-rights of land to ensure that the habitats and ecosystems are safe from degradation due to development or human alteration. Global climate change is expected to profoundly affect the distribution of plants and animals as air and water temperatures increase, sea levels rise, rainfall patterns change, storm frequency increases, and patterns of seasonality are altered. What species of plants and animals will comprise future ecosystems at specific sites 50 to 100 years in the future is usually not clearly known. This presents a dilemma for the conservation community – will areas that are protected now retain viable populations of diverse native fauna and flora in the future? Several authors have advocated for the identification and protection of landscapes that have diverse combinations of physical properties because these landscapes have been shown to support diverse ecological communities. They argue that it is important to protect the stage (physical setting for ecological communities) not just the specific actors (species) on the stage. Commonly considered physical properties include elevation, land form, soil type, geology, and drainage characteristics. Anderson and Ferree (2010) have shown a strong relationship between high biodiversity and regional variation in bedrock geology and landform. They call unique combinations of physical features Ecological Land Units (ELU). In earlier studies, we have shown similar relationships between physical diversity and biodiversity at site and landscape scales.

We present a rescaling of Anderson and Ferree's Ecological Land Units down to scales that are appropriate for local conservationists. For example, local Land Trusts protect parcels of land on the order of 10-100 hectares; thus, to be effective, ELU's should have a spatial resolution of 1 hectare or less. We developed an ELU metric for the state of Rhode Island (2,500 sq. km. in area) that was based on soil drainage characteristics, soil texture, and landscape position (hilltop, valley, side-slope). The information required to create our locally-relevant ELU's are GIS data that are readily available for most regions in the USA and other countries. For Rhode Island, we identified 204 unique ELU classes. Most were small and uncommon; 85% of the state was encompassed by the 20 most common ELU's. We qualitatively determined that ELU's were often associated with unique plant communities, thus an area of high ELU diversity would support a large diversity of plant communities now and in the future as climate change effects manifest themselves and vegetation patterns are altered. We discuss how the spatial patterns of ELU's are analyzed and represented to inform local conservationists of biodiversity hotspots now and when climate change impacts are realized.

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# **The Challenge of the Spatial and Temporal Scales in the Analysis of the Physico-spatial and Sociocultural Dynamics of the Landscapes: Lessons from A Case Study in Québec**

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The integration of social and ecological knowledge has been identified as one of the research priorities in landscape ecology. More recently, conceptual frameworks have been developed to integrate design and planning into landscape ecology (Nassauer and Opdam, 2008). However, adopt these conceptual frameworks raises important methodological challenges. First, they call for an understanding of both the physico-spatial and the sociocultural dynamics of the landscapes, but also of the interactions between these dynamics through time in a coherent whole. Second, they invite to orient the researches depending on the design and the planning issues of the landscape studied in a way to anticipate and shape the future changes. Some of these challenges have been investigated in a research project on the landscapes of intensive agricultural uses in the south of Quebec (Canada). From a case study of an agricultural watershed, this project aimed at: 1) identify the physico-spatial dynamics of the landscape patterns from 1950 to 2000; 2) identify the relationships that local populations, farmers and non-farmers, maintain with the landscapes; 3) establish a dialogue between the physico-spatial and sociocultural dynamics in order to qualify the discrepancies between them. More specifically, five methodological challenges has been identified at the beginning of the research (Ruiz and Domon 2005): the use of a multi- or interdisciplinary approach, the choice of appropriate methods to study the physico-spatial and sociocultural dimensions, the establishment of a dialogue between the different methods selected, the choice of appropriate spatial scales, the combination of multiple temporal scales. In light of the results of the research (Ruiz and Domon 2009, 2011), this communication proposes to re-examine the initial methodological challenges and more specifically the challenges linked to the spatial and the temporal scales of analysis of the physico-spatial and sociocultural dynamics of the landscapes. In doing so, it emphasizes some of the obstacles to make landscape approaches developed in a planning purpose (ex.: difficulty to study the two dynamics with the same temporal scale) operational. Finally, a way to link more systematically the analysis of the two dynamics in future researches is proposed.

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# **Reintroducing the Multifunctional Character of the Landscape in Areas of Intensive Agriculture: Results of an Integrated Landscape Study in Québec (Canada)**

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Since the advent of productivist agriculture, the landscapes in areas of intensive agriculture of industrialized countries have been affected by a drastic reduction in their diversity and the degradation of their environmental, recreational and aesthetic functions. At a time when the quality of landscapes is a key factor in the vitality of rural communities, it is becoming urgent to develop management strategies designed to reintroduce the multifunctional nature of these landscapes. Within this context, this research proposes to address the landscape management issues of areas of intensive agriculture under the perspective of dialectic approaches in landscape studies originating from Holistic Landscape Ecology (Naveh 2001). By developing a conceptual model of landscape trajectories, it establishes a double interpretation of the physical-spatial and the social-cultural dynamics of the landscapes in areas of intensive agriculture (Ruiz, 2009). An agricultural watershed of southern Québec is used as a case study.

First, an analysis of the physical-spatial dynamics aims at capturing the spatial variability of landscape patterns of the cadastral lots and their trajectories of change from 1950 to 2000. Hierarchical clustering analysis shows that although the majority of lots were subjected to a homogenization of their landscapes patterns since 1950, this trend was not entirely uniform and that since 1980 it occurs alongside trends towards diversification of certain landscape features on some lots. Furthermore, nearly a third of the lots are not following the main trajectories of change detected. Thus, the results underline the strong influence of political forces in the shaping of these landscapes. However, they also suggest the role of the landscape values of farmers in altering these forces.

Thus, the second part of this research uses a landscape sociology approach to identify and to compare the relationships that local populations, farmers and non-farmers, maintain with the landscapes in the study area. A qualitative approach (semi-structured interviews and coding of the data) allows the identification of “communities of relationships to landscape”. These results reveal that diversity of landscape valuations, and of practices affecting landscape, coexist within local populations, thus shedding new light on the usual image of uniformity of these landscapes. The maintenance and increase of this diversity appears likely to contribute significantly to the reintroduction of the multifunctional character of landscapes within areas of intensive agriculture.

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# **Role of Landscape Ecology Studies in Development of Marginal Rural Areas**

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Development of marginal rural areas is depending on changing socio-economic situation, related urbanisation processes and land-use change. Land abandonment and natural afforestation have become common features of the contemporary landscape in marginal areas of Europe (Sirami 2007; Sitzia 2010) and most probably this trend will continue in the future. In this situation the landscape ecology studies should serve as essential tool to prognosticate the possible change of landscape structure and functions that are having impact on potentials of land-use from economic and ecological perspective as well as on well-being of rural society.

Land-cover changes are driven by complex interactions of socio-economic and environmental factors (Hietel, 2004). In abandoned former agriculture land such factors as former land-use, soil properties, size and configuration of fields, and also the random nature of plant colonization by seed might determine different spatial patterns of afforestation process. The most typical patterns in the study from marginal rural area in the Eastern Europe are linear, mosaic, and continuous afforestation, as well as development of afforestation from the forest edge. The results of the study show very diverse character of the afforestation process from spatial and temporal perspective as well as in relation to species composition, mostly not following the classical secondary succession model. At some locations afforestation process is delayed for a period of up to 20 years due to dense cover of herbaceous vegetation.

The specific conditions of the each site could be taken into account when looking for optimal solutions for further use of the abandoned agriculture land. Potential for use of such land first of all depends on possibilities and interest of landowners. At the present economic situation natural afforestation of land is often seen as the only reasonable land-use option. However in the areas where afforestation process is very slow or uneven (e.g. mosaic afforestation pattern), it will take much longer until timber will reach the harvesting time, but on other hand such forest can have higher ecological value. In contrary fast developing afforestation patterns (e.g. continuous, linear) would have higher commercial value and deliver earlier revenues, although having low value from perspective of ecology and landscape aesthetics.

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# Wild Mammal Distribution along Urban-rural-forest Landscape Gradient in the Tokyo Metropolitan Area

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The distribution patterns of various wild mammals along a landscape gradient from urban to forest area should be revealed in order to consider management strategy. Although response of some rodents and carnivores to an urban gradient are studied (e.g. Sauvajot et al. 1998; Randa and Yunger 2006), the comprehensive information of various mammals have not yet been clarified except for a qualitative information (Sonoda and Kuramoto 2008). Here, we clarified the distribution patterns of wild mammals along an urban-rural-forest landscape gradient in the world largest Tokyo metropolitan area.

We surveyed the distribution of wild mammals using camera-trapping in 148 sites from the urban core of satellite cities in Tokyo metropolitan area to the surrounding forest landscapes in the Boso Peninsula and Tama Hills, Japan. We evaluated the effects of surrounding land use (an urban-rural-forest gradient) and a topography factor (curvature) by a mixed logistic regression. As an indicator of urban-rural-forest landscape gradient, we used the first component of the principal component analysis (PCA) of land cover ratios (forest, agricultural area, grassland, golf course and urban area) around the camera-trapping site. Various buffer ranges (500, 1000, 2000 and 4000 m) from the sites were compared by Akaike's Information criteria (AIC) to determine key-spatial-scale for each mammal species.

The total number of detected mammal species decreased along from forest landscapes to urban cores. Sika deer, Reeves's muntjac, Japanese monkey, Japanese squirrel, Japanese marten, Japanese badger and wild boar frequently detected in forest landscapes, and cats (feral and free moving domestic) was common in urban landscapes. Common raccoon, Japanese hare and raccoon dog were frequently detected in intermediate zone of the gradient. The important spatial scale for forest species were 4000 m, thus, conservation and management plans for wild forest mammals should be considered on large spatial scale. However, the species that occurred in suburban and urban landscapes were determined by the spatial scale of 500 m. Narrowness of required spatial scale may be important ecological trait for surviving in fragmented urban landscapes.

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## **Manifesto for the European Landscape Project**

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Canary Islands territories have demonstrated huge potential for art and literary production. In turn, the direct experience of inhabitants and tourists on the territory contributes to the social perception of landscape, consolidated in the form of a cultural heritage, leaving a trace also outlining its evolution. Nonetheless, these overwhelming records of a myriad of agents and factors barely scratch the surface of the complexity of landscape. To address the sheer dimension of the landscape of the Canaries, we propose a simple action: the observation of expediently chosen specific locations. We believe that observation is the action that must necessarily precede an intervention. Observation as an exercise prior to any decision, action or inaction. An observation that is active, creative, deliberate and transversal (with other experiences stored in the memory) forms a groundbase on which to build a constructive rethinking of the territory.

The Observatory is a space for reflection about, and action on, the landscape. A space in which to weave together new paradigms and methods, to identify “new territories” within which to propose research experiences capable of formulating groundbreaking hypotheses. A laboratory for processes of landscape transformation, close to a real scale, intervening in local domains and interrelating them with Spanish and international ones. The Landscape Observatory of the Canary Islands provides the possibility of proposing formal, functional and experimental environmental and social-economic projects for certain areas of the islands which, due to a variety of reasons, have altered and transformed the original geomorphologic conditions of the territory or require a revision of their specificities from a landscape viewpoint.

One of the goals of the Observatory is to update the perception of citizenship and the professional involved related to the European landscape convention. That’s why during the last March the Observatory has organized a congress in Las Palmas de Gran Canaria, where the three landscapes networks (UNISCAPE, CIVILSCAPE and RECEP-ENELC) have coincided around the Manifiesto for the European Landscape. The main points of the manifest are:

- Acting on and in the landscape means positing an interpretation of nature and translating it into a project with its corresponding management.
- Landscape ought not to be seen solely in the light of sustainable, and as such ecological, development as well as urbanness and biological conservation. It is a cultural product.
- The landscape ought to be adopted not only as a right–duty of society, but also as a priority emergency. It is imperative to advocate the idea that enjoying a quality landscape is a new basic human right.
- Landscape is one of a community’s primary essential elements of identity, so this is the basic motive that best explains the concept of the landscape.
- Landscape must define and act on the free public space.
- The free public space defines a landscape that cannot be patrimonialised as “an entity” nor even as a “place” given that it is not an object nor a fragment of territory with fixed limits and signs that define and demarcate it.
- Landscape cannot nor should not be mistaken for territory or environment, nor can the same operative instruments be applied to each term.
- The landscape creates relationships between pieces and elements, able to individualise specific operations between different disciplines in the physical medium, in the countryside and in the city, in the air and in the sea...
- Core to the landscape project is the transversality of knowledge as opposed to inflexible orthodox disciplinary tools and rules.
- We need to

introduce the “intangible” in the recognition and management of the landscape, helping to define its identity. The forms of landscape are fused in movement, in the perception of movement. The factors of time and movement are consubstantial in the understanding and conception of the landscape. “The Landscape” allows us to transcend our individuality in a collective commitment. The concept of contemporary landscape needs to rethink the “idea of space”, offering a new physical and conceptual dimension of landscape itself in consonance with our time. The landscape should respond to the interaction between social agreement and participation and the critical project, coming up with an answer to the permanence and transformation of the territory as a necessary fact. The landscape entails the need for the project as a coherent action, a permanent process; it is the only multi-scale dimension that establishes a vital contact between project and contemporaneity. It is a “mechanism” able to participate in correspondence with the landscape of the community that lives in it through circuits that process goals between the hope of progress and the expression of its characters and identity.

## **Perception of Landscape, Landscape Pattern and Human Well-being**

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Changes in landscape composition and structure affect people’s perception and hence also the experience of the landscape and the value it has for quality of life and well-being. People are sensitive to visual changes that alter the characteristics of a landscape. Identifying the components that are characteristic is hence an important research task to be able to monitor and analyse change both with regards to the physical characteristic of the view and to the spatial representation in aerial photographs and maps. As a support for this the VisuLand framework was developed (Tveit et al. 2006). This framework identified nine visual concepts that are contributing to the formation of visual character and preference. One concept identified here was stewardship, which refers to the experience of care and upkeep of a landscape.

In this paper we will explore what in the landscape that contributes to the formation of perceived stewardship and discuss how this could be spatially analysed. The paper presents the result from a study using eye-movement tracking in order to explore what in the agricultural landscape that is viewed when asked to evaluate stewardship. In the study agricultural landscapes from Scandinavia were shown to 20 respondents while their eye movements were recorded and after each picture they were asked to evaluate the landscape with regards to stewardship using a 7-point Likert scale.

The result of the study was analysed by comparing the viewing behavior with areas identified as visually significant based on image properties. The areas identified as visually significant for assessing stewardship was analysed with regards to its content of landscape features proposed to be significant for stewardship in the indicator literature (e.g. Ode et al. 2008). The

result is discussed in relation to spatially analyzing perception of stewardship in the landscape through the use of remote sensed and mapped data. This paper shows how novel technique from cognitive science could aid in the development of landscape indicators for analyzing aspects important for human wellbeing.

This study has been funded by the Swedish research council Formas.

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## **Land Change in the Bolivian Amazon and its Implications for REDD and Endemic Biodiversity**

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The Amazon biome occupies more than 65 percent of Bolivian lowlands. This area has the second highest rate of deforestation in all Latin America. The rapid land change in this region is expected to be the major contributor to biodiversity loss in Bolivia, due to its effect on habitat degradation, fragmentation, and habitat destruction.

In this work, historical deforestation rates and projections of future deforestation were examined, using land cover maps of the Bolivian Amazon for the years 1991, 2000 and 2004. The implications of those changes to endemic diversity and carbon loss were also evaluated. An analysis of concordant patterns of carbon, biodiversity and threat was performed for current protected areas in order to prioritize them as potential REDD+ projects that would maximize both carbon sequestration and biodiversity conservation.

Results show that land change is increasing exponentially in the region. Projections of deforestation to the year 2050 depend on the historical based period analyzed, producing low, mid and high deforestation scenarios (Figure 1). All projections show an increase in pressure in the northern region of Bolivia. Biodiversity loss increases with the different scenarios, with projections of species range losses of up to 75% for more than 30% of the endemic amphibians, birds and mammals of the region. The amount of carbon loss follows the pattern of the different scenarios, with increasing carbon loss as the demand for land increases. Expected reductions in the carbon pool, ranges from 8% to 48%, for the low and high demand scenarios respectively.

Although in many cases patterns of carbon, biodiversity and threat do not overlap, some protected areas have the possibility of being proposed as REDD+ projects having large number of endemic species, high concentrations of carbon and high threat. When proposing REDD+ projects, explicit evaluation of the effects on biodiversity should be undertaken in

order to maximize co-benefits related to biodiversity protection.

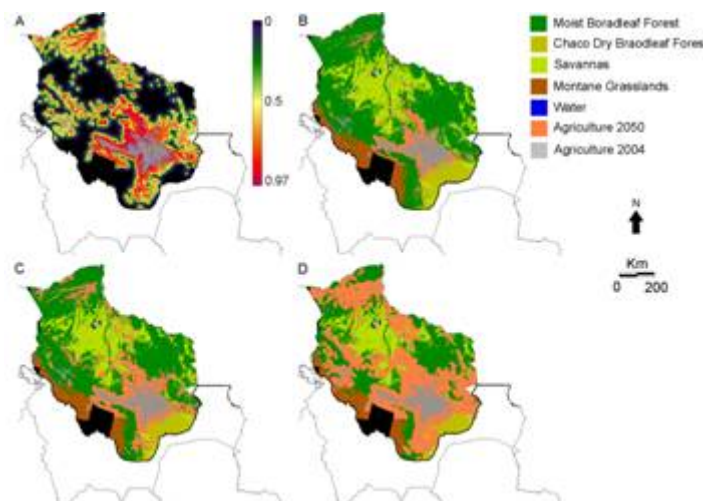


Figure 1: Modeled land changes for the year 2050. A) Vulnerability map, higher values represent higher vulnerability; B) Scenario of land cover change for the year 2050 under low demand scenario; C) Intermediate demand scenario; and D) High demand scenario.

## Spatial Models of Dynamics of Vegetation under Scenarios of Climatic Change in Transitional Zone "Timberline" Paramo - Cloud Forest of North Slope of the Sierra Nevada of Merida-Venezuela

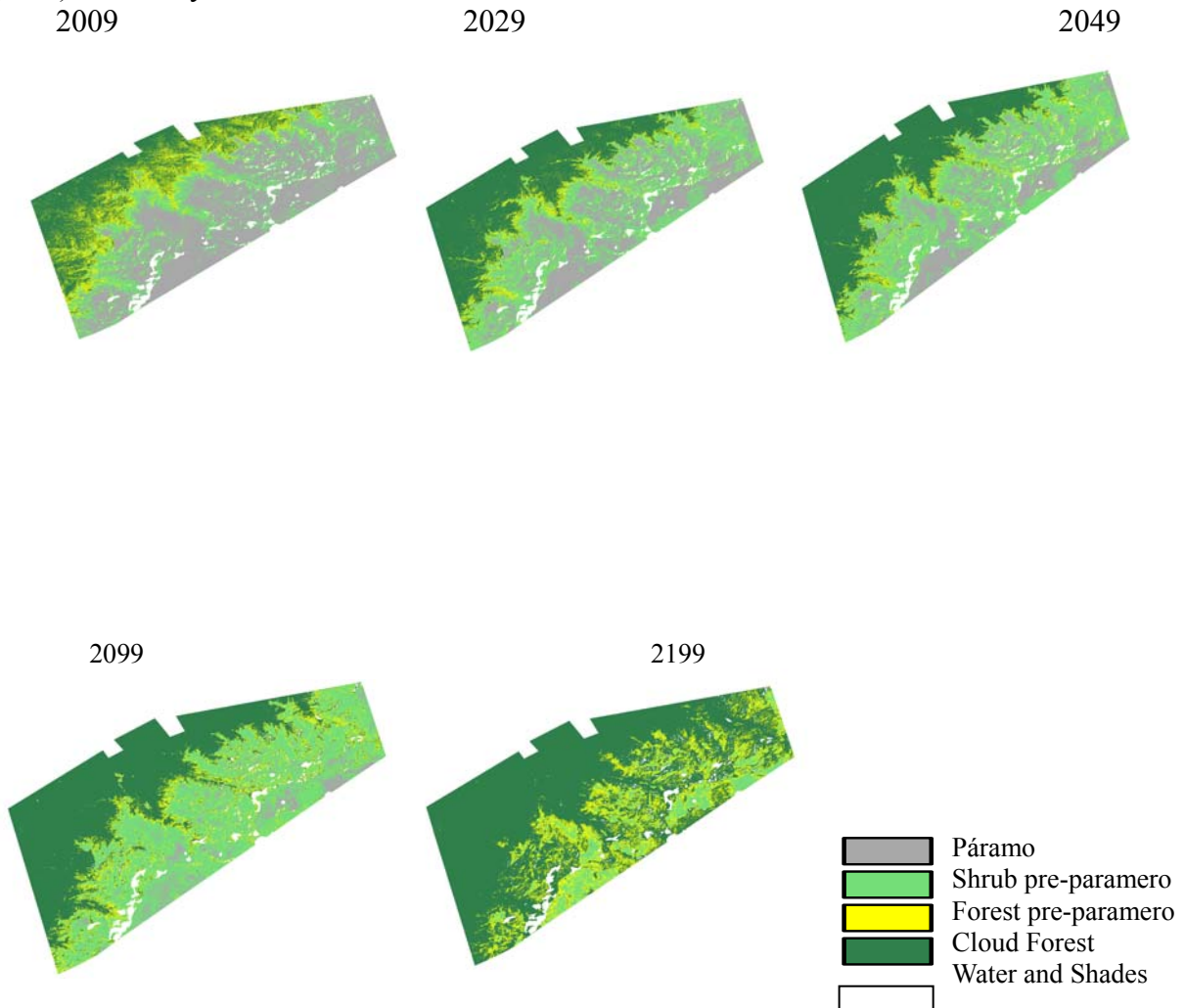
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During the last decades human being has modified gas concentrations greenhouse, generating increase of global temperature, causing alterations in structure and distribution of animals and plants. There developed models of dynamics of vegetation under all scenarios of special report on emission of greenhouse gases IEEE of Experts Intergovernmental Panel on Climate Change IPCC. Methodology was based on statistical spatial analysis of index of vegetation of normalized difference (NDVI) and his relation with thermal gradient in limit of continuous cloud forest - páramo (Timberline). Was determined a decrease of autocorrelation and an increase of variance of NDVI when altitude rises and diminishes temperature (altitudinal-thermal gradient). Was found statistical differences (ANOVA - Tukey -  $P < 0,01$ ) between NDVI average values of units of vegetation, and applying Analysis of probability NDVI ranges determine for same ones; cloud forest, forest pre(before)-páramo, Shrub pre-páramo and páramo, later changes physiognomy of vegetation along the gradient modeled themselves. Strong correlation between NDVI and temperature ( $r^2 = 90.45$ ) was observed, allowing to generate an equation to generate models of possible response of vegetation under all scenarios global warming. Models generated under different scenarios show a decrease of surface of páramo tending to extinction as ecological unit (figure 1), being colonized by shrub pre-paramero and forest pre-paramero, which were evolving later to climax of cloud forest. Models show that there probably will exist a dynamic of evolutionary processes and of advance of timber line on páramo reflected with change of physiognomy of plants and his spectral response.

**Keywords:** Global warming, Timberline, Treeline, Displacement of vegetation, Sucesional evolution, Spatial predictive models, Extinction

Fig.1. Models of spatial distribution of vegetation under more critical scenario A1F1 (4°C/100 years) between years 2009 - 2029-2049-2099-2199.



## Evaluation of degradational change in soils in the Czech Republic and its use in the optimization of agricultural landscape

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At present, there is great concern all over the world for the sustainability of land use. A lot of evidence has been found to show that soil quality is, or may be, worsening. Water erosion is the predominant form of soil degradation. In Czech conditions, accordingly, the most notable being water erosion which threatens more than 45% of agricultural areas, followed by wind erosion (11%), extreme soils – clay soils 4.5%) and soils affected by dryness (1.5%).

By using GIS methods a degradation model for the Czech Republic was created combining all types of individual degradation like water erosion, wind erosion, dehumification, acidification and other forms (Šarapatka, Bednář, Novák 2010) which play an important role in the Czech Republic. The total degradation model also helps to identify the areas where the total extent of degradation, including all degradation factors, has reached a maximum. The relationship between soil productivity and degradation proves our belief that degradation often occurs on very productive soils. Degradation is evenly distributed with its maximums up to an elevation of 300 metres above sea level – which corresponds to very intensively used agricultural soils.

With the use of the degradation model problem areas were identified in terms of water erosion. Alternative methods of evaluation of erosion wash-off were then put into effect. Aerial photographs taken over several periods of time enabled the extent of degradation to be defined and degraded areas to be localized, including the dynamics of the degradation. By measuring the level of  $^{137}\text{Cs}$  in soil samples it was possible to estimate the level and coverage of soil redistribution in the soil profile over the last 40 – 50 years. By measuring magnetic susceptibility (ferromagnetic) the dating of the erosion accumulation process can be shifted further back in time. Spectrophotometric measurement of soil colour and content of organic carbon then suitably supplement the aforementioned methods of research into erosion.

Knowledge of the occurrence, area of extent, dynamics and level of soil degradation, especially the influence of intensified water erosion, is the basic prerequisite for truly effective protection of agricultural land and planning for optimization of landscape use. The results of this study are significant not only in scientific terms, but also serve for ministerial decision-making (e.g. grant politics) as well as for planning farm activity directly in the landscape.

The authors wish to thank the Czech Ministry of Education, Youth and Sports for supporting their research through grant No.2B06101 and the Czech Ministry of the Environment for the grant they provided (SP/2d3/155/08).

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## **Wildlife Conservation Compatible with Local Forest Uses on Seram Island, Eastern Indonesia: Focusing on Relationships between Humans and Wildlife through Indigenous Arboriculture**

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In Wallacea and Near Oceania, local people have met a majority of their dietary, nutritional

and economic needs through the exploitation of arboreal resources, including resources other than trees, that are located in or proximate to a forest environment. Latinis [2000] calls this type of subsistence economy "arboreal-based economy". In Seram Island in eastern Indonesia arboriculture (cultivation, protection, and use of arboreal plant species) have been playing an important role in sustaining local livelihoods. This study aims to clarify 1) how local people create and maintain diverse human-modified forests through arboriculture, and 2) what relationships between wild animals and human have been formed through arboriculture.

Field research was conducted intermittently between 2003 and 2010 in a village we have given the fictive name of Amani Oho , located in the forest interior of central Seram near Manusela National Park. Data collection was done through key informant interviews, one-on-one interviews, group interviews, participatory mapping and participatory observation.

Local people in Amani Oho create and maintain various human-modified forests such as sago groves (*soma*), bamboo forests (*awa harie*) mixed forest garden (*lawa aihua*), itawa forests (*itawa harie*), damar forest (*kahupe harie*). These human-modified forests provide diverse forest provisioning services and contribute to meeting local livelihood needs.

Results of this research reveal that, on the one hand, a CITES1-listed and protected wild parrot, the Mollucan cockatoo (*Cacatua moluccensis*), frequently use mixed-forest gardens and damar forests as foraging and nesting sites. On the other hand local people occasionally trap these parrots attracted to these secondary forests and sell them to intermediaries in coastal areas, thus earning some money in times of hardship [Sasaoka 2008]. This indicates that a mildly interdependent relationship between Mollucan cockatoo and human seems to have formed through indigenous arboriculture. This research suggests similar relationships may occur with other wild animals as well.

Further interdisciplinary study is still needed, in evaluating conservation value as well as sociocultural and economic value of arboriculture for effective national park management and biodiversity conservation compatible with local forest uses in mountainous area of central Seram.

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# Sustainable Soil Use and Sustainable Soil Management in Urban Planning

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This contribution outlines the state of the art, methodological approaches and two case studies in the field of planning for urban sustainable environment from the viewpoint of soil use and soil management. Research and practice experiences from the urban region of Hildesheim, Germany, and the town of Wels, Austria, will be discussed. The first case study introduces a conceptual, scientific approach to a soil protection concept as a contribution to the land use plan. The second case study illustrates the transfer of scientific knowledge into practice for the purpose of sustainable soil management in urban environments.

Soil is a finite resource. Particularly in urban regions, there is strong competition for surface area. These soils also fill soil functions, particularly the natural soil functions which play an important role in the mass balance. In order to provide soil protection, a soil and surface concept must be in place which considers and appreciates the various soil functions. As yet, only a few cities and municipalities have introduced such a concept. First, based on the relevant literature, urban soils are defined and characterized. The urban soils are classified and the diversity of their genesis and transformations are shown. Second, the importance of soils in the urban ecosystem is presented. Here, the potential of soils in terms of their ecological functions holds a central position, e.g. as regards the water balance, and must therefore be considered in the evaluation of urban soils.

The first case study is used to discuss the compilation of the soil protection concept for the urban region of Hildesheim. The concept is orientated around the different soil functions (natural functions, archival functions and land use functions) and evaluates these against each other (Sauerwein, Grube 2010). The resulting hierarchy is digitized into a GIS. These spatial data sets find their way into the land use plan.

The second case study addresses space, cost and energy saving settlement development in the town of Wels (Damyanovic, Reinwald 2011). It shows the implementation of research results in practice. Planning strategies which contribute to sustainable soil use and soil management in urban planning were worked out in co-operation with the town of Wels (civil servants, planners, politicians and building co-operatives). The objective of the project was to design planning measures at the level of the town's local development concept which optimize the interdependency of energy-efficient building and land consumption with regard to everyday usability.

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## Soil Macrofauna Biodiversity is Important for Species Selection for Sustainable Plantation

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Tree species selection is very complicated task for establishing a plantation. We should consider different factors to have a suitable selection. One of the criteria that the previous researches name for forest sustainability and soil quality is fauna populations. We studied the soil macrofauna biodiversity as an aspect of fauna populations in order to species selection for plantation in floodplains of Dez River in southwestern Iran. This study was conducted in a randomized block design with three blocks constitute of *P. euphratica*, *Eucalptus camaldulensis*, *E. microtheca*, *Acacia farnesiana*, *A. salicina*, *A. saligna*, *A. stenophylla* and *Dalbergia sissoo* monoculture plantations that were established in 1992. Soil macrofauna were collected by hand sorting using a randomly located 0.25 m<sup>2</sup> sampling frame, and two sub-samples were taken per plot (one composite sample per plot × 3 block × 8 tree species = 24 samples) in November 2006. All macro-invertebrate organisms (macroscopic organisms) in litter and mineral soil up to 25 cm depth were collected. Several diversity descriptors were calculated for each tree plantation, namely richness (Margalef and Menhenick), diversity (Shannon H) and evenness (Sheldon) indices. These indices were calculated in PAST version 1.39. Earthworm, Formicidae, Coleoptera, Collembola, Araneae, Chilopoda, Isopoda and Gastropoda were found in the plantations. Among diversity descriptors only Menhinick were significantly different between the plantations. It was higher in *E. camaldulensis* and *E. microtheca* plantations than *A. salicina*. Shannon H and Sheldon indices were different among the plantations but there were not significant. Consequently, we could conclude that *E. camaldulensis* and *E. microtheca* are preferred species as a result of higher soil macrofauna richness. As soil macrofauna biodiversity was different among the various plantations we could totally conclude that it is important in species selection to have sustainable plantations.

**Keywords:** Plantation, Species selection, Soil macrofauna, Biodiversity

## Landscape Ecotoxicology: State of the Art and Perspectives

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Will there ever be a field of landscape ecotoxicology? This is the way John Cairns Jr questioned the scientific community in 1993, bringing up his fascination with recent developments of landscape ecology (Cairns Jr 1993). Ecotoxicology is born during the sixties and aims at understanding the fate and the effects of pollutants in ecosystems (Walker et al. 2006). While developing toxicological approaches needed for applied issues demanded by the society (for risk assessment purposes, for instance), ecotoxicologists have progressively adopted concepts and tools of ecology. However, if ecotoxicologists have indeed appropriated some tools used in landscape ecology (remote sensing, spatial statistics, etc), few studies have

really adopted the concepts and tested the hypothesis that landscape might modulate transfer and effects of pollutants. Such a hypothesis, though, is highly relevant. Why landscape features, like the spatial arrangement of habitats, soil types or soil properties (that have extensively studied in a non-spatially explicit way in ecotoxicology), would not influence interception, retention and persistence of pollutants? Why landscape, by influencing biodiversity patterns (number of trophic levels, food web lengths, diversity in each trophic level, etc), would not modify pollutant transfers in ecosystems, as it is now clearly acknowledged for the transmission of pathogens (see e.g Giraudoux et al. 2003)? Why landscape, by the way it is spatially and temporally used by organisms, would not play a role on transfers and effects of pollutants? Studies on the ecology of contaminant transfers (both chemical and biological) using landscape ecology concepts in a systemic approach would better take into account time and space and the diversity of scales and levels of biological organization to be considered. The present talk aims at presenting some of the works that have paved the way for landscape ecotoxicology and will explore what insights could be gained by such approaches.

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### Ecobelts: Structure and Function at the Rural/urban Interface

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The rural/urban interface around communities often becomes a zone of conflict between residents with different goals, expectations, and lifestyles. Urban residents may object to agriculture's influence on the adjacent environment while agrarian neighbors can be resentful of urban intrusion into day-to-day farming activities. Vegetation-based buffers or corridors are one approach to converting the zone of tension into a neighborhood of cooperation. The use of linear arrangements of vegetation in the landscape is not a new concept and has been studied extensively by landscape ecologists. From the hedgerows in agricultural regions to greenways in urban environments, these green areas have been used around the world for many years to meet objectives of rural and urban residents. A recent synthesis of scientific evidence concluded these landscape elements can provide over 27 different functions or services as illustrated by the sample of findings listed on the poster. Despite the potential of these landscape features to provide many ecological, economic and social functions, they are often designed and managed only for a narrow range of functions.

We propose a more holistic approach that combines these plantings into an integrated system of “ecobelts” that can begin to reconcile private land rights with public needs (Schoeneberger et al. 2001). By taking a landscape ecological approach, the positive interactions and synergies of these features can be developed while minimizing the inevitable conflicts and tradeoffs, ultimately accomplishing multiple benefits for all members of society. Examples illustrating components of the ecobelt concept can be found, serving as inspiration (e.g., Bentrup et al. 2001, Ignatieva et al. 2011). One tool for creating multifunctional ecobelts is the U.S. Forest Service publication, *Conservation Buffers: Design Guidelines for Buffers, Corridors, and Greenways* which is available in Chinese, Spanish, French, Korean, and Mongolian ([www.bufferguidelines.net](http://www.bufferguidelines.net)). This guide synthesizes and distills over 1,400 research publications into illustrated rules-of-thumb for designing ecobelts to improve air and water quality, protect soil, enhance habitat, increase economic productivity, create recreation opportunities, and beautify the landscape. By providing services that both rural and urban residents’ desire, a network of multi-purpose ecobelts can help transform the zone of tension into a community asset.

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## Trajectories of Urban Development in China and India: Twenty Cities Over Forty Years

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Understanding the dynamics and the ecological consequences of urban expansion is critical to crafting policies and institutions to manage it properly. Comparative analysis of these processes in different countries is an indispensable prerequisite to such an understanding. This paper presents results from the first systematic comparison between the trajectories of peri-urban development in Chinese and Indian cities in the period of economic liberalization. The study draws on remote sensing, demographic, environmental and other data over a period of 40 years, from the early 1970s to 2010. Data from 20 selected Chinese and Indian cities were used to compare overall variations in urban form and their evolution.

For each city, the paper focuses on 24 land use metrics calculated from Landsat TM and ETM remote sensing images of built-up land for four data points over this period. Metrics of this kind have increasingly been employed to compare patterns of urban form (Angel, Parent and Civco, 2007; Huang, Lu and Sellers, 2007; Ji, 2008). The indicators include multiple measures of such dimensions of urban form as spatial extent, dispersion, shape regularity, complexity of the urban/nonurban border and the ratio of urban to nonurban land. Principal components analysis and other methods are used to explore relationships between these indicators over time. Correlations and multivariate regressions will examine the effects from population, foreign direct investment, and coastal location on the changes in urban form over time.

The results demonstrate striking cross-national contrasts and a continued divergence in urban form between the two countries. In China, a variety of institutional, social and economic conditions that have set distinctive terms of peri-urban development from those in India. The state-dominated development process has in certain circumstances created powerful growth machines that have driven periurban expansion far beyond the extent evident elsewhere.

The process of periurban expansion in the Indian regions has proceeded more slowly than in Chinese counterparts despite equally dramatic growth in urban populations. In urban regions of greater sprawl, such as Bangalore and Delhi, intensification and infill development have matched and partly counterbalanced ongoing expansion. Greater compactness, less irregularity in shape along the urban border, and retention of small rural village centers in the exurban periphery mark the overall Indian patterns of periurban development.

## **Changes in Macroinvertebrate Species Composition between Forest and Urban Watersheds in Istanbul**

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The conventional stream water quality evaluations were mainly based on physical and chemical water quality monitoring data. The drawbacks of the method were the facts that it depends on only the selected parameters and that it reflects the instantaneous conditions of the sampled water body. However, macroinvertebrates which spend some part of their lives in water do not migrate long distances and their ability to adapt to the various habitat conditions of the sampled area have made these organisms gain more importance regarding stream water health and integration evaluations. Macroinvertebrates can react to any change (either good or bad) in lotic and lentic ecosystems in a wide spectrum. As an example, the reaction of the river ecosystem when faced with conditions such as point source pollution caused by humans or extreme natural conditions (flood, drought etc.) can be seen in a most rapid and efficient manner in population dynamics such as number of individuals of organisms, dominant species,

diversity. Hence, for ideal stream health observations it is suggested to evaluate macroinvertebrates along with chemical measurements. Macroinvertebrate species living in different habitat conditions have different pollution tolerance values.

The results of our large scale stream survey study performed in various creeks of Istanbul revealed that urbanization is a significant factor to affect stream macroinvertebrate populations. According to results of this study *Gammarus pulex* species are particularly dominant in the basins in the forest lands, and *Asellus aquaticus* species are dominant in the basins where urbanization prevails. With this research, it has been found that “mayfly” and “caddisfly” species are dominant in forest lands that has good water quality (chemical) and good shading. Inversely, it has been observed that “chironomid” and “snail (Gastropoda)” species were more found in tributaries affected by more polluted areas where urbanization is effective.

## **Urban Riparian Ecosystems in Istanbul**

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Riparian ecosystems as components of stream corridors provide a range of regulating ecosystem services including water production. Water quality, a component of water production is a major concern in urbanized watersheds. Studies have shown that riparian ecosystems can remove a large portion of nitrate and phosphate from the groundwater that flows through them. Riparian ecosystems are also capable of trapping sediment runoff from land, promoting bank stability and thus minimising soil loss into watercourses. Another benefit of the riparian vegetation lies in shading of water surface and thus regulating the temperature of aquatic ecosystems. Water quality monitoring on the hand has been a very common way of investigating watershed impairment particularly in case of human impacts. However, hydrological monitoring that involves quality and quantity may not always reflect a watershed condition adequately. Ecological parameters may support and improve monitoring. More than ten reservoirs are producing water to large Istanbul city with a population of more than 12 million. Watersheds of most reservoirs are under pressure of urbanization and sprawl. In 3 major watersheds of the city (Alibeyköy, Sazlıdere, and Kağıthane) we initiated a large scale study towards the objective of evaluating integration, health, and functionality levels of riparian ecosystems. To reach these objectives we combined a thorough field survey study with a GIS assessment.

Study Watersheds cover a large portion of Istanbul’s European side peninsula. Alibeykoy and Sazlıdere watersheds drain into reservoirs while Kagithane creek drains into an estuary called Golden Horn. The streams draining Kagithane and Alibeykoy are 2 fluvial systems that receive all kinds of pollution and pollutants that are generated by urbanization. Flooding is also a major problem at downstream of Alibeykoy and Kagithane streams because riparian ecosystems are replaced by settlements in many places.

A total of 66 sub watersheds have been selected in the main study watersheds and survey

points have been determined at their outlets. All perennial streams in the study have been surveyed for 5 main categories; ecological water quality, water quality for use, riparian integrity, riparian functionality, and riparian habitat potential.

We found out that majority of the streams in or close to urban areas had lost their functionality. Furthermore, around 10 percent of all streams in the peri urban areas had been channelled. Water quality has also been deteriorated in many streams. For example average NO<sub>3</sub> concentration at the urban streams was 76.63 mg L<sup>-1</sup> while it was 2.67 mg L<sup>-1</sup> at the forested part of the same watershed.

## **Degradation of Urban Riparian Ecosystems in Istanbul**

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Riparian ecosystems as components of stream corridors provide a range of regulating ecosystem services including water production. Water quality, a component of water production is a major concern in urbanized watersheds. Studies have shown that riparian ecosystems can remove a large portion of nitrate and phosphate from the groundwater that flows through them. Riparian ecosystems are also capable of trapping sediment runoff from land, promoting bank stability and thus minimising soil loss into watercourses. Another benefit of the riparian vegetation lies in shading of water surface and thus regulating the temperature of aquatic ecosystems. Water quality monitoring on the hand has been a very common way of investigating watershed impairment particularly in case of human impacts. However, hydrological monitoring that involves quality and quantity may not always reflect a watershed condition adequately. Ecological parameters may support and improve monitoring.

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A total of 66 sub watersheds have been selected in the main study watersheds and survey points have been determined at their outlets. All perennial streams in the study have been surveyed for 5 main categories; ecological water quality, water quality for use, riparian

integrity, riparian functionality, and riparian habitat potential.

We found that a substantial amount of the streams in or close to urban areas had lost their functionality. Furthermore, around 10 percent of all streams in the peri urban areas had been channelled. Water quality has also been deteriorated in many streams. For example average  $\text{NO}_3$  concentration at the urban streams was  $76.63 \text{ mg L}^{-1}$  while it was  $2.67 \text{ mg L}^{-1}$  at the forested part of the same watershed.

**Acknowledgement:** The study was supported by TUBITAK with the Project number 107Y149.

## **Impacts of Land Use and Climatic Changes on Dust Emission in South-West of Iran**

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Historical records of dust storms show that during the past decade dust storms have increased in arid or hyper arid parts of Iran. Population growth and a need to provide food, fiber, water, and shelter causing dramatic changes in land use and land cover. Besides to these human activities, natural desertification processes and climate changes increase dust sources. The purpose of this study is to investigate the potential of the land use, land cover and climatic changes to alter dust emission in South-West of Iran (Khuzestan province). Three main sources has been recognized for dust emission in Khuzestan province, first loss of vegetation cover due to wetlands destruction and agricultural lands abandonment; Second, blocking rivers such as Karoon, Dez and Karkheh by dams, and third climatic changes and its effect on precipitation. In this study, we evaluate the most related synoptical parameters to dust emission, such as temperature, wind speed, number of dusty days and visibility below 2 kilometres, derived from data records of synoptical weather stations located in Khoozestan province. We tested how climatic parameters have changed during the last 50 years and how the changes in dusty days are correlated with the changes in climatic parameters. We found that increasing in minimum temperature and relative humidity are the most influential climatic factors on dust emission in the study area. To investigate impact of the land use changes on dust emission, Land use and land-cover maps of the area will be prepared for recent decades and in addition changes in landscape patterns (including Number of Patches, Edge Density, Largest Patch Index, Fractal Dimension and Shannon's Diversity Index) will be quantified for the study area. The results of this study can reveal the relative importance of land use, climatic change and their interactive effects on dust emission in the study area.

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## **Effect of Land Development on Environmental Challenges and Landscape of the Persian Gulf**

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The Persian gulf include many ecosystems with high diversity, coral reef, seaweeds communities, mangrove forests, more than 500 fish and 15 shrimp species and 5 monotype species of marine turtle are a part of this unique area characteristics. With cross to space of the Persian Gulf and looking to this unique area and close to coastal countries, much construction will appear that look like as palm and ports that developed on sea bed. Land development on the Persian Gulf and Oman Sea from side of Iran and Arabian countries is phenomenon that occurs on this area and its growing more in time. Sea drying to obtain land and developing human made islands have a great effects in marine ecosystem and natural landscape, the countries with their programs to achieve economic advantages and tourism development, may be don't consider long term and short time effects of environmental transgression to sea shores and aquatic life, however marine ecosystem (animals, sea weeds and aquatic landscape) also affects from this constructions (Armaghan, 2008). RAPMI (Persian Gulf and Oman Sea environmental program) may be the best authority for prevent of develop this projects that must be safe guard about environmental rights in the area and should be support all countries (Moharam Nejad, 2003). Study show that UAE becomes as pioneer country to making these artificial islands in the Persian Gulf in recent years, also Qatar, Iran and Bahrain on land development in coastal zone. In view point of sediments and unusual erosion making the ports and islands like other sea construction have special effects in sedimentation. These processes in RAPMI area needs to develop a comprehensive plan to achieve economics, political and environmental benefits for the countries without any treat on natural resources sustainability.

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## **Vietnam — A Rising Green Dragon? The Case of Cantho**



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Vietnam is in the midst of incredible economic growth, second in fact only to China. It is a rising dragon in Southeast Asia. It is rapidly transforming from a rural to urban nation and new cities are appearing amidst vast paddy fields and existing cities are expanding vertically and at urban peripheries. As modernization and urbanization engulfs landscapes, ecologies are severely compromised. Low-lying lands are filled, disrupting fragile ecosystems; water-based to road-based transport systems fundamentally change the socio-cultural nature of *dat nuoc* ('land water' — referring to myths, feng shui and ancient settlement structures).

The case of the Mekong Delta city of Cantho (pop. 1.2 million) exemplifies how the rich legacy of the territory's majestic canal-landscape can structure the contemporary reconfiguration of the use and regulation of the man-made and natural landscapes. A new masterplan for Cantho aims to generate an urban waterscape with a clear structural interweaving of topography, hydrology and soil conditions and a new urban morphology that *works with the landscape* for water protection, retention, discharge, and treatment — but also for productive use. The proposed landscape urbanism strategies are a catalyst for the development of a climate-resilient and adaptable city. Through context responsiveness, scale and a precise interplay of spine, blue and green systems, a middle ground is offered in which structuring from above and substantiating from below can, in the best tradition of the region, weave an additional layer, as were it warp and woof, into the landscape.



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## **Driving Factor Region of Construction Sites Model ---A Study Case in Costal Region of Jiangsu Province, China**

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For the increasing frequency of human activities in regional landscape patch changes the number of driving factors and the regional construction sites critical control point is very important for regional sustainable development. Quantifying and understanding what influences landscape patterns is a key research area for landscape ecology. A model was developed to accommodate several driving factors. We used a Bayesian framework for parameter selection. First, we explicitly accounted for spatial structure. Second, we considered the particular influence of landscape pattern and chose major factors. Third, we added a parameter,  $b_i$ , encompassing policy factors and technology, for which there was no data. Finally, our model accounts for poor detection, which may be a source of bias in choosing parameters.

We focused on the case of the land use in coastal areas of Jiangsu Province, China. 2005 GRID data and data from the construction sites of the coastal city were used. Construction is one of the most severe landscape changes. Our model provided four parameters for driving factors following empirical study: Natural geographical, economic, demographic and policy factors, and technology. Differences in the relationship between driving factors and construction probabilities were detected. A map of construction sites is provided that may be show the spatial character parameters as an example of practical application of our work.

**Keywords:** Regional planning, Logit model, Driving factor, Construction sites

## **Blowing Litter across a Landscape: Effects on Ecosystem Nutrient Flux and Implications for Landscape Management**

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Lateral flows in landscape mosaics represent a fundamentally important process in landscape ecology, but are still poorly understood in general. For example, windblown litter nutrient transfer across a landscape has rarely been studied from an ecosystem perspective. In this study we measured the litter nutrient transfer from an *Acacia mangium* plantation to a *Dimocarpus longan* orchard in an agroforestry landscape for 3 years from January 2002 to December 2004. About 11% of the total litterfall of the acacia plantation were transported to the longan orchard annually, accounting for ca. 9–59% of the total litter nutrient input of the longan orchard. The windblown litter transfer showed high spatial variation mainly caused by wind speed and directions. Slope positions 5 m away from the source acacia plantation received significantly greater amount of allochthonous acacia litter than those 10 m away, and the northwest-facing slope of the longan orchard received 2 to 3-fold more litter than the

southeast- and south-facing slopes because of the prevailing southeasterly wind in the region. To explore how different management practices may influence the litterfall, leaf production, and soil nutrient status of the two ecosystems, we developed a Meta-Ecosystem Litter Transfer (MELT) model to simulate the processes of litter-related transformation (production, deposition, and decomposition) and transfer (wind- and management-driven movement). Our simulation results suggest that less than 30% of acacia litter should be transferred to the longan orchard in order for the acacia plantation to sustain itself and maximize production of the longan. Connectivity of nutrient flow between adjacent ecosystems as shown here leads to a functional meta-ecosystem with higher landscape-scale production of ecosystem services. That is, managing this connectivity through landscape design or active litter transfers can lead to large changes in overall landscape functioning and service production.

## **The Effect of Topography on Biodiversity: Its Roles as Cradle and Museum**

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Topographic variation and geomorphic processes are the results of interaction between inner earth energy and solar energy. The geographic pattern of biodiversity on earth has been attributed primarily to the latter as indicated by the distribution of the climate system. Meanwhile, the role of the interaction of inner earth energy (i.e., forces of gravity and uplift of volcanoes) and the solar energy driven processes of weathering and erosion as a drivers of biodiversity and its underlying mechanisms have been mostly neglected until the last decade, and a comprehensive framework of understanding remains elusive.

We make a thorough search of the databank of Science Citation Index for studies published in the mainstream of journals of ecology and biogeography in the last fifty years, with key words such as “topography”, “geomorphic processes”, “biodiversity” and “species richness”, and did a meta-analysis on the current knowledge of the effects of topography and geomorphic processes on the distribution of species richness. We summarize the mechanisms underlying topography-species richness relationship from four aspects, i.e. niche effect, barrier effect, area effect, and species pool effect with reference to current hypotheses for the mechanisms behind the spatial variation of species richness. We set up a hierarchical estimation framework to assess the contribution of topographic variation to biodiversity at  $\alpha$ ,  $\beta$ , and  $\gamma$  diversity levels. Topography and geomorphic processes affect species richness at a variety of spatial and temporal scales, with different mechanisms operating on its ecological and evolutionary aspects. Scale plays a critical role in estimating the topography-species richness relationship. By referencing the fundamental processes of biodiversity, i.e. speciation, extinction, competition and dispersal, we suggest topographic variation as both the cradle and museum of biodiversity.

Based on the reviewed empirical observations and theoretical explorations, we put forward 10 predictions to be tested about the topography-species richness relationship, and we propose potential directions which need further effort.

**Keywords:** Topographic variation, Species richness, Energy inner energy, Mechanisms, Cradle, Museum, Scale

## **Bringing Climate Change Science to the Landscape Level – The Role of Landscape Visualization**

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Responding to climate change creates an urgent need to bridge between science and practice in landscape and community-scale planning (Nassauer & Opdam, 2008). Programs such as the US National Climate Assessment and ongoing municipal planning demand stronger processes to accelerate uptake of climate change science and support decision-making under considerable future uncertainty. This paper describes a framework and process for envisioning local climate change futures, using a collaborative, science-based approach to produce mapping and data-driven 3D modelling of climate change scenarios at the landscape level.

The Local Climate Change Visioning Process is structured around a cross-scale framework of future climate change scenarios, based on IPCC emissions scenarios and other global/regional climate modelling, best available local data and models, and stakeholder/practitioner input via local working groups and design studies (Sheppard et al., 2011). The process integrates the causes, impacts, mitigation and adaptation of climate change. It aims to localise, spatialise, and visualize plausible alternative landscape scenarios. The process has been tested in several Canadian case studies, including a floodprone coastal community (Delta), a mountain community with dwindling snowpack (North Vancouver), and an interior community vulnerable to forest fires and flooding (Kimberley). Visioning material, showing for example flooding of neighbourhoods and various adaptation and mitigation options (Shaw et al., 2009), has proved to be powerful but credible in exercises with practitioners and lay-people. The process provided meaningful new data on landscape-level impacts and solutions, increased participants' support for policy change, and legitimized consideration of options for land use, flood management, and renewable energy.

Such studies suggest that spatially explicit and visually iconic applications of science at the landscape level can be very informative, relevant, credible, and compelling. However, there are dilemmas in going beyond the hard science to reach the local level and visualize scenarios that are partly qualitative (Sheppard and Cizek, 2009). We need vigorous scientific debate among experts from various disciplines on the benefits, risks, and appropriate role of landscape visualisation and related design processes in conveying science.

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## **Water Quality Monitoring in A Dam-lake with Artificial Wetland by Using**

## Advanced Ion Chromatographic System

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Recently, there are serious water pollution problems in closed aquatic environment like dam-lake. For example, Haizuka dam-lake located in Hiroshima prefecture of western Japan is facing by the eutrophication problems caused by influx of various nutrients such as nitrogen and phosphorus emitted from public and private sector institutions on upstream area of the river watershed. On this dam-lake, an artificial wetland is placed for improving water quality of incoming river water. The water quality monitoring operation to evaluate the effect of eutrophication is extremely important task for the dam-lake water quality management based on the environmental policy by national/local governments. In this study, the water quality monitoring of the dam-lake was performed using an advanced ion chromatography (IC) consisting of ion-exclusion/cation-exchange chromatography (IEC/CEC) with conductivity detection for determining simultaneously common anions such as  $\text{SO}_4^{2-}$ ,  $\text{Cl}^-$ , and  $\text{NO}_3^-$  and the cations such as  $\text{Na}^+$ ,  $\text{NH}_4^+$ ,  $\text{K}^+$ ,  $\text{Mg}^{2+}$ , and  $\text{Ca}^{2+}$  (Mori et al., 2003), the IEC with spectrophotometric detection at 700nm for determining simultaneously phosphate and silicate ions as the nutrient component (Mori et al. 2005) and the IEC with enhanced conductivity detection for determining  $\text{HCO}_3^-$  (alkalinity) as a inorganic-carbon source (Nakatani et al. 2008). Additionally, analytical methods like “the Standard Methods” to determine BOD, COD, total-P, total-N and chlorophyll-a were also employed. The water quality evaluation of the dam-lake waters including wetland waters was performed using the IC systems and the Standard Methods. As a result, it was found that the water quality of dam-lake is improved by the effect of various biological reactions taking place at the wetland. In conclusion, the advanced IC system was judged to be extremely useful and powerful for the water quality management of the dam-lake.

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## Mapping Urban Vegetation by Support Vector Machines

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The amount and distribution of various vegetation types are critical information for understanding ecological processes and ecological services in urban ecosystems. Urban vegetation types can be mapped by remote sensing but challenges exist due to the complexity of the urban landscape and the spectral similarity of various vegetation types. Over the past several decades, various pattern recognition techniques have been developed to improve urban vegetation mapping from remote sensor data. In this study, we examine the utilities of support vector machines (SVM) for urban vegetation mapping from a Landsat Thematic Mapper (TM) image covering part of the Atlanta metropolitan area that is characterized by a mosaic of complex landscapes including various vegetation types. The SVM is a group of relatively novel statistical learning algorithms that have not been extensively exploited in the remote sensing community (Yang, 2011). Several recent comparative studies have found that the SVM can outperform most of the conventional classifiers (*e.g.*, Huang *et al.*, 2002; Marcal *et al.*, 2005). Nevertheless, these studies were largely based on the assessment of the overall classification accuracy providing little information on the classification accuracy for specific classes that may be more valuable for many applications. In our current study, a SVM configuration recommended from one of our previous studies has been used to classify the TM scene into nine major land use/cover types that include five vegetation types, and both the overall classification accuracy and the accuracies for specific classes are evaluated. With identical training and reference datasets, we further compare the performance of the SVM *versus* the maximum likelihood classifier. We found that the SVM generally performs better than the maximum likelihood classifier in terms of the overall accuracy but substantially outperforms the latter for several vegetation types that are heterogeneous by nature. This study has further confirmed the robustness of the SVM as an image pattern classifier, particularly for heterogeneous vegetation types.

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## **Extraction Net Primary Production (NPP) from MODIS Data on the**

## landscape

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This is a one of the most important problems in Landscape Ecology that the data conversion between different land scale. The high serial time resolution and low spatial resolution are characteristics in RS (Remote sensing) data of large scale(for example MODIS data), but in contrast in remote sensing data of small scale(for example TM/ETM data). For the reason, the more parameters in the MODIS NPP model, The NPP(Net primary productivity) model built from MODIS data is better than from TM/ETM data which data is most usefully applied for landscape scale, so it is significance that converting the NPP data from MODIS model into TM/ETM landscape scale. In view of lacking continuous NPP data on the landscape TM/ETM scale research, this research is based on the MODIS source data of NPP, research objects as WuSu-KuiTun-Dushanzi region (hereinafter short for WuSu Oasis) , using the tools of RS ,GIS (Geographic information system), math statistics, analyze and extracte the NPP of landscape types on the landscape scale in the typical arid area, The NPP model estimation results on the region scale have been converted into the landscape scale successfully. and the treatment method and introducing principle for this process have also been explored. This research indicated that exploration and analyzing on the frequency distributions of NPP pixel values for every landscape types which extracted by map overlay in GIS, and eliminating some small probability NPP pixel value in some conditions based on the fact situation, and calculating the mean NPP of every landscape types can get the landscape NPP relative accurately on the scale of landscape. Therefore, the base data can help to research on eco-environmental function for temporal-spatial dynamic change in the same region and across comparison in different area based on the landscape scale. The author also considered that under the condition of lacking more accurate NPP data sources, this approach of by use of the mature NPP data sources for region scale and the landscape classification maps from TM images to extract and estimate the landscape NPP is practicable and meaningful.

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# Irrigation Cooling Effect on Temperature over the Huang-Huai-Hai Plain of China

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Irrigation has important influences on regional climate, especially on temperature and precipitation (Bonfils and Lobell, 2007; Kueppers et al., 2007; Lobell et al., 2008, 2009; Mahmood et al., 2006; Puma and Cook, 2010). In this study, changes of surface temperature and precipitation related to irrigation on the Huang-Huai-Hai Plain of China from 1955 to 2007 were analyzed. Long-term weather observations, and updated high-resolution irrigation and land use dataset were used to better characterize their effects on temperature and precipitation. Linear trends for 1955-2007 for all temperature and precipitation values were computed using ordinary least squares regression. The results showed that irrigation had a significant cooling effect on average daily maximum temperature, while had a clearly warming effect on average daily minimum temperature on the Huang-Huai-Hai Plain. Irrigation also affected extreme annual precipitation trends. We analyzed the seasonal variation for the irrigation effects on temperature and precipitation, which showed that the irrigation effects were different in various seasons. On the other hand, Irrigation effects depended on some other factors, such as urbanization and climate regimes. Our findings highlight the importance of land use change in evaluating regional climate change and its implications. Further efforts to understand irrigation effects on climate should not only use observations, but also couple with dynamic land use and regional climate models to understand the complex processes and controlling mechanisms.

We are supposed to present this paper in the symposium of “Climate optimized land use – a sustainability strategy between adaption to and mitigation of climate change”, if applicable. Our abstract is for oral presentation.

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## **Detection of Land Use Change Trajectories in Urban Areas – A Comparative Analysis Using Global Land Cover Database**

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The importance of information describing the extent of land changes over time is increasing, especially in growing urban areas in terms of mitigation and adaptation strategies for global environmental change. Urban growth, that is the movement of residential and commercial land use to boundary areas, has long been considered a typical phenomenon of regional economic growth but the benefits are balanced against ecosystem impact. In addition, changes in land use structures within urban areas are other phenomena of current urban land change.

In this study, the temporal dataset for fifty urban areas (cities or metropolitan regions) from Landsat Thematic Mapper (TM) was developed to analyze the changes in urban land structures over the past thirty years. The Landsat images in 1980's, 1990's and 2000's were classified into 6 land use types based on IPCC guidelines (IPCC 2006) using maximum likelihood classification method. Owing to the tendency of the conventional land cover transition matrix derived from remote sensing data to focus on changes in categories, methods of detecting post-classification land change have been further developed and used to identify the important land change signals. We applied the methodology to detect urban land trajectories using the classification database.

The results show that the land cover in urban areas is highly dynamic in various regions. Forest and grassland vegetation, wetland and human-created area such as crop land and settlement show the high total change. The important signals were presented in each area. These changes may have effects on the terrestrial ecosystems including carbon balance, material circulations and biodiversities and appropriate strategies are needed for prompt mitigation of the adverse effects of dramatic land change.

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## **Critical Study in the Southern Landscape of the Madhya Pradesh State in Connection with Forest Dwellers Livelihood, Sustainable Development and Ecosystem Services**

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Madhya Pradesh(MP) the central state in India is endowed with rich and diverse forest resource with 24.40 % of forest cover of the land area .The forest harbors native flora mainly of Teak (*Tactona grandis*) Sal( *Shorea robusta*) Bamboo (*Dendrocalamus strictus*) and miscellaneous forests. The Bamboo covers a major area of the forest, about 1.8 million hectare area is under Bamboo in the state of MP (MP forest statistics 2004) whereas India is second largest bamboo genetic resource after China. It has a great utility for the local masses, being recently declared as the Minor Forest Produce instead of the major forest produce and a revenue earner .Bamboo plays a vital role on all the life aspects of the poor society and their livelihood. The area considered for the study encompasses is the critical eco system in southern MP providing services such as food, water, fuel wood and other non timber forest produce as well as social, religious and cultural life of the native tribal community. Social function, nutrient cycle and water regulation are primary production are the major supporting services for the area. The rural landscape is highly susceptible to soil erosion, surface soil run off and seasonal floods resulting in intensive land use, social erosion, forest degradation and reduction of soil fertility in agriculture land. Studies revel for last decades around 20 % of land area has become un productive due to land degradation and soil erosion,65 % of the house holds in the villages have been affected , crop production has decreased by 25-30 % , average house hold income has reduced by 25 % and 40 % of the forest and grazing areas have been adversely affected. Simultaneously the human population and cattle have been increased by 15-20 % and 50% respectively which added to the stress of the landscape. Various efforts have under gone for the sustainable land eco system management, watershed management, joining rural community through participation, liberalizing the trade of minor forest produce , change in government policies, empowering the local masses but the institutional, economic, financial ,technological and knowledge barriers have imposed a major problem in the desired direction( Costanza Robert 1999,p 7). Looking to the critical landscape scenario there is a need for integrated approach for sustainable land management, main streaming of the use of biodiversity for livelihood, balancing the ecological need for poverty alleviation, strengthening the linkage between investing and institutional sector, capacity building and realization of community participation beneficial in long run (SAARC consultative workshop 2010).

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## A modified Landscape Aggregation Index

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There is often need to measure aggregation levels of spatial patterns within a landscape class in landscape ecological studies. The aggregation index (*AI*) has certain limits when measuring aggregation of spatial patterns, for instance, the exactly equal results could be calculated by

*AI* even when the shapes and amounts of landscape patches are difference in two landscapes, and the value of *AI* tend to 1 if the landscape patch is large. To solve the problem above, an error in the mathematical formulation of the original *AI* was corrected, the effects of the patches spatial distribution characters and changing spatial extent on *AI* measuring were considered, based on this, a modified aggregation index was developed. The aggregation indices (both original and modified) are then evaluated against Chengdu city's green land landscapes. The results show that the modified *AI* calculates aggregation more precisely than the original *AI*, and it can be compared between classes from different spatial extent landscapes.

**Keywords:** Landscape indices, Aggregation index (*AI*), Landscape ecology, Green patch, Spatial element

## **Fragmenting Landscapes and Biodiversity**

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“That habitat fragmentation causes a decrease in biodiversity” is not a controversial statement for most landscape ecologists. But of course the truism of this statement is dependent on scale (extent and scale), the characteristics of the target species, the landscape in question, and the nature of the fragmentation. Further, other processes such as climate change and land use may further impact on biodiversity. The patterns of the landscape heterogeneity in space and time is an important predictor of species distribution and abundance. However, the level and mix of heterogeneity across a landscape that maximizes a species occurrence is still not well understood. Such knowledge though is paramount to the management and conservation of species richness in natural ecosystems.

In this presentation we summarize some recent examples of our work in fragmented landscapes in China and Africa which demonstrate the impacts on flagship and keystone species of fragmentation patterns. We explore the state of fragmentation, and methods to measure it. The examples highlight systems that have relatively stable species occurrence (Wang et al 2010), as well as an example of a catastrophic reduction in a species once a threshold of fragmentation was reached and passed (Murwira and Skidmore 2005; Murwira et al. 2010).

The results are discussed to define required research on fragmentation, and finally, we explore when and how natural resource managers must respond to a fragmentation process. If current trends in landscape fragmentation continues, what will then happen to biodiversity, and how can climate change impact on these processes?

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## **Analysis of Soil Heavy Metal Pollution and Landscape Pattern in Nahavand, Iran**

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Increasing heavy metals concentration in soils is known as one of the major environmental problems because of its effects on human, crops and ecosystem health. The main goal of the present research was to mapping five soil heavy metals (As, Cd, Cu, Pb, Zn) and assessing the relationship between landscape metrics and soil heavy metals in Nahavand, Iran. Twenty eight soil samples from a total surface of 158112 ha were systematically collected from the top 0-20 cm of the soil in fall 2008 and the concentration of heavy metals were measured. IDW was applied for mapping the heavy metals concentration and mean of elements concentration was then calculated in hexagonal nets. For quantifying landscape pattern, various metrics such as number of patches, edge density, largest patch index, fractal dimension and Percent land were calculated in patch and landscape scale. Pearson correlation test and regression analysis were applied for assessing relationship between landscape indices and soil heavy metals concentration. The results of correlation analyses illustrated a significant relationship between a number of the landscape metrics and the heavy metals. Results of landscape analyses also revealed impacts of human activities on Arsenic concentration in the study area. Arsenic was mostly recognized in urban and industrial zones, but mountain and rangeland zones had lower concentration of As. Nevertheless, we found evidence that origin of Ca, Cu, Pb and Zn is mostly related to parent materials in the study area. The comparison of the soil heavy metal concentrations with the maximum value admitted by the universal standards revealed that concentration of As and Cu in the soils of the region is more than universal standards.

**Keywords:** Landscape Patterns, Heavy Metals, Soil, Hexagonal nets

# **Nested Assemblages of Butterfly Species in Urban Forest Fragments in Japan: the Importance of Life-history Traits and Matrix Environments**

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In nature ecosystems, species assemblages among isolated ecological communities frequently show a nested pattern. We examined how geographic factors and life-history traits related to this nested pattern of butterfly species on 20 fragmented forests in Japan.

Butterflies on each fragments were surveyed by transect counts. Fragment area, shape, connectivity and isolation (distance to the mainland) were used as geographic factors. Host plant type, host plant range, voltinism, and adaptability to the matrix (existence of host plants in matrix) were considered as species life-history traits. Species with host plants that were cultivated in the matrix were defined high adaptability species.

We found the butterfly assemblages to be significantly nested. The nested rank of fragments was correlated with fragment area, but not with other three parameters. The best model based on AICc included host plant type, host plant range, voltinism, and adaptability to the matrix.

Our findings indicate that selective local extinction may contribute to the nestedness of butterfly in Tokyo forest fragments. Understanding the factors that influence extinction vulnerability has important conservation implications because it allows us to predict why some butterfly species are more susceptible to extinction than others.

## **Ecological Restoration Strategies of Natural Landscapes Case Study: Lost Paradise, Fars, Iran**

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Survey and analytic- descriptive methods have been applied in the current research to present ecological restoration strategies in Lost Paradise protected area. So, at first, basic concepts and theoretical approach in the field of landscape restoration have been studied and analyzed. Then economic, social, environmental and cultural features of this bed have been investigated through presenting SWOT tables. In the next stage, structural elements (patches, corridors, flows and etc) of the landscape mosaic have been analyzed to recognize the present destruction of the bed. At last ecological restoration strategies of Lost Paradise protected area have been presented with emphasis on achieved results from analyzing its landscape mosaic.

The results of this paper emphasize on protecting the available waterways in the site out of the reach of tourists, covering ground surface with green bushes to prevent soil erosion, creating protective fences around the riverside trees, protecting weak plant which has been trampled by tourists, providing the optimum conditions for laying eggs of aquatics and birds and reviving extinct patches of Zagros oak forest.

**Keywords:** Natural landscape, Landscape restoration, Ecological approach

## **Large-scale Assessment of Potential Natural Vegetation in Hungary – A Baseline for Habitat Restoration**

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Human activities have altered the natural vegetation over large land surfaces, urging for human efforts towards the restoration of lost habitats. However, a thorough knowledge on the potential natural vegetation is crucial for successful ecological restoration, since only the knowledge of potential vegetation can give adequate guidelines on what habitats can reasonably be restored.

We created distribution models of potential natural vegetation based on data of actual natural vegetation from the MÉTA (Landscape Ecological Vegetation Mapping of Hungary) database, which contains among others presence/absence observations for each vegetation type of Hungary at the scale of 35 ha . Biologically relevant explanatory variables (including climate and soil conditions) were calculated for the whole extent of Hungary. Models were built using the gradient boosting algorithm (GBM), which tolerates existing correlation among predictors. Redundant variables in the models were eliminated by means of cross-validation to provide parsimonious models for individual habitats.

Models were visualised by applying them to the existing environmental conditions of the full country. Existing locations were masked from the probability models, thus remaining representation gives a full overview of the likely locations. Currently known old-fields were investigated for potential vegetation as a sustainable restoration target by overlapping an old-field database with the individual predictions. Actual potential locations were also compared to prehuman vegetation patterns.

Models of individual vegetation types were supported by expert knowledge, both regarding explanatory variables and the predicted distribution. The use of GBM models proved to be useful, since variants of environmental descriptors (such as precipitation sums of different seasons) finely discriminated related vegetation types. Potential maps revealed often large suitable areas for long-declined vegetation types within agricultural landscapes of the country, and the use of the old-field layer further specified sustainable target locations for restoration.

For example, forest steppe communities, which have been the victim of agricultural use could still be 5 times more widespread compared to the actual distribution and solely the appropriate and already abandoned fields provide about the same size of potential habitat for forest steppe as can be observed actually.

However, the potential and the prehuman distribution differed for certain vegetation types, especially in the agriculturally affected lowlands, thus current environmental conditions do not always support vegetation that have been present before human disturbance. Consequently, sustainable restoration should be based on potential vegetation modelling rather than trying to reconstruct past vegetation patterns.

## **Identification of Ecological Health Indicator to Select the Suitable Alternative for Urban Development in Iran**

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Rapid urbanization is among the most important causes of ecological degradation across different spatial scales ranging from global to regional and local. There is a recognition that protection of ecological health and integrity has a profound effect on human being and welfare. It is therefore essential for planners to incorporate ecological considerations into landscape and urban planning in order to realize wiser management of the future changes in harmony with sustainable development goals. In order to manage landscape change, planners must be aware of the characteristics that are likely to change. Landscape metrics can be employed as a tool to quantify landscape structure and pattern for landscape change detection and monitoring. This research introduces an approach to combine imperviousness indicator with landscape metrics to provide quantitative information on the spatiotemporal dynamics of Shiraz region. Landsat images are used to map the land cover of Shiraz region in 1990, 2000 and 2005. Using landscape metrics, spatial composition and configuration of impervious surface have been quantified. The metrics indicated increase in the size and connectivity of impervious surfaces. Results reveal that the growth of urbanization have had tremendous effects on the size and connectivity of natural landscapes particularly agricultural areas and wetlands. The results suggest that the measurement of imperviousness combined with landscape metrics can provide a useful tool for monitoring changes and supporting sound decision making for future development scenarios.

**Keywords:** Ecological Health, Imperviousness Indicator, Urbanization, Landscape Ecology, Remote Sensing, Spatial Metrics

## Strategy for Protection and Management of Historical Structures of Agricultural Landscape in Slovakia

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**Historical structures of agricultural landscape (HSAL)** represent a mosaic of small-scale arable fields and permanent agricultural cultivations (grasslands, vineyards, high-trunk orchards) and are significant as the unique islands of species-rich plant and animal communities, originated by continuous succession over centuries. The objective of the study was to elaborate strategy for *protection and management* of HSAL in accordance with sustainable development. The interdisciplinary research of biodiversity and ecological conditions was performed in 3 pilot territories, representing main HSAL type on the territory of Slovakia. This contribution is oriented on mountain grassland-arable landscape – Liptovská Teplička cadastre. The research in the pilot areas consisted of analyses of biotic, abiotic conditions, land use, socio-economic conditions, demographic and sociological conditions on cadastral level, synthesis and evaluations of biodiversity.

Based on vegetation and zoological survey and its ecological conditions biodiversity was evaluated. The assessment was oriented to evaluation of species richness and vulnerability of species and identification of driving forces, and threats to the biodiversity of HSAL.

The main threats of HSAL were determined on the basis of the comparison of conflicts between the present state of the ecosystems and the main potential and real drivers. The trends are dependent on the realization or non-realization of threats. They are the responses of the landscape to the pressure of human activities. Three main scenarios of the agricultural landscape have been developed for study areas:

- disintegration trend of HSAL (gradual extinction of mosaic) when the threats will be transformed in real activities – pressures on the traditional agricultural landscape connected with economical development
- maintenance of traditional management of HSAL (optimal land-use) when the threats are minimized
- abandonment of agricultural linked with depopulation of rural landscape.

*The Strategy for protection and management* of HSAL is oriented to optimal multifunctional utilization and management of investigated landscapes in relation to sustainable development of traditional agricultural landscape and maintaining the biodiversity of landscape, by application of agro-environmental scheme, maintenance of traditional management of HSAL as well as development of tourism. The proposal of ecological management brings about not only protection of valuable habitats, but it should have positive impact on healthiness of local inhabitants as well as visitors by reduction of stress phenomena (pollution of water, air, soil etc.) and by the production of healthy bio-products.

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# The Influence of Green Space Characteristics towards the Feelings of Fear in Urban Parks of Malaysia

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Often the failures in the design of a park can be attributed to the lack of understanding about human spatial behaviour amongst the designers involved. This is even worse when the design is to catering for the needs of people with different cultural backgrounds. Extensive studies on the relationship between vegetation and human responses such as fear and crime (Schroeder & Anderson, 1984; Talbot & Kaplan, 1984; Shaffer & Anderson, 1985) have been conducted and well documented in Western European and North Americans environments. However to our knowledge no studies have been conducted in South East Asia concerning people's emotional responses in terms of encounters with vegetation that evoke fear. In Malaysia, for example, most studies on urban parks have been looking at landscape preferences and park usage (Suhardi, 2002; Mustafa Kamal, 2000; Wan Sabri et al., 1983). In urban parks, the role of plants depends on their spatial configuration in landscape planting and the wish to accommodate the users' needs. Such needs relate not only to visual aesthetics but also to ensuring social safety. Regarding the latter, not all plants or vegetation arrangements attract people or evoke positive feelings. Previous studies have indicated that residents generally feel most vulnerable and unsafe in outdoor urban settings with dense vegetation (Buhyoff et al., 1978; Shaffer & Anderson, 1985). Within the context, the presented research investigates the relation between plants and types of vegetation and feelings fear among urban park users in Malaysia. A review of international literature on the topic of vegetation and fear will be presented as well as a frame for analysing these aspects, with focus on the case of Malaysia.

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## **Landscape Specific Maximum Extend of GM Cropping as a Function of Coexistence Rules**

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Coexistence of farms with and without GM crops is often regulated by minimum distances of GMO fields to non-GMO fields, and to potentially susceptible habitats. We analyzed some agricultural regions in Germany with different landscape structure (size distribution of arable fields and distribution patterns of nature conservation sites). We analyzed maize cropping scenarios with different proportions of GM maize and different minimum distances to nature conservation sites in order to relate the effect of coexistence rules to important landscape characteristics.

## **Adaptation of Landscapes to Climate Change**

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The Netherlands can be characterised as a metropolitan delta, densely populated area with a history of top-down planning and co-operation between governmental organisations. In the 1980's a national ecological network (NEN) was planned and its realisation depended on the voluntary cooperation of land owners. Nowadays, the planning culture is shifting from national to regional or local governments and stakeholders' preferences play an increasing important role in landscape planning. In the future, changes are expected in land use pattern as a result of socio-economic developments and climate change. Biodiversity and other land use functions require larger areas for adaptation to climate change, which increases competition for available space and requires a different type of land use planning and more efficient management of resources.

Today, the NEN is partly realised and public support for the realisation of a mono-sectoral nature network has diminished over the last 10 years, resulting in a slower realisation rate. Due to shifting climate zones and more frequent weather events, combined with the small and highly fragmented nature areas, climate change will only increase spatial requirements. To adapt the NEN to climate change, so-called 'climate adaptation zones' or CAZ are proposed (NEAA, 2008). This is a national zone of multifunctional land use which is permeable for species, contains a number of key populations, and is connected to habitat networks in neighbouring countries. In international perspective, especially the CAZ for wetland areas is important for sustaining biodiversity, as the Netherlands have an important portion of and responsibility for wetland habitat and species in Europe. For an ecologically functioning CAZ, it is important to plan on a (inter)national scale, but it is equally vital for its realisation that regional implementation is in harmony with the requirements of other land use functions. Thus involvement of stakeholders is crucial.

We explored 2 ways to plan a Wetland CAZ: 1) Top down: different national policy strategies on biodiversity with a spatial allocation model which takes into account socio-economic developments, climate change and competition between land use functions (Loonen and Koomen, 2009); and 2) Bottom up: planning adaptation strategies for biodiversity with local and regional stakeholders, preferably in synergy with requirements for other land use functions. The model showed competition between agriculture and nature, and that without a planned CAZ land use configuration will not be sufficient for adaptation of biodiversity. The bottom-up approach showed different ways to realise the CAZ by locating areas for synergy, it increased the involvement of stakeholders for the CAZ and multifunctional land use CAZ (Steingröver and Van Rooij, 2010). The different approaches give insight into possibilities and pit falls for the realisation of the CAZ.

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## **The Bionic City: A Model for the Resilient Metropolis of the Future**

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Over millennia floods, earthquakes and fire have brought hell and high water to cities, leaving death and destruction in their wake. Until now, no civilization has been spared from the worst-case scenarios unleashed by extreme meteorological and geological events. However, the legacy of fear surrounding many of our planet's essential operating mechanisms, such as tectonic plate movements, need not continue forever and today's disasters could be turned into tomorrow's opportunities.

The cities of the past and present were built on the assumption that we live in a steady state world, however Earth is anything but. We live on the surface of a series of ever-moving plates, upon a ball of molten rock spinning through space at approximately 1038 miles per hour. Several thousand years of relatively low seismic activity, against the backdrop of a generally stable and temperate climate in most parts of the world, have led us to forget the shifting nature of our planet.

The planet's natural ecosystems are remarkably resilient to extreme meteorological and geological events. Having started to research why, I conclude that there are several distinct universal principles that enable these systems to sustain their core infrastructures over expansive periods of time. These principles are completely at odds with the built environment

design paradigm that determines current city construction. In contrast to human architectural design, nature builds flexible interconnected smart infrastructures with the ability to anticipate and prepare for significant environmental changes. Where such changes occur with relative frequency (i.e. annually), nature builds the changes into lifecycles – for example ecosystems located within deltas and wetlands are designed to accommodate annual flooding events.

Mankind has become the master of off-the-peg built environment design solutions. In contrast, nature is a master tailor, creating made-to-measure bespoke solutions within each and every ecosystem, which is the primary reason our planet is graced with such an abundance of biodiversity. While nature works with common principles and we see similarities between ecosystems, upon close inspection we find no two ecosystems are exactly alike; each has its own unique collection of species, each of which is subtly tweaked in size or colour or behavior to suit its specific locale. For example, forests located in regions that experience strong winds in winter are primarily comprised of deciduous trees, which thanks to their reduced surface area are less likely to be blown over by seasonal gales.

The Bionic City embraces nature's adaptive approach to building complex infrastructures. Whereas the conventional city is a mass of static, disconnected and inert structures operating independently and irrespective of one another and their environment, The Bionic City operates as an interconnected and intelligent ecosystem in which every entity is engaged in an ongoing symbiotic relationship with all others, from the molecular to the metropolitan in scale. The model embeds seasonality into its structures, whereby its various parts change form, colour, texture and functionality throughout the year, as befits the seasons. Knowledge transfer from natural to man-made ecosystems is explored as a platform to enable resilience to a range of meteorological and geological events including flooding, hurricanes, firestorms and earthquakes.

## **Landscape Design with Indigenous Vegetation in New Zealand - A Review**

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Since colonisation over 150 years ago, exotic plant species have dominated landscape design in New Zealand. It has only been in the last several decades that an increased awareness and appreciation of indigenous species has resulted in their incorporation into landscape design. They are now much more widely used in commercial and residential areas, in street tree plantings and restoration projects. One significant recent use has been in residential developments incorporating aspects of Low Impact Urban Design and Development, LIUDD (Ignatieva et al. 2008). In these situations, primarily indigenous tree and shrub species have been used in swales, detention ponds and wetlands to aid in storm-water retention. But there is a perception that even though more indigenous species are being incorporated into urban design, the range of species being used is very limited.

In this presentation I analyse the suite of indigenous species being used by landscape practitioners in commercial and residential design, by residential property owners (e.g., Stewart et al. 2009), by city authorities in urban street tree planting, and by government and non-government agencies involved in indigenous restoration projects. By consulting nursery

catalogues potential lists of indigenous species will be constructed to analyse the potential suite of indigenous species (by life form) for a variety of urban habitats. Comparisons with current use will be explored and also the inherent values in using indigenous species for valuable ecosystem services (cf. Stewart 2010).

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## Vision and Possibilities in Ecosystem Services of a Cultural Landscape

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Cultural landscape was uniquely rooted in landscape architecture and resource management. With increasing anthropogenic influences in the biosphere, the nature we used to know is now gradually being encroached by human activities, and its capacity of providing ecosystem services was infringed. In this study, we took the Yanhe Watershed of northern China as studying area to evaluate ecosystem services and probe their socioeconomic driving mechanisms. Net primary production (NPP), carbon sequestration & oxygen production (CSOP), water conservation, soil conservation, and grain production were selected. A quantitative composite human activity index (HAI) was formulated by integration of human population density, farmland ratio, and influence of road networks and residential areas.

Spatially, NPP, CSOP, and water conservation in both 2000 and 2008 roughly decreased from south to north, while soil conservation decreased from southwest to north in 2000 and decreased from west to east in 2008. Grain production decreased from center to the peripheral area in 2000 and 2008. Temporally, NPP, CSOP, water conservation, and soil conservation increased from 2000 to 2008, while grain production decreased. Increments of NPP/CSOP show gradient southeast-high northwest-low spatial patterns, while increment of soil conservation showed a decreasing pattern from northwest to southeast. Increment of water conservation shows an increasing pattern from the northeast to the northwest, southwest, and southeast. Grain productions were more decreased in the central belt than the south and north fringe area. HAI of both 2000 and 2008 were proportional to the administrative level and economic development. It decreased from 2000 to 2008 with the northeast decreased more

than the other parts of the area. Tradeoffs were detected between regulating ecosystem service and provisioning service. Synergy existed within certain regulating ecosystem services, i.e., soil conservation and water conservation. The negative correlation between variations of water conservation / soil conservation and that of HAI implied the lowering of human disturbance played the leading role in soil and water conservation enhancement.

Through landscape metrics analysis, we found a fragmentation, simplification, connectedness tendency of the whole Yanhe Watershed around the GfG period. Landscape metrics variations of different land use type were: cropland decreased and fragmented; woodland remained nearly stable, grassland expanded with an anti-fragmentation tendency, while rural settlement has a aggregating tendency. We qualitatively analyzed the underlying driving factors of policy, economic development, rural settlement upgrading, and labor force transfer, in which GfG (Grain for Green) policy played the leading role.

Special thanks to Assistant professor Zeng Yuan from Institute of Remote Sensing Application, CAS, who provided the interpolated satellite images and helped calculated the NPP.

## **Study on Landscape Pattern Changes and Dynamic Forecast in Jinzhou and Huludao Coastal Area**

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Selection of typical areas is the key of landscape pattern changes study. This paper selected Jinzhou and Huludao coastal area as the study area. Jinzhou and Huludao coastal area is both a city-hot area and an ecological fragile area, so it's representative. This paper based on 3S technology, used transition matrix, land-use measure formulae and landscape pattern analysis to analyze the landscape changes in Jinzhou and Huludao coastal area during 1990-2010. The results showed that: Major landscape changes occurred between the farmland, forest, water and construction land. In the conversion of landscape types, construction land played a more important role. Land use degree gradually increased, which reflecting changes in the landscape was characterized by the continued expansion of construction land and the constant drain of farmland, forest, water. The number of landscape patches was on the rise, the average size of landscape patches became smaller except construction land, and the landscape became more and more fragile. This paper also used spatial model to simulate landscape changes during 2011-2020, and got the conclusions that: Along with the development of the regional economy, construction land will expand constantly, and the extent of landscape fragmentation will aggravate further. Thus, how to protect landscape resources and ecological environment effectively as well as develop economy in Jinzhou and Huludao coastal area will become the core problem to be solved.

**Keywords:** Coastal area, Landscape pattern changes, Transition matrix, spatial model

# The Appropriate Scales to Study Bird and Butterfly Biodiversity in Taiwan Rural Areas

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How does biological conservation work effectively at the appropriate scale? In order to discuss the scale issue in the fragmented landscape and focus on rural areas which has very high biodiversity (Chapman and Reich, 2007), this study conducts an empirical research to establish the appropriate research scale for birds and butterflies, and help define the effect of landscape structure accurately. See Figure 1.

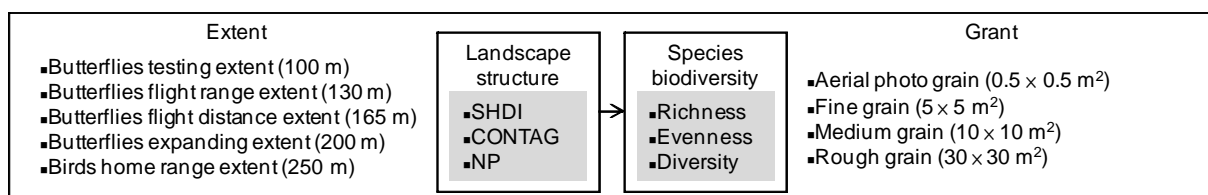


Figure 1. The explanatory power of landscape structure on species biodiversity is examined at spatial scales with different extents and grain sizes.

This study conducts a regression analysis to indicate the statistically significant relation between landscape structure and species biodiversity. When the regression is significant on a specific spatial scale, it is seen as an effective scale. In order to quantify landscape structure and species biodiversity, both of them are indicated by quantitative indices.

In order to explore the relationship between landscape structure and biodiversity, previous studies apply landscape structure metrics such as patch richness (Pino et al., 2000), mean patch area (Baguette et al., 2003) and patch connection (Sutcliffe et al., 2003) at landscape level. It uses number of patches, mean patch area, patch richness (Shannon diversity index, SHDI), and patch proximity (contagion, CONTAG) on landscape level, which are recommended to describe the landscape features with a comprehensive overview. Besides, it calculates three indices, including species richness (SR), species capita (SC) and Shannon-Wiener ( $H'$ ), to perform the biodiversity.

This study is expected to filter the spatial scales which are effective to discuss the correlation between landscape structure and biodiversity. Furthermore, there will be an appropriate scale with highest significance providing the scientific basis for ecological investigation, analysis, and planning.

## Compatibility between Biodiversity Conservation and Human Activities – An Evaluation Based on the Forest Ecosystem Services in Japan

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Biodiversity provides various kinds of ecosystem services, while a large area of forests are reserved for its conservation. The Japanese forest reserves in general set aside small core areas for limited indirect uses and allow forest resources utilized in large areas of buffer zones. As a case study in Fukushima and Ibaragi Prefecture of Japan, we used some indicators to evaluate ecosystem services that biodiversity provides and analyzed the effects of human activities on the species diversity and ecosystem services.

A forest reserve in Fukushima Prefecture is known to have rich biodiversity. There we used such indicators as the amount of wild plant species collected by local people and frequency of forest use. We found that local people visited forests frequently and collected a large amount of plants. Yet, negative impacts of their collection were not identified from the observation frequency of any species. Forest cutovers appeared to provide favorable habitats for some species, while a great variety of edible mushroom was found in old secondary broad-leaved forests. Another study in Ibaragi Prefecture suggested that a landscape with fragmented forests was heavily used for recreation, where avian species diversity was high.

We found that a forested landscape with a variety of seral stages had high species diversity of bees and wasps, cutovers having the highest diversity. Bees were the most abundant flower visiting insects in common buckwheat fields Ibaragi Prefecture. There were significant correlations between the abundance of flower visiting insects and the areas of forest and natural grassland around farmlands and between these areas and the pollination success. That is, the insects appeared to make a great contribution, when a farmland was located next to a large area of forests and natural grasslands.

These findings suggest that a landscape modified by human activities can provide a high level of species diversity and ecosystem services. Landscapes with a variety of seral stages seemed to provide greater pollinating services than those without cutover areas. Besides, fragmented forests with high species diversity provided a large amount of recreational services.

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# Modeling the Impacts of Climate Change on Water Supply Stress and other Ecosystem Functions in the Conterminous United States

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This paper presents a water-centric monthly scale simulation model (WaSSI-C) that was developed by integrating empirical water and carbon flux measurements from the FLUXNET network and an existing water supply and demand accounting model. The WaSSI-C model was evaluated with basin-scale evapotranspiration (ET), gross ecosystem productivity (GEP), and net ecosystem exchange (NEE) estimates by multiple independent methods across 2103 8-digit Hydrologic Unit Code watersheds in the conterminous United States from 2001-2006. Among the 18 U.S. water resource regions, the southeast ranked the highest in terms of its water yield and carbon sequestration capacity. We show that future climate change, especially under dry scenarios, and population growth would likely to cause an increase in water supply stress and reduction of ecosystem productivity even in traditionally 'water-rich' regions. Under all four projected climate change scenarios examined, water stresses are projected to be the greatest during the peak growing season when both ecosystem and human water demands are the highest. Our water-centric model offers a new tool for examining the tradeoffs between regional water and carbon resources under a changing environment.

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## Evapotranspiration: the Critical Landscape Ecosystem Process

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Evapotranspiration (ET) is a critical process that links the energy, water, carbon, and other biogeochemical cycles, and thus it is a very important variable in understanding the ecosystem functions at multiple spatial and temporal scales. Climatic and landuse/landcover changes directly affect ecosystem structure and functioning by altering the ET process. Understanding the ET processes received renewed interest not only from climatologists, meteorologists, agricultural engineers, and hydrologists, but also landscape ecologists who

study the interactions between climate and ecosystem processes, functions, and services. Quantifying ET and its components remains challenging due to the complex environmental controls on ET fluxes. Since the invention of the Penman-Monteith Equation more than half a century ago, much progress has been made in quantifying ET. Most notably are the development of the eddy flux networks and advances of remote sensing technology. This paper provides a synthesis of existing methods and results in quantifying ET at multiple scales, and presents examples developed at individual sites within the United States-Carbon Consortium (USCCC) and elsewhere. The paper presents a modeling approach to developing a generalized monthly scale ET model (Sun et al., 2011) and results of model applications to map key ecosystem processes (GEP, NEE) the conterminous U.S. (Sun et al., 2011). This study found that monthly leaf area index, precipitation, and potential ET together explained about 85% of the variability of actual monthly ET. Model validations suggest the water-centric ecosystem model (WaSSI-C) that ecosystem carbon fluxes are tightly coupled with water fluxes, thus climate change likely affect both water and carbon cycles, and climate change mitigation and adaptation strategies much consider the tradeoffs among all ecosystem functions (i.e., water supply and carbon sequestration) at the landscape to regional scale.

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## **Effects of Gap Thinning on the Regeneration of Native Tree Species and Forest Restoration in *Cryptomeria japonica* Plantation Forest in Central Taiwan**

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Forest management around the world is facing the dilemma between biodiversity conservation and timber production, and Taiwan is no exception. Currently, Taiwan has more than 420,000 ha of plantation forests. In order to provide science-based knowledge to improve forest management policy, we carried out a multidisciplinary research project that investigated the effects of gap thinning in plantation forests on biodiversity, natural forest regeneration, timber production, and ecosystem functions since 2005. We established 12 one-hectare plots in *Cryptomeria japonica* plantation forest in central Taiwan in 2005 in which all trees  $\geq 1$  cm is permanently tagged, mapped and identified. These plots were used as the basic unit in

which all associated projects were carried out. This talk focused on the effect of gap thinning on the regeneration processes of native tree species, especially to understand whether dispersal limitation and recruitment limitation were differed under different thinning practice.

To monitor seed and seedling dynamics, we established 108 seed traps and 324 seedling plots in the 12 one-ha plot and monitored their fates since 2006. These 12 plots received 0%, 25% and 50% thinning treatment in 2007 and we have completed 102 seed trap census and eight seedling survey until May 2011. A total of 25 species and more than 11,760 seeds were collected from seed trap census. We also recorded 42 species and over 3,000 seedlings in seedling census. According to preliminary data analysis, there is no difference in seed arrival between control and thinning plots in species richness and abundance. However, species composition was very different between thinning treatments. Our results also indicated that seeds from gap dependent species increased after thinning, and seedling richness was much higher in thinning plots, which was resulted from the increase of gap dependent species.

Our results indicated there were strong dispersal limitation as well as recruitment limitation for most species. However, gap dependent species suffered higher recruitment limitation than dispersal limitation. On the contrary, shade tolerant species showed stronger dispersal limitation than recruitment limitation. However, due to limited sample for most species, longer term study is needed before we can reach conclusive conclusion.

## **Dynamic Changes and Ecological Effects of Wetland Landscape in Tumen River Area in Last 50 Years**

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Wetland, which is the special natural integration of wet creatures. It is an important natural resource and is one of the most important environments for human survival as well. However, Reclaiming lands from lakes and exploring a large-scale agricultural development in wetlands make wetland landscapes tremendous change and cause serious environmental problems as well. More and more research covers on the relationship between human activities and changes of landscape patterns of wetlands. The research on changes of wetland landscapes in Tumen River Area is still in initial stage.

With the technical support of geographic information systems, remote sensing, the 1:50,000 topographic maps, Corona image, MSS/TM image and Alos image, this paper has collected the information of Wetlands in Tumen River Area by using remote sensing image software process. It analyzes the distribution, the growth principle, landscape pattern and the changes of the wetlands in last 50 years with the concept of landscape ecology, a dynamic degree, transfer matrix and the landscape pattern index. It tries to help up master the wetland types

and the spatial distribution of the wetlands in this region in time. It also explains the dynamic changing process and rules of the wetlands, reveals what causes the changes of the wetlands. Studying the changes and relationship between these changes and the natural surrounding environment as well as the socio-economic development can help enhance the protection of wetland resources and management. The result shows the following features:

1) The man-made wetlands including paddy fields, reservoirs and etc. increase significantly according to its way of changing; yet the natural wetlands including swamps, lakes and rivers are decreased constantly. 2) According to the changing characteristics of wetland types, a large of natural wetlands are changed into man-made wetlands and non-wetlands, and a large of non-wetlands are changed into paddy fields. 3) According to the change of wetland landscape pattern, the numbers of landscape patches, landscape fragmentation index and landscape evenness index increase, but the average patch areas, landscape diversity index are decreased. 4) Human factors are the main driving forces of causing the reduction of natural wetlands in this area, among which agricultural activities is the most important impact. 5). The wetlands ecological function retrogression, edge effect significant, decline in biodiversity, soil nutrients reduces, as a result of natural wetlands were greatly broken.

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## **Quantifying the Cool Island Intensity of Urban water body in Beijing, China**

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With increasing world population and urbanization, the need for reducing urban heat island (UHI) effect and their related health consequences is becoming more critical. The cooling effects of water bodies, which form “urban cool islands” (UCIs), are important for mitigating UHI effects. However, it is still unclear and unquantified how water body characteristics and surrounding landscapes can affect the cooling effects of water bodies at a regional scale. This study intends to quantify the cooling effects of water bodies inside the sixth ring-road of Beijing, and relate them to four important indicators of microclimatic landscape design, including water-body’s area, configuration, location, and surrounding built-up proportion. The information on land cover and land surface temperature (LST) are extracted from the ASTER images in summer of 2007. The UCI intensity of a water body is defined as the maximum LST gradient, which is calculated by the temperature difference and buffer distance outside the water body. The results indicate that: (1) the maximum cooling effects are mostly inside 100-m buffer outside the water bodies, and the UCI intensity of 197 water bodies ranges from 0.28 to 22.02 °C/km, with an average of 5.4 °C/km. (2) The UCI scale is mainly determined by the configuration of water bodies, while the UCI intensity is positively correlated with water-body’s area and intensified built-up areas, and negatively correlated with water-body’s

configuration and location. (3) A linear regression model developed with four indicators could account for 60.7% of the variations in the UCI intensity. The relative contribution of the water-body's area, configuration, surrounding built-up proportion, and location to the variations in UCI intensity is 34.1%, 30.16%, 21.07%, and 14.67%, respectively. This study may provide some implications for urban planners and designers to design climate-sensitive landscapes in mitigating urban thermal environment.

**Acknowledgements:** The work was financed by the Natural Science Foundation of China (40925003) and the Innovation Project of State Key Laboratory of Urban and Regional Ecology of China (SKLURE2008-1-02).

## **Comprehensive Evaluation Model and Driving Forces of Land Use along Reclamation Time Based on the PCA and CLUE-S Model at the Yangtze Estuary**

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Based on the TM image data of 1990, 2000 and 2009, Fengxian reclamation zone at the Yangtze Estuary was select for the study of land use dynamics along temporal series, with combined methods of “spatial sere substituting for time sere”, Principle Component Analysis, RDA and CLUE-S model, while two reclamation zones from Nanhui were used for verification. The results indicated: (1) The comprehensive evaluation index (F) based on PCA was positively related to farmlands (Paddy field>Greenhouse land>dry land>forest land>orchards), and negatively related to coastal land cover types (breeding ponds>grass land>open water>bare flat). (2) The F-value increased with time logarithmically ( $R^2: 0.5119$ ), and reached stable around 40 years after reclamation. Regression analysis showed that F-value can reflect the trends for both land use levels (L) and diversity index (GM). (3) The contribution from human induced factors (57.10%) is higher than that from natural factors (42.9%) to the landscape dynamics in the reclamation area. (4) The prediction accuracy from CLUE-S model reached 82%, While the kappa index for major landscape types such as farmland, unused land and breeding ponds were all higher than 0.75. Therefore the CLUE-S model could be used for future scenarios simulation, and the driving factors selected for this study were also effective in depicting the spatial distribution of landscape transformation. Future development scenarios of the study area were simulated for the next 10 years (2010-2020), which can provide scientific support for decision making in the newly reclaimed area.

**Keywords:** Changjiang River Estuary, Landscape dynamics Comprehensive Evaluation Model, Driving force, CLUE-S model

# Future Land Use Change and Its Effect on Carbon Biomass Distribution in China

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Land use changes (LUC) have great effects on the amount of biomass and carbon stored in vegetations (Tappeiner et al. 2008; Olofsson et al. 2010), and has raised considerable interest among researchers and policy makers. We assessed how land use change under government control can influence future carbon stock distribution change in vegetation in China.

The impact of LUC on carbon storage in China not only depend on the overall changes in areas of different land use types planned at national level but also on the change in spatial configuration of the area of each land use type. The reason is that different provinces have different biomass density for each land use type because of the disparity in climatic conditions and geographical position and plant function groups. Therefore high resolution assessments of future land use change are required to provide insight into the impacts on landscapes and other environmental indicators.

We used the Dyna-CLUE model (Verburg et al., 2009) to spatially allocate the national scale land use requirements to a 2-km<sup>2</sup> resolution. Seven land use types are distinguished which are built-up, arable land, grassland, shrub land, forest land, water area and unused land. Changes between land use types are simulated based on local habitat conditions, including climate and economic conditions, accessibility, soil texture, topography and demography.

The bookkeeping model (Houghton, 2003) is used to calculate the carbon biomass distribution. Empirical datasets on carbon biomass density of grassland, shrub, forest, arable land are available for each province of China. The carbon biomass stock of forest vary with age, therefore forest age is taken into account. For the forest age, data from forest inventory data are used.

Two scenarios are evaluated: business as usual scenario and planned by government scenario. In the planned scenario, higher carbon stock is expected. Notable differences are found in the spatial distribution of carbon stock between the two scenarios.

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## **The Effect of Land Reclamation Time and Land Use Types on Soil Properties in the Yangtze Estuary, China**

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Based on the survey data taken from 216 soil sampling points in the Fengxian Reclamation Area in April 2009 and TM data in 2006, while with multivariate analysis of variance (MANOVA), geo-statistical analysis (GA), principal component analysis (PCA) and canonical correspondence analysis (CCA), the study analyzed soil physical and chemical properties, soil comprehensive function differentiation and controlling factors in different reclamation zones. The results showed that:

(i) With the increase of reclamation years, soil moisture, soil salinity, soil electric conductivity and soil particle size tended to decline, yet soil organic matter tended to increase; soil available phosphorous tended to increase in the early reclamation period, yet it tended to decline after about 100 years of reclamation; soil nitrate nitrogen, soil ammonia nitrogen and pH changed slightly among different reclamation years; soil physical and chemical properties reached a steady state after about 30 years of reclamation.

(ii) According to PCA analysis, the weighted value (0.97 in total) that represents soil nutrient factors (soil nitrate nitrogen, soil organic matter, soil available phosphorous, soil ammonia nitrogen, -pH and -soil particle size) were higher than the weighted value (0.48 in total) of soil limitation factors (soil salinity, soil electric conductivity and soil moisture); and the higher the F-value is, the better the soil quality is.

(iii) Different land use types play different roles in the soil functions maturity process, with farmlands providing the best contribution.

(iv) CCA analysis indicated that soil physical and chemical properties in the reclamation area were mainly influenced by reclamation time, and then by land use types. The correlation (0.1905) of the composite index of soil function F with reclamation time was greater than that with land use types (-0.1161).

**Keywords:** Soil properties, Land use types, Reclamation time, Principal component analysis (PCA), Geo-statistical analysis (GA), Canonical correspondence analysis (CCA), the Yangtze Estuary

## **Is REDD+ A New Hope for Conservation? Lessons Learned from Integrated Conservation and Development Projects**

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Integrated conservation and development projects (ICDPs) have been a pervasive, although widely criticized, approach to landscape-scale tropical conservation for more than 20 years. More recently, international biodiversity conservation discourse has shifted away from project-based approaches and towards reducing emissions from deforestation and forest degradation (REDD+). While REDD+ is based upon experience with payment for environmental services (PES) initiatives and forest-related discussions in the United Nations (UN), REDD+ implementation will still require sub-national projects. Issues of equity will likely pit these sub-national projects against some of the same challenges that have dogged ICDPs. This suggests that REDD+ project developers stand to learn a great deal from the lessons generated by experience with ICDPs. This paper provides a list of best practices for ICDPs and applies their lessons as principles to guide the development and implementation of sub-national REDD+ projects. The intent of this approach is to encourage the design and implementation of sub-national REDD+ projects in a way that avoids the past pitfalls and mistakes, while building upon some successes, of the ICDP conservation approach. In addition, adherence to clear social and biological safeguards should avoid human rights issues or leakage to high biodiversity areas. In learning from experiences of the past, REDD+ will be more likely to be implemented in a way that is effective, efficient and equitable.

## **Application of Landscape ecology in Harmonization and Conservation of Urban Orchards and Agricultural lands in Tehran Metropolitan Area**

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Although urban orchards and agricultural lands are considered to play qualitative urban environmental key roles, the legal ownership of mentioned land uses and their roles in urban land economy on the other hand, the planning and programming perceptions on conservation of these zones covering such land uses seems elaborative and challengeable. Initially the correct comprehension of demand procedure for conservation or destruction of such land uses would be considered as the milestone of project. Literature review show the basically framework of such project mostly come from ecological studies but the final applicable framework issued base on urban design and planning concepts.

This project is being delivered as the complementary of Tehran Master plan in order to present the action plans for active conservation of orchards and agricultural lands remained in the pattern of Tehran metropolitan. The studies are being based upon the landscape ecology and socio-economic factors and driving forces analyzed in a complete process in order to be reconsidered pathologically on urban land use structure. Finalized output is delivered in a spatial report which present actual ecological condition of Tehran in nine homogenous zones. Delivering policies and action plans in final zones is covering conservation plans and



strategies for orchards and agricultural lands.

**Keywords:** Landscape ecology, Urban orchard, Urban agricultural land, Conservation

## **Spatiotemporal Analysis of the Expansion of Bamboo Groves in the Satoyama Landscape in Japan**

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Bamboo is an important plant in Japanese culture (Suzuki and Nakaogoshi 2011). Recently, bamboo groves consisting mainly of *Phyllostachys pubescens* Mazel ex Houzeau de Lehaie, which was imported from China in the 17<sup>th</sup> Century, have been expanding in Japanese satoyama landscapes. This expansion was triggered by a change in the artificial conditions of satoyama. This study clarified the change in the distribution of bamboo groves on Mt. Hachiman, Ohmi-Hachiman, Shiga Prefecture, Japan, between 1947 and 2006 and the factors that accelerated bamboo grove expansion using a generalized linear model.

Vegetation and land-use maps for 1947, 1967, 1985, and 2006 were made from aerial photographs. The change in the total area of bamboo groves (BA) was determined. Using GIS software, the vegetation and land-use maps were converted into raster format maps with a 10 × 10-m cell size. For the cells that changed to BA from other categories during each time interval, the study evaluated the vegetation and land use, spatial factors and topographic factors using a generalized linear model. Similarly, for cells consisting of BA, deciduous broad-leaved forest (DB), cedar and cypress plantations (CP), pine forests (PI), bushes and grasslands (BG), paddy fields (PF), and dry fields (DF) in 2006, the study evaluated the vegetation and land use, spatial factors, topographic factors, and artificial factors related to settlements using a generalized linear model.

BA expanded after the 1960s in abandoned forests and fields, indicating that as forests and agricultural land were abandoned, bamboo, mainly *P. pubescens*, invaded these areas. Topographic factors were seldom related to the expansion of BA. Only the abandonment of lands adjacent to BA caused bamboo grove expansion. Native vegetation in secondary succession trajectories (*e.g.*, DB, PI, and BG) occurred at sites removed from BA. Thus, the expansion of BA is an index phenomenon for satoyama landscape abandonment. Bamboo groves have been expanding in all part of Japanese satoyama landscapes. The relationship between human and nature have broken in satoyama. For the future, we need to develop new relationship between nature and human applying perception about landscape planning.

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# **Empowering Landscape Ecology-Connecting Science to Governance through Design.**

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Landscape ecology has successfully shown the power of the landscape scale as an analytical framework for sustainability science (Wu 2006). The current challenge is to better connect science to policy (Wu and Hobbs 2002). There is growing recognition of the combined potential of design and science working together as a way to generate and test concepts of landscape sustainability at a regional scale (Nassauer and Opdam 2008), and place based and solution driven translational practices have been proposed at a more local scale (Mussachio 2009). However, to fully engage landscape ecology with public policy and action it is necessary to connect the generality of science and the situated practice of design with the responsible exercise of power through various forms of governance. Collaborative planning (Healey 1998) and networked governance (Moore and Hartley 2008) are interrelated approaches increasing used to complement more traditional technocratic forms of public policy and planning, and landscape ecological science and related design practices must connect with these new modes of action. Concepts, opportunities, and challenges are illustrated through a practical example of urban storm water management, based upon recent experience in Christchurch, New Zealand, where local government reforms (Pallot 1997, Thomas and Memon 2007) have enabled an innovative combination of sustainability science, creative design practices, and community engagement to implement an asset management programme involving waterways naturalisation incorporating multiple values (Watts and Greenaway 1999).

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## **Discursive Relationships between Landscape Science, Policy and Practice: Concepts, Issues and Examples**

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Landscape ecology seeks practical and policy relevance (Wu and Hobbs 2002). Proposed conceptual models include ‘transdisciplinary’ landscape studies (Tress et al 2003); ‘design in science’ (Nassauer and Opdam 2008); and ‘translational’ landscape research and practice (Mussachio 2009). A common feature is the central role of landscape scientists as both experts and advocates in solving ‘place based problems’ in a rational way. In practice however landscape ecologists have seldom had the impact they seek (Stevens et al 2007). Main stream practices used to connect scientific knowledge with practical planning action in a democratic society have been extensively critiqued (Flyvberg 1998), and an alternative ‘deliberative’ planning paradigm proposed. Collaborative planning (Healey 1998) places emphasis upon processes of argumentation, value rationality and dialogue, rather than upon instrumental ends-means rationality, and Healey argues for a combination of conflict management and place making as a way forward. This paper uses examples to critically examine the science-practice discourses in landscape ecology associated with planning and policy making. We argue that landscape scientists must be critically aware of their different possible roles as technical advisers, professional practitioners, and policy advocates (Duff et al 2009), and of the way that different roles and interests interact discursively at different stages in place based studies involving multiple values and interests.

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## **Scenario Development for Bioenergy Landscapes Based on the Landscape Services Approach**

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The ecosystems of landscapes deliver a multitude of services for mankind. These landscape services save the basics of our live or enhance live quality. Nowadays, landscapes are changing increasingly faster, not at least because of the growing use of renewable energy. What do these changes mean to several landscape services? How can we intervene accordingly?

Landscape scenarios could give answers to these questions. We present a trans-disciplinary method for the draft, analysis and assessment of future landscapes. The framework consists of seven phases, which integrate scenario development and landscape services evaluation. Using this framework, we include local actors both into scenario outline and assessment. Based on future scenarios, management strategies and compensation measures can be discussed and evaluated regarding their functional efficiency.

The framework is exemplified using the most eastern county in Germany called “Landkreis Görlitz”. This region is characterized by a wide landscape gradient from mountains to lowlands, by decreasing population and a specific cultural tradition. It is also a traditional energy region (with open-cast mining areas, wind farms and an increasing amount of renewable raw materials), having few industry and less productive soils. We assume that the region become more importance as an energy region on the basis of renewable raw materials. Particularly, we regard the role of energy crops in economy and their impact on future landscape structure, as well as their contribution to several landscape services.

The poster shows the description of a renewable energy scenario and several maps show the impact on land use and landscape structures. Evaluations of landscape services are given by a landscape barometer showing the main results in a concise and well comprehensible way.

We thank the German as well as the Saxon departments of science (BMBF and SMWK) for funding the involved projects “LOEBESTEIN” and “Landschaft Sachsen 2050”.

## **Structural Indicators for the Assessment of Biodiversity within the Ecosystem Services Framework**

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The Ecosystem Services Framework is an established approach for a balanced evaluation of

ecological, economic and social landscape resources. It allows the identification of functional synergies (win–win situations) as well as trade-offs among various benefits resulting from ecosystem processes. Besides the direct contributions of biodiversity, also spatial aspects of landscape heterogeneity and configuration play a major role for the maintaining of human wellbeing. Also cultural artefacts contribute the landscape functionality. Therefore, the more suitable term *landscape service* is increasingly used. We pursue particularly spatial aspects of that framework and ask for optimizing the trade-offs among landscape services.

The contribution of spatial heterogeneity and landscape structure measures are distinguished as indicators for landscape services. Landscape heterogeneity is a key measure for biodiversity and contributes to several valuable functions. Likewise, habitat connectivity and other measures of landscape structure are essential criteria for the behavior of meta-populations and for the recreational value. The assessment of habitat and nature protection networks is demonstrated as an example.

Landscape consists also of artefacts, human activity and even social thinking. Using the Landscape Services Approach in a broader sense, we can better address also the so-called social / cultural services because they strongly depend on memorials, structural characteristics, historical conditions and even on mental specifics which can hardly be subsumed to ecosystems. Place-based assessments make it possible to include landscape measures for these issues too and are an appropriate solution for the unification of several spatial categories.

## **Urban Municipal Solid Waste Recovery through Regional Collaborative Research between Malaysia and Japan as Alternative to Landfill Dependency**

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Resource excessive consumption driven by urbanization has put pressure on waste generation and resulted in environmental impact. This study was intended to determine adequate policy response in recovering municipal solid waste in urban area to reduce landfill dependency.

Ecological condition was evaluated by cause-effect analysis method conducted in Kuala Lumpur. Assessment on resource availability was analyzed by means of remote sensing and GIS data based on environmental parameters, whereas abundant resource was estimated from composition of collected waste. To enhance implementation, trend, issue and need analysis was performed and collaborative research was proposed. Applying Japan's experience-based approach, assessment on potential of material and energy recovery was performed. Participation behavior towards material separation practice was evaluated by considering social parameters, while usage for energy feedstock was conducted by assessing the applicability of technologies for waste to energy. As long term initiatives, projection of capacity building aspects was estimated by reviewing technical transferability factors.

During observation between years 1998 - 2007, land use type of open space, recreational and sport facilities has expanded at 21.7%. The greenness level of high vegetation areas however, decreased at 12% rate between year 1990 – 2006 (Shazwin et al., 2010a). This findings on generation point is correlated with composition of collected bulky-type waste indicated that almost 30% of abundant bulky waste consist of landscape waste. In responding, result of feasibility study concluded that there is high tendency for regional collaboration with high interest in legal aspect of waste management. Meanwhile, to motivate participation behavior in resource separation, developing internal elements is important and eliminating external barriers is required to overcome defection (Shazwin and Nakagoshi, 2008). Furthermore, findings from available technology shows that there is high commercialization interest to transfer biogas technology, but currently received none from waste biomass feedstock. It was suggested that decentralized, networked but top-down approach will be the best option to enhance technology transfer in developing Asian countries (Shazwin et al., 2010b).

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## **Integrating Landscape Connectivity and Biomass in Selecting Priority Conservation and Restoration Areas**

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Face to the rapid degradation in environmental conditions, there is an urgent need to develop appropriate approaches to combine biodiversity and biomass conservation and restoration. We propose here a multi-scale method based on potential biomass and landscape connectivity parameters to identify and prioritize natural vegetation remnants for conservation and restoration, which could be used in REDD+ programs. Those programs will probably offer the best opportunities in a near future to develop those kinds of approaches.

The proposed method was experimentally applied for the Atlantic forest, one of the most degraded biodiversity hotspots, in the state of São Paulo (Brazil), where natural forest remnants have been degraded by agricultural activities. Despite several programs of payments for environmental services implemented by governmental agencies and NGOs, São Paulo has few REDD+ initiatives.

The prioritization was made combining biomass estimation and potential connectivity estimated by graph theory approaches. Biomass estimation was based on patch metrics and remnants configuration, while connectivity index was based on a methodology which allows to distinguish the connector importance of each fragment to landscape connectivity (Saura & Rubio 2010).

These evaluations were applied first at a patch level, allowing to identify the best fragments for conservation actions, and at a second step, the procedure was applied at a landscape level

(10,000 ha landscapes) considering the entire state of São Paulo. In this last approach, the landscapes and their indices of connectivity were the graph nodes and nodes attributes respectively.

This method allowed us to prioritize fragments for conservation actions and landscapes for restoration programs integrating their potential biomass, the degree of connectivity inside landscapes and the importance for biological fluxes among landscapes. The results are extremely important due to the fact that highly connected landscapes maintain higher levels of biodiversity and also higher recolonization potential (Pardini et. al 2010), which are key factors for efficient restoration and conservation programs. Moreover, we create a new opportunity to prioritize areas to participate in REDD+ programs that consider not only their potential to capture carbon but also to maintain the high levels of biodiversity.

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## **Spatial Characteristics and Possible Origin of pollutants in Urban Street Dusts from Beijing**

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226 dust samples were collected in a grid pattern from urban roads of Beijing. The present study focuses on the sources identification and the spatial distribution characteristics of Mn, Cr, Ni, Cu, Pb, Cd, total organic carbon(TOC),total nitrogen (TN) and total sulfur(TS). Correlation analysis and Principal component analysis (PCA) were applied to investigate associations between elements. Semivariance function, Moran's I index, Anselin Local Moran's I and Getis-Ord Gi were used to Identify the spatial autocorrelation ranges, global and local pollution spatial patterns and hotspots. multivariate statistics results show that all substances are significant correlated except for Cd, Three groups of elements were clearly distinguished in road dusts which indicates there are three different potential sources. and they are: 1)TOC,TN; 2)Mn , Ni, Cr and 3)Pb, Cd. Spatial analysis results show that in this sampling space range, Mn, Ni exhibited no characteristic of spatial autocorrelation ,and TS show intense spatial autocorrelation, while other elements display the medium spatial autocorrelation. The distribution characteristics of some elements related to human activities present several hotspots in the urban areas, especially in the intersections of the high grade highways and the old centers, which indicate that intense human activities may affect the distribution of elements in the city.

## The Method for Extracting Bamboo Groves in Northwestern Chiba Prefecture, Central Japan Using ALOS/AVNIR-2 Satellite Images

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Abandoned bamboo groves are vigorous and spreading their distribution in Japan (Okutomi, 1994) causing many problems (Isagi et al., 1998), for example, decline of biodiversity. In order to monitor them, this study was conducted to extract bamboo groves in northwestern Chiba Prefecture, central Japan using ALOS/AVNIR-2 satellite images. These images have 10m spatial resolution and were taken in October 2008, February, March, April, May, August and September 2009. They have finer spatial resolution than LANDSAT or ASTER satellite images and more economy than IKONOS or QuickBird satellite images. We used supervised classification (decision tree (Breiman et al., 1984)) with training area separated from accuracy check area in order to avoid overfitting of classifier. The training areas contain evergreen broad-leaved forest, which is difficult to be distinguished from bamboo groves. The training areas distinguish Mosochiku bamboo (*Phyllostachys pubescens* Mazel) from Madake bamboo (*P. bambusoides* Sieb. et Zucc.) because there would be the differences between them in life history strategy and speed of spreading their distribution. The training areas were decided according to results of field survey and images of Google Earth. Borderlines of training areas were backed 20m in order to prevent training areas from including mixels or inappropriate land covers adjacent to the targeted land covers. These bamboo species were extracted with high accuracy because there were differences (1) between evergreen broad-leaved forest and bamboo grove in NDVI (Normalized Difference Vegetation Index) of May and (2) between Mosochiku bamboo and Madake bamboo in red band data of April. In future, we will study differences between Mosochiku bamboo and Madake bamboo in distribution speed, impact on ecosystem and humankind (e.g. bamboo groves mentioned above sometimes cause landslide or spoil farm by invading).

The authors would like to thank Kazuyuki Takahashi and Kohei Emura of Tokyo University of Information Sciences for kindly allowing us to use their vegetation map for the modified vegetation map. In addition, we would like to thank the Satellite Data Utilization Promotion Committee, Working Group for Promoting Utilization of Satellite Data in Biodiversity Conservation, JAXA/RESTEC for kindly providing the ALOS/AVNIR data used in this research; and Center for Environmental Remote Sensing, Chiba University for permission to use data from their 2010 joint research project Spatial Analyses of Landscape Transformation in the Kanto Region Using GIS and Remote Sensing.

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## **Natural Capital and Indicators of Ecosystem Services and Biodiversity in Urban Landscapes**

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The constantly evolving urban landscape is a complex mosaic of human modifications, metabolic flows, networks and built structures and understanding how urban ecosystems work, how they change, and what limits their performance, add to the understanding of ecosystem change and governance in general in an ever more human-dominated world. Today, cities are facing enormous challenges, e.g. climate change and transformation to a future beyond fossil fuels. Urban ecosystems may have a large role in facilitating this transformation, since ecosystems provide flexibility in urban landscapes and help build adaptive capacity to cope with e.g. increased temperature and changing precipitation and through multiple other ecosystem services that promote human well-being.

The concept of ecosystem services has proven useful in describing how biodiversity and ecosystems are linked to human well-being. Cities provide a range of critical ES that are enjoyed by most urban residents. These include regulating services (benefits obtained from regulation of ecosystem processes like air- and water filtration); cultural services (nonmaterial benefits obtained from ecosystems, like spiritual enrichment, cognitive development, recreation, and aesthetic experiences); and the supporting services (necessary for production of all other ecosystem services). It is important that this capital, the urban natural capital is captured and enter into decision and planning processes. Therefore, there is a need to develop indicators of urban ecosystem services so that these can be monitored and also valued both in monetary and non-monetary terms. I will present ideas on monetary valuation methods and perhaps more importantly methods for how to capture non-monetary values in the urban landscape.

The urban landscape provides a public space for the cross-fertilization of minds and various disciplines, enabling a new perspective on man in nature, one that could place human well-being at the core, break the artificial and largely culturally biased divide between the pristine and the human-dominated ecosystems, and contribute to the creation of a new language, with signs, concepts, words, tools, and institutions that would gather rather than divide, broker conflicts rather than create them, and establish responsible environmental stewardship at the heart of public interest.

## **Urban Landscape Pattern (Land Form, Land Use, Biodiversity) and Human Health**

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Topographic effects on landscape complexity and sustainability of land use necessitate the description of land form diversity. Land form diversity is a basis of biodiversity (examples

will be given for agricultural and urban land use). The most decisive characteristics of land form are altitude difference and frequency of complementary depressions and elevations of an area, e.g. a catchment or watershed (a figure will be given).

Urban green spaces in cities and conurbations have important functions, mainly for human health and environment quality, urban climatic conditions.

Agricultural areas are a category of open free spaces, besides forests (their remains), parks, woody plantations (food or timber production). Larger agricultural areas in communal areas are “islands” within built-up areas, residential areas a.s.o.; or they are stretching from peri-urban areas like “tongues” into central built-up areas of cities and conurbations.

Agricultural plots for food production have generally less volumes of living biomass – compared to forests. Therefore they have less bio-climatic effectiveness for human health, e.g. for clean air. Monoculture food plots can need a lot of pesticide spraying (especially vineyards). In cities exists the danger of drifting sprayed pesticides and soil particles by tillage after dry weather into residential areas. These transport processes depend on weather and on topographic conditions (and on high rise building masses in cities) (examples will be given from “industrialized” agricultural mini plots inside cities).

We have to protect the old cultural landscape in cities. The old pre-industrial agriculture in cities was quite different to our modern land use practice. The historic urban agricultural landscape was characterized by high biodiversity, species rich ground vegetation e.g. in vineyards, often mixed cultures with fruit trees and vegetable, without problems of air pollution by pesticides. The biodiversity is now strongly reduced by tillage, use of herbicides, partially used short-time grass cover or herbs for enriching the soil with organic matters. A given table shows rare species of the old vineyards with sub-mediterranean area and eastern steppe species (Table Rare plant species of recent vineyards in the Upper Elbe conurbation, Saxony). They are no more to view within „modern industrialized” vine plots, respectively they are very rare, often Red List species (in small fringe areas). Only *Ornithogalum nutans* resists tillage in some places because of deep grounding bulbs.

Re-integrating of old historic urban cultural landscape cannot be managed as “industrialized” monoculture mini-plots. It needs new basic planning principles. One cannot claim to protect century-old historic agrarian landscape, if takes place the appropriate land use by “industrialized” agriculture with partially negative environmental damage. Historic cultural landscape of a specific pre-industrial era can be preserved only if there is carried out also the historic farming system. This would be possible probably only on smaller areas without using large machines and therefore with higher costs.

Some resulting special tasks for town and landscape planning are containing measures against negative effects like air pollution. This could be done by distance zones; shelter-belt hedges against pesticide drifting into residential areas. Remaining forests on upper slope shoulders, and groves along slope erosion depressions / valleys can protect small agriculture areas from cold air masses. Do not level erosion depressions / valleys for gaining plane areas! They have more sites and biodiversity. Forests and hedges may lead cold air into deeper valley sites. They are subdividing elements of towns.

# Private Swimming Ponds and pervaded Vegetation Mats for Water Purification on Roofs and Their Thermal Activity

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Natural purified swimming ponds have become an increasing market in Europe and a contribution to improve urban life quality. They provide additional water surfaces and improve microclimate in cities. Biological based purification sites improve biodiversity and by the idea to relocate the filter space to the roof, the establishment in dense urban areas is possible. Swimming ponds are then able to function as open cisterns which take in water in case of rainstorms, and store the water for a certain period and provide it for evaporation. The increase of the portion of green roofs is a very effective method to improve the climate in the city, and the otherwise impossible realizability of a swimming pond in small city gardens can be a motivation for the provision of a green area on the roof, which otherwise would not be realized.

Pilot projects with swimming ponds with adequate plant communities on emerged marginal filtering zones (Kircher, 2007) lay the basis for a current research project at Anhalt University. It is focussing 3 main aims:

1. Visually and functionally satisfying plant selection and -combination comparing different hydraulics
2. Analyse evaporation rates of plant selections
3. Shallow constructed wetlands on roofs as alternative locations for natural purification systems including a thermal benefit onto the building

## Tested variants:

Factor A: vegetation type (A1: 8 eutrophic wet meadow species; A2: 8 oligotrophic lime fen species; A3: 5 Sphagnum bog species). B: hydraulic inside the filter system (B1: perfused downward; B2: perfused upward; B3: no active pumping)

## First results can be summarized as follows:

1. Water flushing from the bottom upwards effected the best vigorousness to the eutrophic wet meadow variant (A1-B2), whilst the overall aesthetics of the lime fen plots tended to best evaluation results if perfused from the surface downward (A2-B1).
2. Transpiration rates (l/a) compared bare and vegetated plots differed 27%.
3. Lime-fen is a suitable selection bringing a temperature reduction (max.11°C.)



Swimming pond - pilot project with marginal lime fen planting



Trial plots in Bernburg. In the foreground a lime fen variant (A2)



Sphagnum bog (A3-B3) - *Sarracenia purpurea* & *Pogonia ophioglossoides*

## Assessment on the Status and Spatial Distribution of Green Roofs in Congested Area

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Green roof is a hot topic in current research in urban ecology and landscape planning. However, due to the difficulty of data collection and processing, there are surprisingly few published guidelines exploring the spatial distribution of green roofs and the factors that influence their presence in compact cities. By matching maps of buildings, green cover, district boundaries and roof and podium level layers, the status and the spatial pattern of green roofs and the factors in Hong Kong were analyzed. Suggestions for future development of green roofs were also discussed. The results indicate that both roofs and podiums are not adequately utilized by green spaces. High green ratios of roof gardens exist on 5–20-floor buildings or buildings located in areas of low density for most land uses and most districts. Several factors play significant roles in the green ratios of podium gardens in some districts, such as building density in WC, S, E and HKI as a whole and podium areas in WC, SSP and KC. The development of green roofs has not improved with town development and has not adequately compensated for limited ground-level green spaces. The spacious roof and podium areas that are available provide the potential for the extensive development of green roofs with high green ratios and biodiversity. Systematic planning on a large scale that incorporates measures for increasing biodiversity and forming green networks may be an effective strategy to solve the problem of the extreme shortage of green roofs in compact cities.

**Keywords:** Roof garden, Podium garden, Green ratio, Land use, Building stores, Improvement measure

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## Study on the Changes in the Vegetation and Children's Attitude in A Primary School Biotope in Japan

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There has been decreasing urban green spaces in Japan as a result of rapid urbanization. In Japan, many school biotopes have been created for "wildlife habitats" and "ecological education" in urban area. However, they have many problems of management for keeping "wildlife habitats" and "ecological education". Moreover, it is important to understand the relationship between the vegetation and children's attitude.

In this study, we discussed the changes in the vegetation and children's attitude in a primary school. This research will provide references for space designing for wildlife habitats and ecological education.

The study site is a primary school biotope in Fukuoka City in Japan. Since 2002, The primary school biotope has been planning by process planning (Isozaki, 1970, Ito et al. 2010), and designed by Multi-functional landscape Planning (Ito et al., 2010). a) As for the field surveys, the number of species, height of plants and green area were surveyed for 8 years. For identifying characteristics of ecological. b) Analysis of a child by free-descriptive answer on a map, and a teacher by interview about the space.

In this study, changes in the vegetation and children's attitude in the school biotope was surveyed. From 2002 to 2005, the number of species, green area and Shannon Wiener index gradually increased. However, after 2005, those numbers of the species were stable. Moreover, dominant species were changed by learning about ecological matters (eg: alien species succession and so on). It was thought that the vegetation changes were greatly affected by a curriculum.. On the other hand, by the curriculum, children learned the characteristic of the fauna and flora. Furthermore, children had the sense of responsibility to manage in the biotope. In addition, it is thought that the existence of fauna and flora is important for practical use of this school biotope.

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## Spatial Analysis of Changes in Alligator Weed Distribution in An Irrigation Network Using the Network K-function

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Invasive *Alternanthera philoxeroides*, commonly known as alligator weed, was first observed

in the drainage of Lake Teganuma in Chiba Prefecture in 1998, and is now in the process of spreading around the entire drainage basin (Hayashi et al. 2009). A network of irrigation canals, established as part of agricultural land improvement works since the 1960s, is considered to be one factor in this spread. In this research, direction of flow in the canals and all rivers is used to trace the route of expansion, and changes in spatial distribution of alligator weed over the past 10 years are analyzed using by a spatial statistical method.

The study area, a drainage basin of Lake Teganuma (163.4 km<sup>2</sup>), contained a total of 394 alligator weed populations during the ten year study period from 1997 to 2007. The exact locations of all populations within the network were mapped using ArcGIS. Locations of all rivers (105.8km), canals (589.6km) and pumps were also digitized from maps (1/25000 and 1/3000). To identify the route of expansion, minimum distances between observed points were calculated. To analyze changes in spatial distribution, the K-function and cross K-function, which is a K-function (Ripley 1976) expanded to network scale (Okabe and Yamada 2001), were calculated using SANET. To examine the effect of network on the weed's distribution, logistic regression analysis was used. The network was divided into 17,110 fifty-meter segments and the location of weeds converted to presence/absence data at the segment level.

The spatial distribution of weeds by year showed that clustering was within a limited area at distances of 1 to 5 km before 2004. After 2004, however, clustering was at distances from 1 to 8 km, with random distribution over 8 km. Using the cross K-function to analyze distribution over consecutive years showed a similar pattern. These results revealed that the weeds were originally aggregated around the eastern part of the basin, but then dispersed over the entire basin. The expansion rate of the weeds through the network increased with time, especially following heavy drainage due to typhoons in 2004. Combined with network analyses using ArcGIS, the results indicated that the weeds used the irrigation network, which recycles drainage back across the watershed, to expand upstream from lower parts of the basin.

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## Strategic Urban Forestry for Climate Change Mitigation and Adaptation

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Because in recent years there has been increasing of people who get disturbed in their sleep and have heatstroke, urban heat island phenomenon has become a serious topic of public concern. At first, it shows that green space and anthropogenic heat emission have a great effect on the temperature in downtown areas from the various data collected from 27 observation points in Minato-Ku, Tokyo. Then, it clarifies the cooling potential of green spaces. From the regression analysis, it can be said that the cooling influence by green spaces of 22,500 square meters is equivalent to the heating influence by the anthropogenic heat released from seventy offices of the average size in Minato-Ku, having a total floor area of about 211,726 square meters. Furthermore, the cooling potential of a green space of 22,500 square meters during July to September can be expected to reduce about 236 times as much quantity of the carbon dioxide as the same green space absorb for one year. Based on this background, we obtained that green spaces in urban downtown areas have the function of natural air-conditioner, as well as the indicator 12: Climate Regulation: carbon storage and cooling effect of vegetation in the Singapore Index on Cities' Biodiversity (CBI).

Trees and other plants are recognized as carbon sinks because they absorb and sequester carbon dioxide (CO<sub>2</sub>) in the atmosphere. As urban greening progresses, the amount of absorbed and sequestered CO<sub>2</sub> increases. Meanwhile, thinnings, prunings, and leaf litter derived from tree maintenance and management has generally been thrown away as a negative resource. To address global environmental issues such as climate change and biodiversity, it is important to widen the circle of action beyond the cities. We have the technology (non-chemical method) that provides a key to solving difficult problems, and have succeeded in converting biomass to non-fuel raw materials (Lignin - cellulose complex) for industrial products. A social experiment has conducted to produce biomass-polymer raw materials from biomass such as forest thinnings, weeds such as reeds, *Miscanthus sinensis* and lawn clippings, and bamboo, and produce finished goods (mouse pads, trays, panels etc.) from the raw materials. We propose "Smart Urban Forestry", based on melding this cutting-edge technology with conventional technology, to conserve, create, and utilize urban green space in a sustainable manner. With co-benefit the issue of poverty and employment may be solved.

For climate change mitigation and adaptation, by means of these technologies, social systems could potentially change significantly toward low-carbon urban structures.

## **The Island Species–area Relationship: Biology and Statistics**

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The increase of species richness as sampling area increases, i.e. the species–area relationship, is one of ecology’s few laws. Thousands of studies have reported the pattern, for more than 91 years but still necessity for synthesizing the available knowledge exists (e.g. Connor & McCoy, 1979; Rosenzweig, 1995; Lomolino & Weiser, 2001; Whittaker & Fernández-Palacios, 2007). We conducted the most extensive quantitative analysis of the form taken by the island species–area relationship (i.e. each data point is tallied independently of every other and so the form of the relationship can vary; ISAR). We amassed 601 data sets from strictly geographical islands and employed an information-theoretic framework to compare the 20 available species–area functions (Tjørve, 2009; Williams *et al.*, 2009). Overall, we conclude that over most scales of space, ISARs are best represented by simple models, with the power model, being the overall best but not the single-best one. Biological significance can be assigned to the parameters of the logarithmic form of the power model. The general form of the ISAR is convex upwards without an asymptote; consideration may be given to fitting sigmoid models when the spatial range is around, or exceeds, three orders of magnitude. While, the form of the ISAR varies considerably between study systems, part of this variation can reasonably be related to the array of different mechanisms and processes that constrain the ecological space available within an island system and the geographical context within which the archipelago is located.

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## Identifying Biodiversity Hotspots in Northern Thailand

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Rapid deforestation occurred in northern Thailand over the last few decades and is expected to continue. The objectives of this paper were to 1) generate ecological niches of large mammals, and 2) assess wildlife concentrations and their hotspots in northern Thailand. Future land use map in 2050 was obtained from recent land use modeling study. Geographic Information Systems (GIS) and a maximum entropy theory (MAXENT) were used to generate ecological niches of 18 large mammal species as a proxy of biodiversity. The likely occurrences of selected wildlife species were aggregated and classified as wildlife concentrations. In addition, the predicted deforestation areas between 2002 and 2050 were overlaid on high wildlife concentration to determine threats to wildlife, and the results were



named as wildlife hotspots both inside and outside protected areas.

The results revealed that current suitable habitats for most wildlife species were predicted in the west, north and east of the region. The predicted areas of high wildlife concentration or richness ( $\geq 7$  species likely present) covered approximately 16,000 km<sup>2</sup> or 9.3% of the region. In addition, wildlife hotspots encompassed approximately 3,100 km<sup>2</sup> or 1.8% of the region, and 74% of this figure was predicted in protected area coverage. Based on the model outputs, we recommended conservation measures to minimize the impacts of future deforestation on wildlife hotspots.

**Keywords:** Biodiversity, Biodiversity hotspots, Deforestation, GIS, Northern Thailand

### **Integrated the Aerial Photos and DTM to Estimate the Area and Niche of *Arundo formosana* – An Example of Jiou-Jiou Peaks Natural Reserve in Taiwan**

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The LU / LC was impacted by earthquakes and typhoons in Taiwan, but an endemic grass, *Arundo formosana* (Formosan giant reeds), still widely distributed. For lacking the niche information of this species, we have to study it. The information could provide the manager to make a decision for water and soil conservation. Jiou-Jiou Peaks Natural Reserve was established in 2000 to protect the unusual topography and complex biodiversity. The human disturbances were prohibited. However, the processing of vegetation restoration was still influenced by natural disturbances and steep slope. Several vegetation types no longer grow here, except the Formosan giant reeds. Because of its exuberant root and foliage, the erosion was reduced. Nowadays, most of remote sensing images are two-dimensional (2D) data. Sometimes it's insufficient to explain all natural phenomena only with 2D spatial information, especially some species growing in specific areas. Formosan giant reed is one of them. The species can hang downward from the rock crevices and cliffs and thrive, so the distribution area of it might be underestimated if researches ignore the characteristic. The purpose of this study is trying to make areas estimation of the species more scientific, so we integrated ortho-aerial photos and DTM. In addition, the environment factors, including slope and aspect, were analyzed with statistics to understand the ecological site. The results showed that the area of the species increased from 26.34% to 32.86% after the slope factor was considered. The slope ranges of the species was from 0.00 to 81.82, and the average degree was  $53.99 \pm 13.45$  (mean  $\pm$  standard deviations) in this reserve. The southeast to southwest was the suitable aspect for the species.

**Keywords:** *Arundo formosana*, Ortho-aerial photos, DTM, Niche, Steep slope

## Valuing Ecosystem Services in Wildlife Management

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The practical experience of evaluating the eco-system services for developing the mechanisms of managing and preserving the landscapes proved to be promising in Tomsk region. This being said, the efficiency of the applied methods is directly dependent upon their appropriate selection (Dixon et al., 1994).

First of all, the scope and type of landscape utilization need to be studied. In case of using the natural site in recreational purposes and given the signs of its certain elements evident degradation, the most efficient technique would be a subjective estimation method based upon the willingness of the population to contribute some funds for preserving the natural properties of the wild landscape.

If a natural site is of both recreational and economic value, being a source of food, medical, and other raw materials derived from wood products, then a graded approach to the evaluation of eco-system services needs to be applied (Tsibulnikova, 2001). In this case the economic value of the natural site will be constituted by the sum of the used natural resources evaluations. Primarily the groups of consumers are determined, and the study covers not only the type of the landscape utilization, but also the economic value of its certain components (Tsibulnikova, 2010).

This is proved by the evaluation of eco-system services of Tomsk recreational areas. The city is located in the south of Western Siberia and is a regional centre where half of Tomsk region population live (over 600,000 people). The opinion polling allowed not only performing the economic evaluation but also identifying the mechanisms of natural landscapes management. There are parks in the city that are used by the citizens only for promenades. The average value of the willingness to pay determined in money terms amounted to 29 USD apiece annually. The overall cost of the parks presence in Tomsk is \$8 mln. a year.

Nevertheless, the citizens satisfy their need in outdoor recreation by leaving the city area. Here a unique natural site is situated – Timiryazevsky pine forest, where the recreation can be combined with gathering the wild-growing plants, fishing, and hunting. For this natural site a combination of methods was applied, namely the method of “willingness to pay” with that of the market evaluation of the forest renewable resources. The results of the opinion polls allowed both evaluating the eco-system services of the area and identifying the mechanisms of unique natural landscapes preservation.

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# **Mountain Gods and Water Goddesses on the Roof of World: the Holy Mountain and Sacred Water System of Tibet and the Environmental Protection of the Tibetan Plateau**

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The pre-Buddhist holy mountain and sacred water system of Tibet can be traced back to more than 2,000 years ago, when people believed in man-like gods (gnyan) who dwell on the tops of mountains(la-rtse) and woman-like goddesses(lhamo or kgu mo) and serpentine spirit deities (klu) who reside in lakes, rivers, and springs. This tradition held that the gods and deities safeguarded the mountains and waters from exploitation by human beings.

These gods, goddesses and spirit deities are easily provoked and have a propensity for retaliation as well as repaying debts of gratitude. For example, if you hunt, mine, or cut trees on holy mountains, or fish or dispose of garbage in the sacred lakes, rivers, springs, and their vicinities, you will usually anger the spirit beings who will then take revenge by sending hail, floods, and diseases to the human world; if you respect the holy mountains and sacred waters with sacrifices and offerings, the spirit beings will ensure that your harvest is bountiful and that your livestock will thrive, free from the illnesses caused by demons and spirits, etc.

After the 7<sup>th</sup> century when Buddhism gradually became a dominant religion in Tibet, the holy mountain and sacred water cultural system of Tibet was finally incorporated into the greater Tibetan Buddhist cultural system. In this synthesis, mountain gods and water deities accepted some of the Buddhist doctrines, such as “cyclic existence,” “no killing,” “compassion toward all sentient beings,” and so forth, and became protectors of the Dharma; most of them even become vegetarians and they do not desire animal sacrifice and offerings anymore.

There are thousands of holy mountains and sacred lakes, rivers and springs on the Tibetan Plateau and areas adjacent to the plateau. There are different ranks of holy mountains and sacred waters, varying in size and importance. The greatest mountain gods include Yar-lha-Sham-po in central Tibet, Gang-ring-po-che(Tise or Kalash) in western Tibet, A-nyes-rma-chen(Amnye Machen) in Amdo, the Northeastern Tibetan Plateau, Gnyan-chen-thang-la(Nyanchen Thangla) in northern Tibet and Kha-ba-dkarpo (Khawa karmo) in southern Kham, the southeastern Tibetan Plateau; the greatest sacred lakes are Yar-‘brog gYu-mtsho(Yardrok Yumtso) in central Tibet, Ma-pham gYu-mtsho (Mapham Yumtso or Manasarovar) in western Tibet, Gnam-mtsho(Namtso) in northern Tibet, and Khri-shod-rgyal-mo-gYu-mtsho mtshong-sngon-po (Tso-ngon-po or Kokonor) in Amdo, the Northeastern Tibetan Plateau. All of them are widely known by the whole Tibetan world and have been respected and worshiped by all Tibetans or worldwide Tibetan Buddhists, Bonpos, and other pilgrims. There are also thousands of regional holy mountain gods and sacred water deities---from provincial to prefectural, village and small tribal levels. If you survey those holy mountains and sacred waters carefully, you will find that all the mountains and waters are ecologically important to the human world---the mountains are sources of rivers and lakes, while rivers, lakes and springs are lifelines for agriculture, herding and people’s daily life.

These holy mountains and sacred waters and the areas adjacent to them have actually functioned as permanently preserved zones and refugee camps for wild animals, plants, and as well as for many “treasures” (gold, silver, mines and other hidden treasures) for many hundreds of years.

Scenically most of the holy mountains, sacred lakes, rivers and springs are also the most beautiful landscapes on the Tibetan Plateau and in the Tibetan cultural world, and many of them even among the most beautiful landscapes in the world.

I doubt if we today could still see so many fine forests, so many kinds of wild animals (including panda and Tibetan antelope), and clean and beautiful rivers, lakes and springs on the Tibetan Plateau and her lower reaches without the protection of the mountain gods and water goddesses we have enjoyed since ancient times!

## **Integrating Conservation Policies and Co-management of *Satoyama* Woodlands in the Urban Fringe Areas**

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*Satoyama*, coppice woodlands in Japanese traditional agricultural landscapes (Takeuchi, 2003), provides multiple ecological functions in today's extended urban areas (Yokohari et al., 1994). Traditional management practices play important roles for the provision of recreational and biodiversity functions, however, the loss of economic values of *Satoyama* as fuels and fertilizers resulted in abandonment and the subsequent loss of ecological functions (Fukamachi and Sakuma, 1998). Our research aimed to provide a conservation framework for these *Satoyama* in the urban fringe areas by integrating the existing conservation policies and the emerging co-management activities by citizen volunteers (Kobori and Primack, 2003). We performed GIS analysis, field surveys, interviews and questionnaires in three municipalities (Kawasaki, Machida, Hachioji) located in the west of Tokyo metropolitan area.

The findings through the whole research were summarized as follows: 1) conservation policy types which utilized by municipalities were diverse and determined the extent of management of local governments and citizen volunteer groups, 2) ground floor vegetations were more affected by the socio-economical factors, such as urban planning zonings and the managers, than other environmental factors, such as slopes, 3) there were significant supports for the launches of the citizen volunteer activities, however, only little concern about the continuous of the activities were found. From these findings, four main components of the new conservation frameworks which encourages management activities by multiple stakeholders were suggested: i) continuous land purchasing by the local government, ii) clarifying the role of the local government in the woodland management, iii) supporting the launches of citizen volunteer activities, iv) continuous supports for the groups. Further case studies in other areas will be needed to test this proposed conservation framework.

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## **Ecotourism Activities for Sustainability and Management of Forest Protected Areas (Case of Camili Biosphere Reserve Area in Turkey)**

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Interests of communities changes and diversified in attitudes and behaviors for forest resources. In this way; basic forest management policies have occurred exchanges. In this context, the necessity of forest resources have arisen to provide in sustainability, economic and social development for future and present generation. Forest management have adopted as a "sustainable forest management" which conservation and hold productivity and biological diversity of forests. In summary, sustainable forest management, ecologically proper, economically practical and socially-sensitive applications, including the principles of responsibility represents a business approach. Namely; forest areas have started to gain for biological diversity. Therefore, areas such biological diversity should be "protected areas" be established and managed. As features of protected areas in terms of science and education are important, rare, exposed to danger include the required fields. Especially, approach selected for target management of protected areas is necessary to provide such as interrelated and interactive understanding of sustainability and conservation of biological diversity is necessary. Such a systems approach is essential to protected areas destination management- it enables an understanding of tourism and biodiversity conservation as systems of interrelated and interactive components. An important sustainability issue arises here. In addition, forest villagers located within and around the protected area are especially vulnerable. Within the framework sustainable forestry of the Turkish forestry shouldn't forgotten in the most important group of "forest villagers" for communication and composition. A participant approach making the necessary possible with importance of forest villagers (Geray, 1998).

For development of forest villagers has raised new searches for responsibility due to other society sector significantly lower than income levels of the forest villagers in Turkey and

interaction with management of protected areas. As a result, ecotourism activities which take decisions more effectively and efficiently as a form of tourism are considered as an ideal tool for sustainability and management of protected areas. Forest villagers increased financial income thanks to ecotourism activities. Thus; forest villagers will not be damaged directly or indirectly. So, today's forest resource manager; ecotourism opportunity to review and evaluate. Ecotourism can improve the quality of life and target contribution to the economy on the basis of regional and country while it is exclusive for the actions profit and gain in short-term of tourism. Ecotourism which understanding of structure of nature with cultural values is an activity (Alkan, H. Korkmaz, M. Eker, M. 2010), (Akilli, H. 2004), (Porsuk, T. 2000).

The case study area, Camili Biosphere Reserve in Artvin; explanation of the relationship between protected area and sustainable forestry management, ecotourism activities should be assessed as a tool for sustainability during the management of protected areas and importance of public relations etc. have developed in suggestions. Forest villagers are selected according to full-count method. Questionnaires included every age group forest villagers' personal information of every age group, social- economic effects of ecotourism activities and destruction of the environment etc. like these variables were inquired both before and after the ecotourism activities. Data will be analyzed through descriptives, Chi-Square, paired T tests, and Wilcoxon analyses (Aydın, 2010), (Demirayak, F. 2006).

## **Prototypical Policy Impacts on Multifunctional Activities in Rural Municipalities**

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The project PRIMA (PRototypical policy Impacts on Multifunctional Activities in rural municipalities) aims to develop a method for scaling down the analysis of policy impacts on multifunctional land uses and on the economic activities. This method will rely on micro-simulation and multi-agents models, designed and validated at municipality level, using input from stakeholders. The models will address the structural evolution of the populations (appearance, disappearance and change of agents) depending on the local conditions for applying the structural policies on a set of municipality case studies. We shall consider policies related to use of Structural Funds (SFs), Cohesion Fund (CF), Pre-Accession funds (PAFs) and EAFRD (respectively CAP).

This project includes the following actions:

- Review the EU structural policies, identify driving forces at EU, national and regional levels for multi-functional land use activities and provide baselines for the design of national and regional scenarios on multifunctional land use activities.

- Interaction with stakeholders: pre-model engagement with stakeholders in terms of scenario design and formulating agent decision rules for agent-based models, on-model engagement with stakeholders mirroring agent-based models, and post-model engagement with stakeholders in terms of assessing model out-puts.
- Design and develop micro-simulation and multi-agents models, of local dynamics and of the impact of European structural policies at the municipality level.
- Build a mapping between available data on municipalities and prototypical, contrasted evolutions of micro-simulation and agent based models. This will allow us to aggregate the results provided by these models at a regional level, on a set of regional case studies, and to compare these results with existing models at regional scale.
- Investigate the potential of the approach to design a method that enhances the scope of Strategic Environmental Assessment (SEA), Environmental Impact Assessment (EIA) and Sustainable Impact Assessment (SIA).

## **Distance Decay Patterns across Anthropogenic Landscape in Bangladesh – Implications for Biodiversity Conservation**

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The biodiversity in the tropics is mainly threatened due to conservation problems through land use changes induced by increasing anthropogenic pressures. Nevertheless, especially natural and semi-natural ecosystems still host a high number of species. This is especially true for Bangladesh experiencing with the ever-increasing population density. I first conducted a quantitative assessment of distance decay patterns of tree species across different landscape units in tropical forest ecosystems in Bangladesh where little is known about the landscape patterns of biodiversity. The aim of my study was to visualize the landscape patterns of biodiversity using these distance decay patterns, subsequently its implications for biodiversity conservation. A representative, rapid, unbiased and systematic sampling procedure was applied for the study areas. I used a digital elevation model of the study areas in combination with geographic information system (GIS) software to identify potential sampling sites in broadly defined land use classes based on terrain attributes (aspect, slope, etc.). I performed multivariate analyses using R-package “vegan” (version 1.15-1) to detect the distance decay patterns of the tree species based on their presence-absence data. I calculated Sørensen similarity indices using R-package “simba” (version 0.2-5). Similarity values were then linearly regressed against distance. Finally, I investigated how similarity in tree species composition varies from plot to plot as the distance between the plots increases. I found a distance decay model where similarity decreased rapidly and significantly at very short distances. However, the rate of similarity decay was higher in national park than in reserve forest. This means that in national park, the tree species had lower proportion of shared species while in other area they had higher proportion of shared species which remained

consistent across space in the study areas. The reasons for its higher distance decay in the National Park due to its highest protection status, higher elevation, more patches of natural forests, and variation in its micro-habitat characteristics. Ecological processes such as disturbances (e.g. anthropogenic) and consequent breakdown of dispersal barriers might have the impact on the distance decay model in reserve forest. Regardless of causes, the distance decay patterns across landscape units emphasize the importance of nature protection in Bangladesh as the forest ecosystems of Bangladesh are under the intensive anthropogenic and natural disturbances, which are also likely to impact upon biodiversity in future. Since, the distance-decay reflects the spatial distribution or patterns of biodiversity; therefore, it has high consequences and implications for biodiversity conservation strategy.

### **Trends in landscape indicators**

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There is an increasing demand for indicators to evaluate and monitor the change in landscape quality. This has initiated the development of various landscape metrics. The landscape metrics enable the description of the spatial regularities and trends, and constitute useful indirect indicators of the impact of urbanization on cultural (rural) landscape and of the general ecosystem disturbance (Solon, 2009). Because of the relationships between spatial patterns and processes, landscape metrics can also inform planners about landscape functions, which are often difficult or impossible to measure directly (Botequilha Leitao et al., 2006). The application of the metrics has been very wide despite of the several drawbacks like scale dependence, interpretability etc. There is an appropriate time for assessing the usage of the landscape metrics, and what improvements can be made in the future.

Based on literature, we give an overview on the most important trends in the usage of landscape metrics – what are the most common data sets, spatial resolution, extent etc.? What are the most widely used metrics for measuring the composition and configuration and are metrics different for measuring change in landscape pattern or finding relationships between pattern and process? Most of the landscape metrics were developed for ecological applications and therefore they do not always have a straightforward application for planning. How scientists and planners have overcome this problem?

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## **Determination of Temporal Changes in Land Uses of Princess Islands, Istanbul**

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Istanbul, the city of history, culture and art, has also naturally beautiful places and some of them are the Princess Islands. The climate of the islands is closer to Mediterranean than Istanbul itself which gives to Istanbul the Mediterranean properties like *Pinus brutia* or maquis formation.

In Turkey forest lands shrink with the conversion to agricultural or residential areas. In Istanbul, where the land prices are high, the islands are also under danger. The suppression is getting higher to gain some more from the forest lands on the islands. As a result forest lands on the islands are shrinking.

In this study, the changes occurring forest and other land use forms on the Princess Islands during a twenty year period (1987-2006) were determined by the Post Classification Comparison Change Detection Method. For this purpose, standard topographic maps with 1/25 000 scale, forest management maps with the same scale, IKONOS pan sharpening images from 2008, September 1987 Landsat TM and August 2006 Landsat ETM<sup>+</sup> multispectral satellite images were used as data for this study. The changes occurring in forest and other land use forms with in the study area during a twenty year period were determined and the results were discussed.

**Keywords:** Change Detection, Post Classification Comparison, Remote sensing, GIS, Princess Islands, Land use forms

## **Impact of Street Tree Canopies on Pollution and Microclimate in Bangalore**

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Cities generate considerable levels of air pollution, largely generated by vehicular movement. Such pollution, in addition to generating severe health discords, also contributes significantly to global warming. City streets face the worst of this pollution, while asphalted roads also contribute to microclimatic changes by constituting micro-scale urban heat islands. The city of Bangalore is no exception to such issues of atmospheric pollution, heat islands, and consequent health and climatic impacts. Rapidly growing in size, the vehicular traffic on the streets is a challenge for urban managers. While Bangalore was once famous for its tree-lined streets, in the past couple of years, the city has witnessed large scale tree felling on roads, as a

consequence of road expansion activities as well as construction of the Metro. This research investigates the environmental benefits of street trees in the rapidly expanding city of Bangalore, and assesses the impact of street tree canopies on mitigating environmental pollution and buffering microclimatic variations in the city. We select ten roads distributed in various parts of the city, including major transport corridors, and smaller, internal conduits. Within each road, we identify a paired set of sampling locations, one in a section of road which is lined with trees, and the second in a section of the same road which is devoid of trees. We use two high volume air samplers, to simultaneously record information on primary air pollutants, including nitrates, sulphur dioxide, and suspended particulate matter at these paired sampling locations. We also compare ambient air temperatures, noise levels and traffic densities across paired sampling points. Across all ten roads, our results indicate that street trees have a high capacity to buffer microclimatic changes in urban environments, by reducing heat island effects, and absorbing gaseous and suspended atmospheric pollutants. These findings indicate the critical role played by street tree canopies in urban environments, a role often downplayed or ignored by urban managers.

## **Analyses of Rural Settlement and Landscape Patterns Using Historical Maps in Northern Flanders (Belgium)**

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Rural landscapes are rapidly changing today due to processes as urbanization, suburbanization and fragmentation. The majority of the rural settlements in Flanders became urbanized and lost most of their historical characteristics. An existing rural settlement typology of Belgium dates from 1964 and was based on interpretation of the morphology of the settlements as represented on small scaled topographical maps. New settlement typologies are needed to describe the current form but with respect to the initial historical and rural roots. The goal of this research is to create a settlement typology based upon the morphology of the place itself and considering its relationship with the surrounding territory, both in a historical perspective. The focus is on initial village settlements in a study area covering the provinces of Eastern Flanders and Antwerp, both heavily urbanized.

Although each settlement is unique and has its own history, several models of spatial structuring and development can be recognized. Most often this development depends on changing relationships with the surrounding, both local and regional. The relationship between the local site characteristics and the situation, the broader geographical surroundings and relative location to neighbouring settlements, is the basis of this typology.

Multiple information sources are assessed such as historical maps, semantic maps, soil maps, literature, toponyms, etc. and subsequently checked by field work. Several historical maps contain detailed information about the morphological structure of the place as well as about the territorial organization. As baseline the historical map of de Ferraris (ca. 1771-1778) is used on scale 1:11 520. It represents the landscape before the devastating changes starting with the Industrial Revolution in the 19<sup>th</sup> century.

The result of the typology reflects first the different settlements at the end of the 18<sup>th</sup> century. Second, it includes the present landscape representing the amount of historicity of a settlement. In this study not only a settlement typology is proposed and mapped, but also models of trajectories of development of the place in relation to landscape patterns and the processes involved, linked with their physical and ecological context. Consequently, also an assessment is made of the historicity of the place and its landscape, significant for future landscape management and planning.

## **Circumnavigating Risks of Environmental Contamination in Spatial Planning by the Use of Spatially Explicit Risk Assessment Procedures**

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Contaminants may pose serious risks to wildlife, ranging from effects on individuals to even communities. Exposure of wildlife to contaminants, however, is not only related to their environmental levels, but also to bioavailability of the contaminants (Fritsch et al. 2010, van den Brink et al. 2010), the diet of the wildlife and their spatial foraging behaviour (van den Brink et al., submitted) and to seasonal changes in prey availability (Schipper et al., submitted). Although these interactions may result in complex relationships between levels of contaminants and their risks to wildlife, they may also offer opportunities to resolve such risks. For instance, if the spatial habitat use of wildlife can be optimised to minimise exposure to contaminants this would facilitate the mitigation of the risks. This would provide managers of natural areas with alternative solutions to problems with contaminants, without having to remove them, generally a costly approach. To facilitate this, a Decision Support System (DSS) is under development which can be used to assess risks of contaminants for wildlife in a spatially explicit way (see [www.berisp.org](http://www.berisp.org)). This DSS can be used to perform scenario analyses in which different management schemes can be analysed for risks of contaminants, prior to their implementation.

The approach is based on the fact that habitats differ in their potential for transfer of contaminants to wildlife. This is related to habitat specific occurrence of prey items, species specific habitat suitability for wildlife, habitat specific soil properties that affect availability of contaminants, etc. The basic approach of the DSS is to analyse the spatial foraging patterns of wildlife, in this case the little owl and to assess their accumulation of contaminants. If risks are evident, two approaches may be followed. Either, the little owl is forced to forage where contaminant levels are low. This can be done by providing alternative foraging habitats. Additionally, habitats at contaminated locations may be changed into types that lead to lower food web transfer of contaminants. For instance, food web transfer of cadmium is highest in food chains based on earthworms and much less in food chains based on herbivorous organisms. Since earthworms can only be collected by little owls in relatively short grass, this habitat generally results in an increased transfer of cadmium. However, in long grass,

earthworms are difficult to find, and little owls may feed more on herbivorous small mammals, like the common vole (*Microtus arvalis*). Hence, a shift from short to long grass may result in a decrease in accumulation of cadmium by the little owl.

In the presentation, several aspects that affect accumulation of cadmium in wildlife will be discussed in relation to environmental management at habitat level. The BERISP-DSS will be used to illustrate this with case studies.

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## Variations in Landscape Sensitivity towards Wind Energy in Belgium

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For many decades opponents to wind energy have focused on the landscape intrusion as one of the strongest argument (Wolsink, 2007).

The Lacsawep research project aimed to analyse and assess the landscape capacity and social attitudes towards wind energy parks in Belgium (Van Rompaey et al., 2009). Among other it assessed how people react towards wind farms in rural and semi-rural landscapes.

Belgium is situated at the language and cultural border between germanic (Dutch and German) and romanic languages (French), in Western Europe, one of the most densely populated area of the world. Flanders – the Dutch-speaking part - is far more urbanized (460 people per km<sup>2</sup>) than Wallonia – the French-speaking part (207 people per km<sup>2</sup>). Hence some differences in sensitivity towards landscapes could be expected, as it was noticed in a comparison between French and Dutch situations (Buijs et al., 2006). Contrary to other people, Belgians seem to have few sensitivity towards landscape, especially in the French-speaking part.

A photo-questionnaire survey has been conducted among 1500 Belgians according to the sharing of Belgian people (about 1000 Flemings and 500 Walloons). This survey method allows to reach a broad public. People had to mark various rural landscapes (with or without wind farms) on a likert-scale according to their scenic attractiveness.

Landscape sensitivity varies in Belgium. Flemings scored more positively towards rural landscapes than Walloons who used more often the lower item of the scale. Flemings are also more sensitive to wind farms in the landscape. Of course cultural differences between both communities could explain it. But other parameters have also been tested : urbanization rate, gender, level of education... Separately all those parameters are significative. The paper analyses how they are linked together and wich one influence the most the landscape

sensitivity of Belgians. In other words, can we predict people attitude towards landscape and wind energy through their profile?

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## Objective, Interpretable and Powerful: Introducing least Cost Transect Analysis in Landscape Genetics

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Landscape genetics is a rapidly developing discipline aiming to assess the effect of landscape on intraspecific genetic structure. To quantify the landscape between two populations, landscape geneticists mostly use either landscape resistance surfaces and resulting cost (e.g. Quéméré et al. 2010) or resistance distances (McRae 2006) or methods that use a buffered straight-line transect to quantify intervening landscape (e.g. Emaresi et al. 2011). However, these methods have several drawbacks. Parameterization of resistance surfaces is usually a subjective process and cost or resistance distances are often difficult to interpret ecologically. On the other hand, a transect-based approach might oversimplify dispersal patterns by assuming only straight-line interactions between populations (Spear et al. 2010).

To overcome these limitations, we present a new and more objective landscape genetic method: least cost transect analysis (LECTA). Habitat-matrix resistance surfaces are used to create least-cost paths, which are subsequently buffered to form transects in which the proportion of landscape elements are quantified. To maintain objectivity, this analysis is repeated so that each landscape element in turn is regarded as habitat. Furthermore, we introduce a specialization factor that quantifies the relative resistance value of the matrix and thereby accommodates the testing of various migration hypotheses. The relationship between landscape predictor variables and genetic distances is assessed using multivariate regression on distance matrices (Smouse et al. 1986). We apply LECTA to an empirical genetic dataset of the endangered damselfly, *Coenagrion mercurial*, within a fragmented agricultural landscape in Switzerland. We compare the results to those obtained from traditional cost and resistance distances and show that LECTA not only outperforms existing methods in a statistical way, but also provides more information about the ecology of the focal species.

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## **Addressing the Challenges of Climate Change in the Greater Everglades Ecosystem: Participatory Spatial Simulation Methods for Climate Adaptation and Strategic Conservation Planning**

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There is widespread recognition that climate change will fundamentally affect how conservation planning can and should be done. As Hansen et al. (2010) state: “to be successful, conservation practitioners and resource managers must fully integrate the effects of climate change into all planning projects.” In this regard, climate change poses a challenge to conventional “fixed protected areas conservation” because changing climate is expected to shift the distribution of suitable areas for many species. In addition ongoing urbanization processes in low lying topographies will be exacerbated by climate related effects. Few landscapes will be so challenged by climate and landscape change as the Greater Everglades Region in Southern Florida. Under climate change, this region will experience significant loss of land, and potentially complex changes to human population settlement patterns. The need to address and plan strategically is critical given the complexity of overlapping systems and competing interests.

This paper presents a participatory spatial-scenario and simulation modeling method developed to detect the major challenges to conservation efforts due to climate and urban change in the Greater Everglades landscape of Southern Florida, USA. The application of the method allows testing the effectiveness of participatory simulation and scenario modeling methods as exploration, learning and uncertainly management tools. The project integrates two methodological approaches: 1) stakeholder-based participatory landscape planning and 2) scenario-based simulation modeling. The merging of these two methods has proven as a useful route forward in dealing with the multidimensional complexities of climate change as it relates to landscape and ecological change. It allows some substantial progress to be made using explicit assumptions as placeholders for future information, and indeed can help to scope which research is needed and where. This approach is especially useful when embedded within an

adaptive management framework in which stakeholder and social learning across disciplines, agencies and jurisdictions is needed.

Through extensive consultation with over one hundred policy makers, scientists, land use planners and conservation and water managers, a series of future scenarios were derived. The scenarios generated were nested within global IPCC scenarios, but included additional information and assumptions relevant to conservation planning in Florida. The scenarios were then used as inputs to spatial simulation models which simulated sea level rise and spatial shifts in human land use and settlement patterns. The resulting "alternative futures" represent a range of plausible future land use and land cover configurations in 2020, 2040 and 2060. This set of spatially-articulate potential future land use maps allows us to explore the interaction between global climate change, human population settlement preferences, and state and local policies. In doing this, this study begin to judge the effectiveness of current conservation strategies against a landscape in which people - as well as species - are likely to relocate in response to climate change.

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## **A Methodological Proposal for Valuing Multiple Ecosystem Services: An Example in the Mexican Humid Tropics**

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It is now widely recognized the importance of ecosystems have to maintain human well-being by providing of goods and services; however, evidence of the serious degradation of human activities on ecosystems has generated a great concern (MA, 2005). Therefore, economic valuation of ecosystem services has had a great response to integrate biophysical and social dimensions in a target group, the environmental protection. This integration can help to potentiate the technical progress as well as to provide more information about the importance of ecosystems from an economic perspective. For decision support most studies of ecosystem valuing have focused in a qualitative approach rather than a quantitative one. For that reason, this study aimed to develop and to implement a tool for economic valuation of multiple environmental services. The Region of "La Chontalpa" in Tabasco, México, was used as a case of study; this region is located in the humid tropics, at the southeastern part of the country. The economic valuation tool has contributed to generate strategic knowledge about the ecosystems of the region that can help in decision support (Vazquez-Navarrete *et al.*, 2010). This valuation tool consisted of three stages: (1) classification and delimitation of natural ecosystems and agro-ecosystems, (2) selection and economic valuation per unit area of 16 ecosystem services, (3) quantification of partial and total economic value of those services. This method allowed to effective and efficient viewing of the total economic value of "La Chontalpa" Region (1553 million dollars). Natural ecosystems accounted for 84% of

total value and flood zones (wetlands) accounted for 49.4% of the total, mainly for water regulation, contingencies regulation and water supply services. The production of food and raw materials accounted for 76% of the value of agroecosystems. The conservation and protection of this natural capital is essential to maintain these services. Deepen the technical information and monitor changes in economic value are important recommendations.

**Keywords:** Economic valuation, Environmental services, Wetlands, Tabasco

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## **Monetization of Recreational Services for Protection Needs of Coastal Landscapes**

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The global financial and economic recession of the last years lead to revaluation of the use of available natural resources, including those services provided by landscapes. The coastal landscapes have been traditionally exploited by different economic actors - harbours, fishery, agriculture, forestry and tourism. On the one hand these sectors are bringing financial benefits for society and on the other hand they are causing changes in landscape structures and functionality. In a situation when governments are desperately seeking for additional incomes or cutting public expenditures the necessity for maintenance of the coastal natural landscapes versus expansion of economic development and related change in land use is heavily debated.

This situation has induced an opportunity to explore how recreational services associated with certain landscapes are valued in a changing economic environment. For that purpose, a study was performed during August 2010 at several beaches of Latvia. Latvia as one of the countries of the Northern part of European Union has 500 km of coastline for recreation and tourism. Up till now access to beaches has been free of charge independently form the ownership status. The study was conducted in two urban, one semi-urban and one rural location in areas with different landscape types. In total 643 respondents were interviewed at beach to investigate a range of the issues related to beach and landscape management. The



key research questions were related to important landscape elements identified by the beach visitors as future customers, readiness of a customer to contribute to the protection of beaches and adjacent landscapes and factors driving the decision to contribute to the landscape protection.

The study revealed that the absolute majority of visitors are aware about the importance of the protection landscape at present state as well as to keep the beach in good status. The respondents recognise natural landscape features, e.g., beach, dunes, pine-forested shoreline, waves and waters as more impressive characteristics compared to the artificial ones, e.g., fishermen boats, ports, ships, lighthouses. Despite of the partial dissatisfaction on the present status of the beach area, the results show an unexpectedly high share (72% of respondents) of unwillingness to allocate any monetary sum for protection of the coastal landscapes. The reason for declining a potential payment is justified that the landscape protection shall be ensured by the law or the state or local government shall take care about this. Comparatively few of the respondents excuse their negative answer with low income.

The results of this research are in line with those of the earlier studies. The valuation of landscape services might be influenced by the political background and economic circumstances during the study period. Therefore, an intention to attract national and local policy makers to protect coastal landscapes for recreational services based on market mechanisms may not be promotable in certain economic and financial conditions.

## **Discussing and Mapping Territorial Capital for Ecosystem Service Provision and Rural Development at Multiple Scales**

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Regional distinctiveness is supported by the European Union in rural development policy. However, there is little information about the spatial distribution of the potential for rural development across Europe. The concept of territorial capital is offered as a methodological framework for considering spatial characteristics in assessing capacity for rural development. Translating expert-based descriptions of territorial capital in mappable proxies we locate regions with development capacities in intensive agriculture, off-farm employment, rural tourism and conservation. Combining these potentials, the capacity for multiple functions within regions is assessed. The assessment output maps offer policymakers specification of competitive locations for a number of rural development options. Besides the European Scale assessment of potentials and constraints for rural development a regional case-study is presented to derive rural development options in more detail. Within this case study use is made of photorealistic visualization tools to support the discussion of alternative future developments. Participants indicated that such visualizations have added value for the discussion. Based on the results of the analysis the value of the concept of territorial capital for determining landscape functionality will be discussed.

## **Quantification and Valuation of Ecosystem Services under Conditions of Land Use Change**

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The quantification and valuation of ecosystem service demand and supply is essential to design effective mechanisms and policies that aim at preserving ecosystems vulnerable to conversion or degradation. Standard methods for quantifying and valuing ecosystem services are not available. In quantification and modeling of ecosystem service dynamics the connection between land use change and ecosystem service provision is critical. Ecosystem service provision not only depends on land cover but also on the specific socio-economic and environmental context of a location and many non-linear and threshold effects are apparent. Scenario-studies may be used as a tool to explore the land use change effects on ecosystem service provision. This presentation outlines new approaches for exploring the effects of land change on ecosystem services at different spatial scales ranging from the global scale quantitative assessment for TEEB to a regional level analysis. Both demand and supply of ecosystem services are affected by changing societal and environmental conditions. Whereas ecosystem services are mostly analyzed as an impact of changing environmental conditions it is shown that a more integrated approach accounting for the changes in both demand and supply provides more valuable information for design of alternative management strategies.

## **Spatial Heterogeneity in Human-environment Interactions as a Concept for Landscape Sustainability Assessment**

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The design and evaluation of alternative pathways of governing the earth system requires an improved representation of the interactions between human decision making and the environment in large scale assessment methods. Especially the spatial and temporal variation in decision making and governance structures as result of variability in land use history, cultural and environmental conditions is not well represented in current assessment methods. While in regional scale approaches progress has been made, e.g. in multi-agent models, most large scale integrated assessment methods rely on simplistic representations of decision making and represent the landscape structure by land cover only. The presentation aims at discussing the options and constraints of including variation in human-environment interactions, including adaptation to global change, in global scale assessment methods. An innovative representation of landscape characteristics in global assessments is presented based on the notion of typical mosaics of land cover and human management intensity that represents some of the variation in human-environment interactions more explicitly. Pathways to better represent human-environment interaction in integrated assessment methods are shown and the implications for earth system governance towards sustainability discussed.

# Planning the Urban Fringe: Theoretical perspectives and practical limits in China

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Urbanization in China, especially in coastal areas, is generally assumed as the environmental cost of the strong economic growth of the recent last decades. The mechanism of land conversion to non-agricultural uses is producing a dramatic reduction of open-space in between cities, that tend inexorably to merge and, in some areas, like in Southern Jiangsu Province, the loss of landscape connectivity means also the non-reversible transformation of a valuable rural historic landscape whose structure can be dated back to the ancient Yangtze River Delta settlements (Liu et al., 2010).

Open space management and conservation is by now recognized as a fundamental object of planning decision-making process addressing the challenge of ecosystems preservation such as the need of landscape protection. Moreover the development and the systematization of different open space planning methods makes more evident the importance of “landscape-related methods” especially for fast-growing metropolitan areas treating agricultural lands as landscape assets (Maruani et al., 2007).

The outcome of some recent research works on urban fringe planning evaluation has stressed the role of advanced systems of governance in open space allocation (Verdini, 2009) but, at the same time, a still unsolved question about the conflicting relationships between state and market in open space preservation at least in western planning culture (Van Dijk, 2009).

This long lasting and ongoing debate represents an important set of theoretical tools, for facing Chinese metropolitan areas challenges in open space management today, but raises some questions on the applicability of these models of intervention due to some contextual features that have to take into account such as the often precarious social condition at the fringe and to the presence of fuzzy and informal economic practices as engine of economic and urban development (Huang, 2011). The paper’s aim is to depict a theoretical framework, based on international literature, for urban fringe planning in China outlining practical limitations based on some evidences from the Southern Jiangsu Study case.

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## Using Remotely Sensed Surrogates to Increase the Efficiency of Payments for Ecosystem Services

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Programs of payment for ecosystem services (PES) are emerging in many places around the world. They provide incentives for environmentally friendly activities, including forgoing damaging economic activities. However, the efficiency of PES programs at large scales is largely unknown. The objective of this study was to develop a simple yet general approach based on remotely sensed surrogates for targeting land to maximize environmental benefits and aid with poverty alleviation. This approach was applied to evaluate the effectiveness of currently enrolled parcels in one of the largest PES programs in the world: China's Grain-to-Green Program (GTGP). This program encourages farmers to return steep hillside cropland to forest by providing cash, grain and tree seedlings. The approach developed constitutes a first order but suitable targeting approach, as it allows locating parcels to be enrolled in the program for maximizing soil retention and reducing soil erosion and landslide susceptibility. The approach also allows for locating the parcels in areas under cropland and with low opportunity costs for farmers. Results show that around half of the parcels currently enrolled in the GTGP program in a county situated in Sichuan province (i.e., Baoxing) of southwestern China are placed in areas with gentle slopes and tend to be located distant from forest areas. This reduces the environmental benefits potentially obtained from the program. Targeting parcels for enrollment using the proposed approach may substantially increase the efficiency of the program. Targeting may also contribute to poverty alleviation, as it may allow the program to potentially reach poorer people. Due to its simplicity and generality, the approach described may be applicable to similar PES programs around the world.

**Keywords:** Baoxing, China, Grain-to-green program, Opportunity cost, Payment for ecosystem services, Remotely sensed surrogates, Targeting

## Mosaic-Pest: Landscape Management of the Pollen Beetle Using a Spatially Explicit Model

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There is growing body of evidence that agrochemical inputs have led to a decline in biodiversity at the field, cropping system and farm levels. Many scientists are arguing recently that functional biodiversity could maintain important ecological services, such as biocontrol of pests. Moreover, increasing studies point out that pest management in agro-ecosystems requires a landscape perspective to be achieved, as landscape composition and structure affect both pest populations and their relative beneficial organisms (Rusch et al. 2010). Pollen beetle (*Meligethes aeneus* F.) is the major insect pest of oilseed rape (*Brassica napus* L.) in Europe, and is parasited by the ichneumonid *Tersilochus heterocerus* (Thomson). It appears that semi-natural habitats, especially woodland and grassland, are favorable for both overwintering of beetle populations and nutrients acquisition of parasitoids (Rusch et al. 2011). Moreover, soil tillage and pesticides use influence natural parasitism at large scale. To study this conflicting influence of landscape, and to explore new crop management and landscape arrangement, a modeling approach at larger scale is essential. Therefore, we developed a lattice model to simulate the spatio-temporal interactions between beetles and parasitoids in relation with landscape composition and structure.

The model describes the most important processes (dispersal, mortality and fecundity) affecting population structure in space and time. Parasitism rate was described by Thompson formalism. Landscape elements (semi-natural habitats, crops and grasslands) and agricultural processes (crop rotation, soil tillage, pesticides use) were explicitly considered in the model, considering their influence on beetle and parasitoid populations. Species-specific parameters were derived from the literature available on the species or its closed taxon. Landscape mosaic was defined on the basis of GIS maps collected in north-western France, figuring contrasting situations in terms of landscape complexity.

The model was confronted to real population levels of beetle collected in the zone. A sensitivity analysis of the model allowed evaluating the importance of each species trait and landscape parameters in the explanation of population level. By linking species traits and landscape complexity, the model helps us understanding the ecological processes underlying landscape patterns. We discussed the potential of this model to use ecological services provided by landscape to select landscape managements that limit populations of beetles.

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## Combining Pattern and Network Analysis to Identify Key Connectors

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Conservation and enhancement of ecological connectivity is widely recognized as one of the

key objectives of forest landscape management. We present the novel integration of two recent approaches for analyzing forest structural connectivity that offers considerable synergies and potential relevant benefits for forest planning at a variety of scales. Morphological Spatial Pattern Analysis - MSPA (Soille and Vogt, 2008) provides an intuitive description of image pattern structures as well as a reliable detection of connecting pathways. This pattern analysis can then be transferred for further studies using network theory approaches, which are particularly suited to quantify the importance of the MSPA-detected nodes and links. The proposed integrated approach can equally serve to identify (a) those forest areas that play a crucial role to sustain ecological fluxes that are to be promoted by management, such as the dispersal of native biota or (b) those sites where the spread of wildfires or invasive species can be halted more effectively. The potential of the proposed methodology to inform and guide landscape-planning decisions is reinforced by the availability of the required analytical tools (Guidos and Conefor Sensinode) as freeware software packages. The key features of MSPA and network analysis in Guidos will be illustrated and explained on a sample data set.

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## Maximum Entropy at Intermediate Anthropogenic Dynamics

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Landscape entropy represents heterogeneity within a landscape (Renyi, 1961; Bogaert et al., 2005). Previous researches found increasing values of entropy by studying a limited number of zones increasingly affected by anthropogenic effect (O'Neill et al., 1988; Bogaert et al., 2005). The present research aims to generalise the relationship between anthropogenic effect and landscape entropy, with a further goal of linking these concepts to overall biodiversity.

16 study zones from classified LANDSAT TM scenes and Africover maps presenting different anthropogenic effect intensities have been used (Djibu et al., 2008; Bamba et al., 2010; Barima et al., 2010; Munyemba, 2010; Vranken et al., 2011). Simpson's  $H$  diversity index based on class number has been used for entropy measurement (Renyi, 1961; Pielou, 1975; Shannon and Weaver, 1963).  $1-H$  has been retained to get the relationship between the index and diversity directly proportional. For anthropogenic effect measurement, O'Neill's  $U$  disturbance index, quotient between anthropogenic and natural areas, has been used (O'Neill et al., 1988).  $\log H$  has been retained to linearise the exponential relationship between the index and anthropogenic effect. Correlation between those variables has then been analysed.

The scatter plot of the 16 study zones shows a Gaussian curve (Fig. 1) presenting maximal landscape entropy at intermediate anthropogenic effect. This distribution has been modelled by a second order polynomial regression with determination coefficient and significance.

This phenomenon has been interpreted in terms of spatial transformation processes (Bogaert et al., 2004) and linked to the habitat heterogeneity hypothesis (Tews, 2004), as well as the intermediate disturbance hypothesis (Connell, 1978; Lindenmayer and Brugman, 2005).

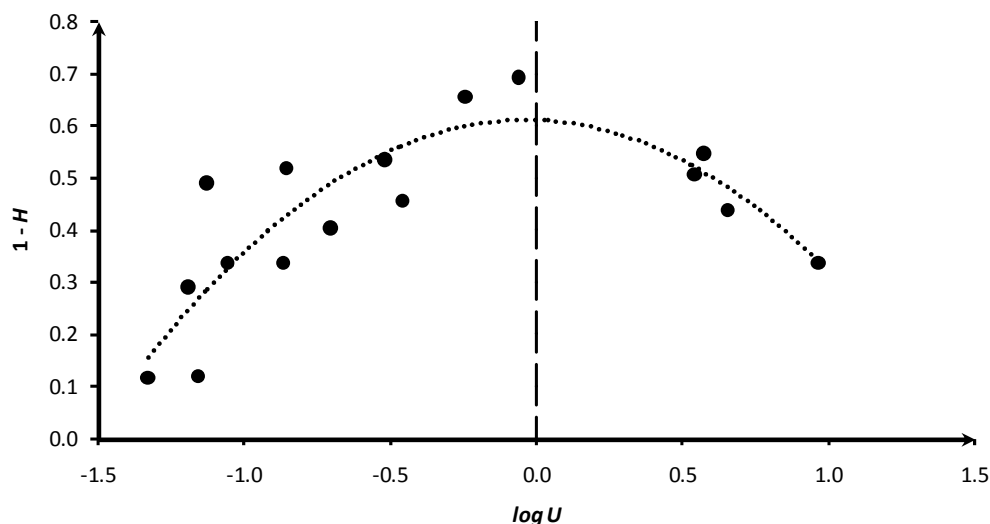


Figure 1: Entropy ( $1-H$ ) depending on anthropogenic effect ( $\log U$ ). Dashed line shows the intermediate proportion of anthropogenic land covers. Equation of the regression line (dotted line):  $y = -0.271 x^2 - 0.018 x + 0.610$ ,  $R^2 = 0.720$ ,  $P$  value of quadratic function = 0.000256.

## Vietnamese Magnolias: Potential Resources for Landscape Ecology

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Vietnam is one of the biodiversity's hot spots in Asian countries. Of totally 12000 plant species, there are more than 20% of those endemic for Vietnam and number of species are being use for traditional medicine, lanscape and other values. The family Magnoliaceae is one of the important groups in flowering plants and the important component of tropical rain forest. With totally ca. 300 Magnolias species world-wide, there are at least 55 species occurring in Vietnam and most of them are used for potential landscape by their wonderful aromatic flower, nice stratum and leaf canopy as well as fast growing. By observation as well as study the Vietnamese Magnolias over the years, the author would like to provide comprehensive and widely accessible data-set of the Vietnamese Magnolias's potential landscape ecology including the currently accepted taxonomy, distribution maps, geo-referenced specimens etc., especially in endemic species such as *Magnolia annamensis* Dandy, *M. clemensiorum* Dandy, *M. nana* Dandy, *Michelia braianensis* Gagnep, *M. tonkinensis* A. Chev., *Manglietia blaoensis* Gagnep., and 2 endemic doubt species: *Manglietia phuthoensis* Dandy ex Gagnep. and *M. poilanei* Dandy ex Gagnep. The presentation will be very essential to contribute scientific lanscape ecology both Vietnam and the world.

## **The Whole is more than the Sum of Its Parts - the Potential of Landscape Metrics in the Assessment of Land-use Changes**

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Landscapes and open space in central Europe are still under pressure due to settlement development and fragmentation by technical infrastructure. Concurrently agriculture experiences an enormous intensification process, especially by growing plants for bio fuel. All of these changes in land use often take place as small-scale individual measures, insignificant in themselves. However, over the long-term, the accumulation of such minor changes can lead to significant shifts in landscape structure – and hence also to the abiotic and biotic functions and potentials of a landscape environmental conditions.

Such structural changes in landscapes can be detected, measured and monitored by the means of landscape metrics (Walz, 2008). They can be used to describe the composition and spatial arrangement of a landscape – such features as size, shape, number, type and arrangement of landscape elements. Especially in the context of biodiversity, landscape metrics play a considerable role in the analysis and assessment of diversity of landscapes, to carry out isolation or connectivity analysis and to recognize and to monitor the results in changing landscapes (Bolliger et al., 2009; Uuemaa et al., 2009).

The contribution will give examples for the application of landscape metrics in monitoring of land use changes and the detection of cumulative effects. Also effects on Landscape Services were evaluated. In the focus are the topics of land use changes in rural and protected areas (structural changes in sizes of land units, distribution of grassland etc.) and the development of landscape fragmentation by infrastructure and development of settlements in Germany.

Results of the investigations in rural areas show, that small-scale structural changes at a whole have significant effects on Landscape Services, e.g. on Regulating Services (Soil Erosion) (Wolf et al., 2009) or Cultural Services (Recreation). Also effects on biodiversity can be observed: Comparisons between historical and actual landscape structure as well as the diversity of plants indicated a decrease within the last 50-60 years (Walz and Müller, 2009). Methods and indicators for evaluation of changes in land use and fragmentation including the degree of naturalness, the connectivity of biotope corridors as well as the permeability of roads are presented. Because the small scale landscape structure between these corridors is also very important, a concept postulating large core areas, connecting biotope corridors as well as a small scale diverse landscape between these areas is proposed.

## **A Software Framework for Food Provisions Simulation and Integration with HASM**

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A software framework conducted in the modeling process of food provisions services assesment through surface modeling and spatial simulation modeling is presented here.

Food provisions services constitutes a critical part of ecosystem services assessment and sustainability research(Munns 2008; Battisti and Naylor 2009). However, there are a couple of challenges behind this issue including heterogeneity of multiple data sets and complexity of model building. To handle compatibility between heterogeneous data sets, the modeling process need to link surface modeling representing ecological data in grid cells with ecological modeling. However, there are error problems in classical methods of surface modeling(Yue, Du et al. 2007). Furthermore, there is still limited experience in developing food provisions models that consider surface modeling of climate change and food productivity computation in a single framework.

High-accuracy and high-speed methods for surface modeling (HASM) were used to solve error problems and improve the quality of climate interpolation. Food provisions potential and spatial distribution can be obtained by means of the mechanism methodology and process of gradual modified computing models considering natural and social factors. Not only is batching existing data and models executed, a supermatic and high efficiency modeling approach is also designed for specialized data exchange between the various components.

This framework is easily applied to the development of natural system modeling integrated with climate change in other ecosystem. Our knowledge emphasize the challenges in synchronizing earth surface modeling and ecosystem modeling .The studies from the model integration process are meaningful for future studies that aim to integrate earth surface modeling and ecological modeling.

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## **Wetlands and Regional Climate Change : A Case Study on the wetland of Sanjiang Plain**

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Global environmental change is the core question of the sustainable development. Since “Land-Use and Land-Cover Change ” research has been posed, the persistent influence of land-use history and natural disturbance on contemporary ecosystems has become apparent.

Landscape patterns result from complex relationships among multiple factors (Turner,2005). Climate strongly controls landform and bio-geographic patterns. But the ways in which humans use the land are key drivers of landscape pattern (Riitters et al., 2002).

Wetland is an ecosystem, which has many unique functions, especially in regulating regional climate. Sanjiang plain is the largest concentrated area of the freshwater wetlands in China. In the past decades, the area of wetland in this place declined sharply. Agricultural activities, particularly reclamation, are considered major threats to the wetland ecosystem (Wang Z. et al., 2006).

For the purpose of explaining how wetlands landscape patterns influence the regional climate, Jiansanjiang state farm in Sanjiang plain were chosen for study. Based on application of remote sensing and geographical information system, using geo-statistical analysis methods, the conversion of wetlands landscape were evaluated firstly, then discussing the regional climate change. The result shows that: (1) It is an essential factor for the rise of air temperature that the wetlands landscape matrix has been different; (2) the matrix has affected the original form of water circulation on earth, leading into the lack of precipitation; (3) the region climate has altered by the change of wetlands landscape, converting from humid and cold to dry and warm gradually.

**Keywords:** Wetland, Landscape change, Climate, Sanjiang Plain

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## **Urban Environment on Transpiration of Horse Chestnut (*Aesculus chinensis*) in Beijing**

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Urban environments can significantly influence the transpiration of trees. Therefore, optimum green space design, tree species selection and tree maintenance requires that the transpiration patterns of urban trees be quantified. In this study, the diurnal, daily, monthly, seasonal, and annual variations of transpiration of horse chestnut (*Aesculus chinensis*) in Beijing were studied with respect to climate factors and airborne pollutants. Higher values of sap flux were observed between 10:00 and 13:00 in summer, and lower values during the night in winter. The annual sap flux in 2008 was similar with that in 2009, although rainfall was much higher

in the first year (724.8 mm) than in the second year (432.8 mm) due to timely scheduled supplemental irrigation. Based on outcomes of Principal Components Analysis (PCA), the evaporative demand index consisting of air temperature, soil temperature, total radiation, vapor pressure deficit, and atmospheric O<sub>3</sub> level explained 68% and 80% of the hourly and daily variations in trees' water use, respectively. Sap flow reached two asymptotes where evaporative demand did not cause sap flux to increase further. Air quality, air humidity, rain factors had little influence on sap flux. Using hierarchical partitioning, the variation in transpiration was accounted for by independent and joint effects, with joint effects explained more of the variations in tree transpiration patterns. PCA coupled with hierarchical partitioning was able to demonstrate unequivocally the minor yet consistent adverse impacts of atmospheric O<sub>3</sub> on the transpiration of urban trees.

## **Landscape Ecology Planning and Design of Land Consolidation in Karst Area: A case of land consolidation project in Libo, Guizhou, China**

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Land consolidation is re-organizing and re-optimizing of the land resources and land use type process, it changes land use type, spatial structure, landscape pattern and ecological process. Therefore it is urgent and important that research on the landscape ecological protection of land consolidation especially fragile karst area. Landscape ecological planning and design promotes effectively the protection and recovery of the ecosystem, which is merged into land consolidation which is an important trend of development. In the paper, on the basis of theories and principles of landscape ecology, the methods of landscape ecology planning and design in land consolidation are discussed. At the same time, taking a land consolidation project in Libo country, Guizhou province as an example, the landscape planning and design of farmland patch, irrigation and drainage engineering, road engineering and biodiversity projection engineering are deeply analysed. It should be an effective way for preserving the natural landscape and biodiversity. The aim of this research is to provide scientific insights for planning and design and evaluating of impact on ecology and environment in land consolidation practice.

**Keywords:** Karst area, Land consolidation, Landscape ecological planning and design

## **Value Evaluation on Soil Conservation Function of Ecosystems in the Southern Mountain Region of Jinan**

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Production, medicine, materials of industry and agriculture, but also has an important functional value that is soil conservation, water conservation, regulating climate and revitalizing environment. In the process of the using and transforming human nature, the individuals focus on the direct value of the natural resources, ignoring the functional value of ecosystem, however, its service function in fact has great economic value. To some extent it can measure the ecosystem environment of the region to determine the value of ecosystem services, which provides an important basis to formulate policies about ecology. Therefore this article selected the important groundwater supplement area ----the southern mountains of Jinan to be the study area and measured the value of the soil conservation function of four kinds of agricultural land including arable land, woodland, grassland and garden-plot in this area and also studied the changes of the value on the basis of land use.

Based on 3S technology, using the methods of matter quantity and value quantity, the value of soil conservation function about the woodland, grassland, garden-plot and arable land in the southern mountain region of Jinan has been calculated on the basis of land use in 1996, 2001, 2005. The results express: the value of soil conservation function lost 9363.84 million yuan from 1996 to 2001, but it increased 6641.3 million yuan from 2001 to 2005, so the value of soil conservation function lost 2722.54 million yuan from 1996 to 2005.

## **Interplay between Soil, Water and Vegetation in Water- limited Systems**

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In water-limited ecosystems patterns of both nutrient and water availability constrain the spatial and temporal dynamics of plant growth. Water and nutrients (e.g., nitrogen) are often explored separately in terms of the individual constraints they place on ecosystem function within water-limited ecosystems. This research will demonstrate that integrating biogeochemistry, hydrology and vegetation feedbacks leads to better understanding of ecosystem patterns and processes across a wide range of dryland environments based on results from manipulation experiment, field observations and modeling. The results show that water availability determines nitrogen availability across regional rainfall gradients, but these patterns are strongly mediated at local scales by vegetation patchiness, which plays an important role in nitrogen re-distribution and availability (Wang et al., 2009a; Wang et al.,

2009a). We used a recently developed laser-based isotope analyzer and Keeling plot approach for surface flux partitioning. The results show a clear vegetation feedback in dryland water cycle: there is a significant increase in transpiration relative to total evapotranspiration as woody plant cover increases from 61% at 25% cover to 83% at 100% cover (Wang et al., 2010). These results demonstrate that integrating biogeochemical and ecohydrological observations is necessary to provide holistic views of the complex processes governing dynamics of dryland ecosystems.

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## Spatial-Temporal Patterns of Food-Potential Conversion Ratio and Population Pressure in China

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Food security was defined by The World Food Summit as all people, at all times, having access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (FAO, 2009). As food nutrition indexes become more and more important in evaluating the degree of food security, it is necessary to estimate the food provision with nutrition indexes besides the traditional food security evaluating indexes like grain productivity (Yue et al., 2008, 2010). Besides total food provision, the spatial-temporal patterns of population pressure and conversion ratio of food-potential are also worth study.

Based on county-level food yield data and population data (1990-2005), this study developed calculating models (Formula 1-3) to calculate the food nutrition provisions of agricultural ecosystem as well as the food-related population pressure in China. Total provisions of food nutrition were calculated through Formula 1 referring to the book of China Food Composition (Yang, 2005). Maps were drawn through ArcMap tools, showing the spatial patterns of food provision and population pressure (Fig.1). The conversion ratio of food potential of the terrestrial ecosystem in China was calculated with formula (4), and nationwide sectional statistical map and analysis was made (Fig.2). These maps and analysis can illustrate the food provision situations in China, providing basis for further study and policy making.

$$(1) P_{ij} = \sum_{l=1}^5 M_{il} \times QN_{jl} \quad (2) Pop_{ij} = P_{ij} / 365 / F_{jk} \quad (3) Pr s_{ij} = Pop_i / Pop_{ij}$$

$$(4) \quad Tr_i = P_{ai} / P_{0i}$$

In formula 1-3,  $P_{ij}$  means the total nutrient production from farmland in county  $i$ ;  $M_{il}$  is the total production of crop  $l$  in county  $i$ ;  $QN_{jl}$  is the conversion factor from crop  $l$  to nutrient  $j$ .  $Pop_{ij}$  represents the population that food nutrition  $j$  provided in county  $i$  can support.  $P_{ij}$  is the provision of food nutritious  $j$  in county  $i$ .  $F_{jk}$  is the consumption standard of food nutritious  $j$  under living level  $k$ .  $Prs_{ij}$  represents the population pressure index;  $Pop_i$  is the actual population in county  $i$ .  $Pop_{ij}$  is the population that food nutritious  $j$  can support. In formula 4,  $Tr_i$  represents the food potential conversion ratio;  $P_{ai}$  represents the present food provision, and  $P_{0i}$  is the food potential.  $i$  is the region number.

Results show that, population pressure in North China is the lower than in South and East China. Food nutrition provision structure is imbalance - food fat shortage and food calorie and protein surplus is the main problem for most counties with high population pressure. Food potential in the south part of China is much larger than in the north, while the conversion ratio is exactly the opposite. There is still great food potential remaining to be explored in South China. While the actual situation is that large amount of high-yielding cropland in South China has been occupied by buildings or other landuse types every year for the rapid economic development. Therefore, in order to ensure sustainable food security for the country, it's necessary to preserve the croplands and reclaim new food resources in the unclaimed arable land in the south and east part of China.

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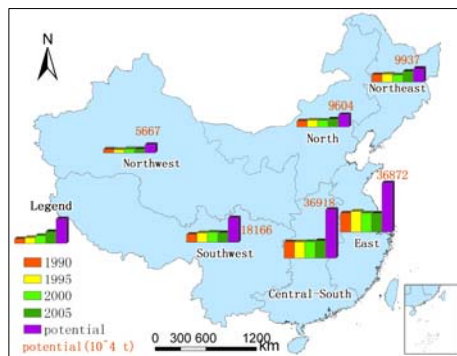


Fig.1 Potential and actual production of grain in each region of China

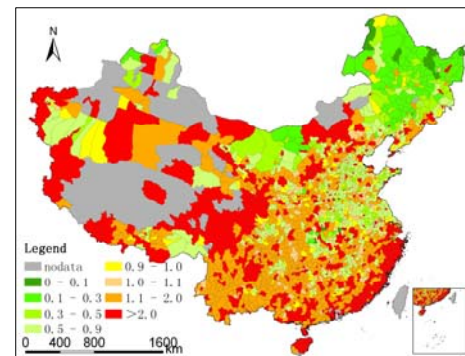


Fig.2 Population pressure in China

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# Assessment of Urban Green Space Using Park Cool Intensity and Net Primary Production

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Improving the urban vegetation coverage is identified the effective way to mitigate the urban heat island especially in city center. To understand the cool effect of urban green space, this study select the parks in city center to estimate the mitigation effect on urban heat island.

In this study urban surface temperature, normalized difference vegetation index, land cover data and parks in the city center were used to analysis the cool effect of parks.(Wang and Nakagoshi, 2010a;Wang and Nakagoshi, 2010b;Li et al..2010 ). 42 parks that located in the urban center were chosed in this study.

Park cool intensities(PCI)are determined on the basis of the thermal difference between the parks and the surrounding area as follows:

$PCI = T_b - T_p$  Where  $T_b$  is average LST of the buffer zone;  $T_p$  is the average LST of the park.The park cool intensity is used to identify the mitigation effect.

Landscape shape index (LSI): ratio of sum of edge lengths to total area for a landscape measured against a circle standard.

The results indicate that the park size and park shape can effect the cooling effect and there was no obviously linear relation between the park size, park shape and PCI intensity, but the park size that above 3km<sup>2</sup> has a PCI intensity more than 2°C. The green space coverage in the park and the buffer zone around the park determined the PCI intensity and water body inside the park has positive impact on PCI. The park with high NDVI in city center has large PCI intensity.

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- Wang RH, Nakagoshi N, 2010b.Urban green space planning and its potential countermeasure mitigating heat islands in Beijing, China.The fourth East Asian Federation of Ecological Societies.

# Urban Heat Island in the Capital Area of China: Analyzing the Environmental Significance of Urban Green Spaces

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The objective of this study is to analysis the change and affect facotrs of urban heat island effect using remote sensing and GIS technology. The urban green space plan and park cool intensity were used to assess the urban heat island effect mitigation and it was main parts of the author's Ph.D dissertation(Wang and Nakagoshi, 2010a; Wang and Nakagoshi, 2010b;Li et al.2010 ).

The land cover change is one of the important factors for the aggravate urban heat island intensity. The increasing energy consumption is the another driving force for UHI effect. The anthropogenic heat explore to the air caused the surface temperature increased. In summer, it show urban heat island phonomenone while in winter it appeared urban cool island.

From 1978 to 2008, the coverage of city green area increased from 22% to 43% and the per capita park green areas increased from 5 to 13 sq.m/person. Although the past 30 years the population increased sharply, the results showed that everyone live in this city enjoyed more green space than ever before. In the urban greenspace planning of Beijing city which was published in 2008, it designed the coverage of city green areas will be 46~50%, the per capita park green areas will be 15~18 sq.m/person until 2020. The designed urban green space consisite the green corridor for the city not only improve the ecological environment but also import the cool air from rural area to the city center and relieve the urban heat island effect.

The results indicate that the park size and park shape can effect the cooling effect and there was no obvirously linear relation between the park size, park shape and PCI intensity, but the park size that above 3km<sup>2</sup> has a PCI intensity more than 2°C. The land cover especially green space coverage in the park and the buffer zone around the park determined the PCI intensity and water body inside the park has positive impact on PCI. The park with high NDVI in city center has large PCI intensity.

This research was supported by the Global Environmental Leader(GEL) Education program for designing a Low Carbon Socociety(LCS) of Hiroshima University, Japan.

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## **Influence of Urban Vegetation Structure on its Carbon Storage Function**

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In the context of global change, researching on the terrestrial ecosystem carbon cycle is a hot topic (Xu *et al.*, 2010; Ying *et al.*, 2009). In this study, the vegetation of three districts near the north bank of Hangzhou Bay (including Pudong New Area, Fengxian District, and Jinshan District) which close to the coastal zone of the six towns (such as Luchaogang Town, Zhelin Town, Shanyang Town, Caojing Town, Shihua streets) as the study object, stratified sampling method was used, coupling with randomly picking up sample plots with vegetation in the north bank of Hangzhou Bay. Biotic parameters (e.g. Diameter at breast height DBH, tree height etc.) were investigated. The improved volume-derived biomass method (Zhao *et al.*, 2006) was used to calculate the carbon storage of main vegetation types. The results showed: 1) In the north bank of Hangzhou Bay, the carbon storage among different forest type was different, *M. glyptostroboides* forest (0.156762 Mg C) had the higher carbon storage compared with other forest types. 2) Vegetation structures significantly influenced carbon storage, of which, the influence of tree height on carbon storage ( $r^2=0.568$ ,  $p<0.01$ ) was larger than others, for example crown base, DBH, and healthy condition etc. This study would provide a baseline in managing urban forest so as to maintain the cities' sustainable development, and it is useful to built "Shanghai low-carbon city".

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## **Detecting the Impacts of Climate Variability and Land Use Changes on Watershed Hydrology Using Multiple Approaches**

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Both climate change/climate variability and land use change has great implications for water resource availability of regions. With climate change and increasing global population stress that commonly results in great land use change, it is important to evaluate the respective hydrological impact of past climate change/climate variability and land use change on water resources availability of watershed. That is the prerequisite to adaptive watershed management under the changing environment. By using three different methods which are a simple conceptual model, the differential elasticity-based analysis, and MIKESHE model, we have evaluated the impacts of past climate variability and land use change on the decrease in streamflow of Chaohe watershed over 1963 to 2008. The simple conceptual model qualitatively assess the reasons responsible for the change in streamflow during three successive analysis periods (i.e. 1980 to 1989, 1990 to 1999, and 2000 to 2008), and the results was general in accordance with that of the other methods. Although the estimations of the contribution of climate variability and land use change to the streamflow evolution was a little bit different between the differential elasticity-based analysis and MIKESHE model due to the modeling errors, both methods has indicated that, compared with the reference period (1963-1979), the change in streamflow over 1980 to1989 was generally accounted for by climate variability and land use change with almost similar contributions. The change in streamflow over 1990 to 1999 relative to the reference period could be explained by the equivalent magnitude contribution of climate variability and land use change, but both factors showing opposite influence which causes the change in streamflow over this period was not great, whilst the change in streamflow over 2000 to 2008 was mainly attributed to climate variability. Moreover, it was revealed that climate variability usually incurs the advent of the change in streamflow time series, whilst land use change may affect the magnitude of hydrological response by impairing or augmenting the change in streamflow, depending on the direction of the influence of climate variability and land use change on streamflow. We concluded that, in the face of the global climate change, it is urgently requisite to take adaptive watershed management for sustainable water resource availability.

## **The Evolution of the Ecological Infrastructure of Beijing City**

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In the context of rapid urbanization in China, the economic development and ecological protection are in conflict. Lands for construction and lands for ecological protection are competing intensively, which has posed a serious threat to regional ecological security. The Ecological Infrastructure is the critical landscape network which is of strategic significance in providing basic and supporting ecosystem services, providing important theory and spatial strategy for the smart conservation of ecosystem, so it has important practical and theoretical significance.

In this paper, a systematic theoretical and empirical research on the identification, evolution

and evaluation of Ecological Infrastructure are studied. First, the content and characteristic of Ecological Infrastructure, and its significance for the smart conservation of ecosystems are analyzed. Then the overall research framework and the method of landscape ecological evaluation based on the Ecological Infrastructure are proposed Taking Beijing as an example, the evolution and evaluation of the Ecological Infrastructure of Beijing are studied.

The Ecological Infrastructure of Beijing is composed of the Security Patterns for hydrological regulation, soil conservation and biodiversity conservation. The Ecological Infrastructure covers about 80% of the total lands, providing significant and non-replaceable ecosystem services. From 1993 to 2007, the area of the Ecological Infrastructure of Beijing has decreased, and part of the lands with higher ecological functions have changed into lower ones. In the terms of landscape pattern, the Number of Patches and Patch Density of the Ecological Infrastructure have increased, while the Euclidean Nearest-Neighbor Distance and Patch Cohesion Index have decreased. The overall landscape pattern became more fragmented. Using the Ecological Infrastructure as evaluation standards, the indexes of landscape ecological functions of Beijing in 1993, 2001 and 2007 were calculated by Polygon Index Evaluation Method. The results show that the overall landscape ecological function of Beijing has declined, but the rate of decline slowed down significantly. Among other ecological functions, the water ecosystem, the capabilities of recharge of aquifer, stormwater regulation and biological conservation have obviously declined. The existing landscape pattern of Beijing does not meet the demands of safeguarding the ecological processes.

## **Shifts in Agricultural Phenophase and its Implication for Soil Erosion in the Loess Plateau of China**

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Loess soils are found on some of the most productive and widespread agricultural lands around the world, but the sustainability of these areas are increasingly threatened by soil erosion. Conventional plow-based agriculture summer fallow period concurrent with the heavy-rainstorm season greatly accelerated soil erosion and undermined the sustainability of the Loess Plateau (Wang et al., 2010). In this way, the longer fallow days, the higher the erosion risk. A 20+ year records (1981-2005) of phenology of winter wheat in central Loess Plateau detect the change in fallow days. Taking the period of 1981-2005, over 85% of analyzed stations showed a significant increasing trend in spring temperature at the significant level of 0.05 over the Loess Plateau. The rising temperature has caused significant shifts in timing of winter wheat. Winter wheat sowing dates became later by 4 days/decade ( $P<0.01$ ) for the period 1981-2005, while flowering and maturity dates became earlier by 5.0 and 5.6 days/decade ( $P<0.01$ ), respectively, resulting in the fallow days (sowing to maturity) markedly lengthen 8.7 days/decade ( $P<0.01$ ). The fallow days was significantly related to spring temperature and became earlier by 8.6 days for each 1°C rise in mean temperature in spring. Sowing date and maturity date became later and earlier 4.12 and 5.4 days for each 1°C rise. The longer soil bare days as response to warming and soils are subject to the heavy

beat of erosive rainfall in summer implying higher erosion risk.

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## Application of Landscape Ecology in Giant Panda Conservation

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Populations live in habitats whose quality varies spatially and temporally. Quantitative habitat assessment at large landscape scales using remote sensing and GIS methods plays a critical role in endangered species conservation planning and policy (Wang *et al.*, 2010). Serving as the essential food source for giant pandas, bamboo is the most important ecological variable in panda habitat assessment (Schaller *et al.*, 1985). However, lack or inadequate information about understory bamboo distribution in previous studies has led to the variety in both quantity and quality of panda habitat (Loucks *et al.*, 2003; Linderman *et al.*, 2005). In this study, the bamboo forests of the Qinling Mountains were mapped using Maxent model based on panda occurrence and multi-temporal satellite data. By incorporating this satellite-derived bamboo information, together with topography and human factors, the suitability of panda habitats were reassessed. Consequently, the conservation status of the current nature reserve network for pandas in the Qinling Mountains was also evaluated. The study results indicated that the panda occurrence data may be used as a surrogate for bamboo distribution modeling at a spatial resolution of 250m with an accuracy of Kappa 0.74 and AUC 0.92. The study also showed that deficiency of bamboo information and human disturbance factor may bring about a huge overestimation of the total suitable panda habitat as well as a serious underestimation of the degree of habitat fragmentation. The sharp drop in habitat area with bamboo information indicated overestimations of more than 70% and 80% in suitable habitat and marginally suitable habitat, respectively. Human disturbances further led to a reduction of 33% in suitable habitat and a decrease of 63% in marginally suitable habitat, as well as more severe habitat fragmentation. The reassessed panda habitats in the Qinling Mountains cover a total area of 1808 km<sup>2</sup>, which is much less than the area of 3475 km<sup>2</sup> that estimated from China's Third National Panda Survey (State Forestry Administration, 2006). About 54% of the habitat area consisting of large patches with good quality is under protection of the current panda nature reserve network, which is lower than the expected number of 72%. The study suggests that it is necessary to incorporate accurate and spatially continuous bamboo information that derived from remotely sensed satellite data into large-scale panda habitat research and management and to avoid overestimation of habitat.

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## **The Ecohydrological Approach for An Integrated Forest-water Management in the Loess Plateau of NW China**

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The historical deforestation and grassland overgrazing have resulted in serious soil erosion and desertification in the Loess Plateau in Northwestern China. Thus, large-scale forestation as an effective erosion-controlling measure has been undertaken over several decades, and will be continued in the future to meet the increasing demands on the multiple services of forests, including carbon sequestration and clean water supply. However, numerous studies have shown that forestation can reduce water yield on the dry Loess Plateau, as compared with the native vegetation of grasses and shrubs. Therefore, large-scale forestation could threaten the water supply security for downstream communities. Thus, innovative forestry development strategies are urgently needed to balance the conflicting forest services of water supply and erosion control. The objective of this study is to develop an ecohydrologically based decision approach to manage these competing forests' services in the Loess Plateau.

Our studies found that soil erosion can be markedly reduced when the ground vegetation coverage reaches a certain level (e.g., 70%), regardless of the vegetation types of forests, shrubs or grasses. This means that it is possible to protect the soil against erosion by restoring more water-saving vegetation other than the high water-consuming forests. A decision procedure for determining the forest coverage and management measures was developed based on findings as follows: 1) the maximum forest coverage in a region or watershed can be roughly determined according to the statistical relationship between forest coverage and annual precipitation; 2) the suitable forest coverage can be estimated based on the designed

water balance and the relationship between forest coverage and annual water yield; 3) the priority of sites and tree species for forestation can be identified for better timber production and higher stand stability against drought stress; and 4) the current forest management measures mainly for optimum productivity can be improved for achieving the goal of multifunctional services, especially a safe water supply. In addition, the application of process-based ecohydrological models as decision tools will be discussed in our paper.

**Acknowledgement:** Funding for this work was provided by the research projects of the State Forestry Administration of China (201104005, 200904056), the National Science Foundation of China (40730631, 41071023), the DFG (SCHW 1448/3-1), the NSFC-DFG Sino-German Center for Research Promotion, and the Key Laboratory for Forest Ecological Environment of the State Forestry Administration of China.

## **Landscape Characterization along the Appalachian Trail towards Decision Support for Monitoring, Reporting and Forecasting Ecological Conditions**

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The Appalachian Trail traverses most of the high elevation ridges of the eastern United States, extending about 3,676 kilometers across 14 states, from Springer Mountain in Northern Georgia to Mount Katahdin in central Maine. A.T.'s gradients in elevation, latitude, and moisture sustain a rich biological assemblage of temperate zone forest species. The Trail's north-south alignment represents a cross-section MEGA-Transect of the eastern United States forests and alpine areas, and offers a perfect setting for collecting scientifically valid and relevant data on the health of the ecosystems and the species that inhabit them. The A.T. and its protected corridor provide an ideal barometer for early detection of undesirable changes, from development encroachment to recreational misuse, acid precipitation, invasions of exotic species, and climate change.

Quantitative description of the landscape characterization and change is among critical information in understanding of the A.T. environments and the ecosystem conditions and functions associated with it. This study employs the National Land Cover Data (NLCD), the time series remote sensing data products from the Terrestrial Observation and Prediction System (TOPS) models to obtain the information about landscape configuration and composition of the A.T. corridor. This presentation will introduce the development of seamless data from remote sensing and GIS modeling, with integration of *in situ* observations for monitoring and assessment of historical and current landscape features and trends of landscape dynamics. This study is a part of the project for which the ultimate goal is to develop an Internet-based implementation and dissemination decision support system for monitoring, reporting and forecasting ecological conditions of the A.T. (Wang et al., 2010).

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## Heritage-led Rural Regeneration: A New Dawn in China?

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The idea of heritage-led rural development first emerged in the late 1980s as the Council of Europe campaigned for countryside regeneration. Under the slogan ‘Let’s make the most of countryside’, the campaign emphasized the mutually beneficial relationship between ‘the development of rural areas’ and the ‘preservation of qualities of these areas for future generations’. Following that, the European Commission initiative LEADER was introduced in 1991 as a funding scheme to support the development of rural areas across the European Union. Whereas the focus of rural development initiatives in the 1990s appears to be on agricultural reform and economic growth, the first decade of the 21st century has witnessed a growing interest in the heritage values of rural landscape and the employment of heritage tourism as a key strategy for rural regeneration. In United State, for instance, the National Trust for Historic Preservation launched the four-year pilot projects in the rural areas of Arkansas and Kentucky in 2005, in which a ‘heritage-based’ approach was employed to foster economic and community development of rural regions. Similarly, in the United Kingdom, the delivery of the Rural Development Programme for England (2007-2013) sees heritage conservation and tourism as one of the important components to protect and enhance historic features of rural landscape through appropriate management. Across the world, continuing efforts are made to conserve ‘rural heritage’ – the unassuming agricultural buildings and their surrounding open spaces. Whereas heritage-led rural regeneration appears to be a new trend and attracts more and more attention in practice, appreciation for the heritage value of agricultural landscape hardly can be seen in China and the recognition of its tourism potential is yet to be developed. As a result of the country’s relentless pursuit of economy growth, agricultural lands on the urban fringe often bear the brunt of rapid urbanization and are quickly disappearing. Original tranquil rural landscape is under threat of destructive development and irreversible transformation.

This paper sets out to unlock the heritage value and explore the tourism potential of existing agricultural villages and their characteristic landscape on the urban fringe of Suzhou City in China. It aims to review the evolution of discourse on rural regeneration in relation to heritage tourism and the recent pioneering initiatives undertaken in industrially advanced countries. The rural planning policies and the current socio-cultural and economic circumstance of deprived rural areas in Suzhou will also be examined to identify the issues and challenges posed when promoting heritage-based approach towards rural development.

# Climate Change Induced Range Shift of the Crested Ibis Based on Logistic Regression Model

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The range of the crested ibis is still small after its recovery from critical endangered status, so that climate change might be a threat to its long term survival. we used logistic regression model to predict the range shift of the crested ibis in the future.

We used the locations of nest site to represent the distribution of crested ibis, which have high accuracy and has being accumulated from 1981 to 2010. We compared the current climate conditions with those in 2080, and found that the current habitat of the crested ibis would become warmer and wetter in the future.

We applied logistic regression model to predict the current and future (i.e. 2020, 2050, and 2080) distribution ranges of the crested ibis using five climate variables (i.e. annual minimum temperature, annual maximum temperature, seasonal variance of temperature, annual total precipitation, and seasonal variance of precipitation) based on CGCM2 climate model A2a emission scenario in WorldClim database. Among five climate variables, the seasonal variance of precipitation is the most important variable that associated with distribution of the crested ibis; and seasonal variance of temperature is the secondly important variable.

Logistic regression model indicated that the crested ibis would have a northward range shift (actually a higher elevation shift), and the distribution center would be out of the current nature reserve. Therefore, it is necessary to develop a long term conservation plan for the crested ibis.

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## **A Study on the Wildlife Fauna along China-Pakistan Karakoram Highway (KKH)**

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China-Pakistan-Karakoram highway, which was built with the help of the Chinese government during the 60s of the 20th century, is an international highway linking Kashigar, a city in the western part of China, with Takhot, a city in the northern part of Pakistan. Completed and open to traffic at the end of the 70s, the highway cuts through the world-famous Karakorum Mountains and Himalaya Mountains. The highway condition has deteriorated in the past 30 years due to frequent natural disasters. The Chinese government has committed to help Pakistan with reconstruction (FHCC, 2006). In September 2009, a survey of the animal fauna along the highway was conducted. According to our preliminary classification and statistics, there are 22 orders, 51 families, 105 genera and 147 species of wild vertebrates, among which there is 8 species of reptiles, 103 species of birds and 36 species of mammals.

The design and construction of the highway is very important because it is located in a region where fauna distributions overlap. Here species are found common to the Tshinghai-Tibet, Palearctic, and Central Asian plateaus. A few species classified as sub-tropical co-occur with species common to the Himalay-Hengduan (sub-alpine) regions (Abudukadir et al., 2010). For these reasons, the construction and design of the highway is being evaluated to minimize negative impacts to fauna including efforts to alleviate potential barrier effects. Due to the unique species assemblage and biophysical characteristics, large-scale range shifts are likely to occur in the area during the 21st century. The Chinese government has explored novel solutions to minimize road impacts and monitor fauna distributions.

**Keywords:** Vertebrates, Animal fauna, China-Pakistan, Karakoram highway

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## **Wildlife Roadkill on Changbai Mountain Scenic Highway, Jilin Province, China**

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Highways passing through nature reserves have adverse impacts on wildlife, of which road-kill is the most obvious and direct (Patten et al., 2008). Research on wildlife road-kill has been carried out widely all through North America, Europe, and Oceania (Forman et al., 2003). However, few scientific studies have been conducted in Asia, and almost none in China (Wang et al., 2010). We investigated the wildlife road-kill along the Changbai Mountain scenic highway in 2009 and 2010. The 85 km long highway encircles the larger mountainous area while 20 km-section of the highway encircles the nature reserve, and a 6 km-section of the highway enters into the nature reserve. According to field surveys in 2010, traffic flows ranged between 100 - 900 vehicles/day and the speed limit was 60 km/hour. Over 31 surveys (2,215 km traveled) we recorded 2,726 road-kills of 51 different wildlife species. The overall kill rate was 1.23/km. Amphibians comprised 87.8% of road kills, followed by birds (5.1%), mammals (4.8%) and reptiles (2.3%). Deserving our attention, two protected species, the Ural Wood Owl (*Strix uralensis coreensis*) and Hazel Grouse (*Tetrastes bonasia amurensis*) were among road-killed birds.

The official scientific academy in China has recently begun to recognize the emerging problem of road-kill (Wang et al., 2010). Amphibian and reptile mobility (slow to react to vehicles) may account for high mortality rates among these species. However, excess driving speeds may result in higher mortality for birds and mammals. During our field surveys in 2010, most drivers operated cars at 80 km/hour or more. In the future, we plan to analyze the spatial and temporal patterns of road-kill so that relevant countermeasures such as wildlife passages, reduced speed limits, and wildlife warning signs can be implemented to reduce vehicle-caused wildlife mortalities in China.

**Keywords:** Wildlife, Roadkill, Road ecology, Changbai Mountain natural Reserve, China

**Acknowledgements:** The authors thank Benjamin Dorsey of the Western Transportation Institute at Montana State University in USA for his helpful review and comments. This research is funded by the Western China Communications construction and Technology Project (Grant no. 2010 318 221 009 ) and Jilin Provincial Transport Science and Technology Project (Grant no. 2008-1-29)

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# Reduced Diversity of N Cycling Microorganisms in Artificial Plantations

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China has one the largest plantations area in the world, as much as 62 million ha<sup>1</sup>. How artificial plantations, especially introduced species plantations, influence ecosystem services including the maintenance and cycling of N nutrient deserves much attention. However, there is little knowledge on how artificial plantations influence soil N cycling microorganisms. Based on a high-throughput functional microarray (GeoChip 3.0), this study investigated N cycling microorganisms in forests restored under three different forest restoration approaches in the red soil region of Southern China, namely natural restoration, native Masson pine (*Pinus massoniana*) plantation and introduced species slash pine (*Pinus elliottii*,) plantation. The results showed that artificial plantations had significantly different soil N cycling microbial community structure with a natural restoration approach (Fig.1). Compared with natural restoration, artificial plantation using an introduced slash pine in particular, significantly reduced diversity of N cycling genes (Fig.2). Variance partitioning showed that vegetation factors, soil biochemistry and forest types could explain 38.8% of the variation in community N cycling (Fig.3). The results shed light on forest restoration and corresponding ecosystem services of N maintenance and N cycling potential.

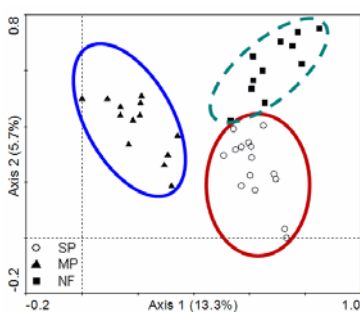


Fig.1 DCA biplot of soil N cycling microorganisms.

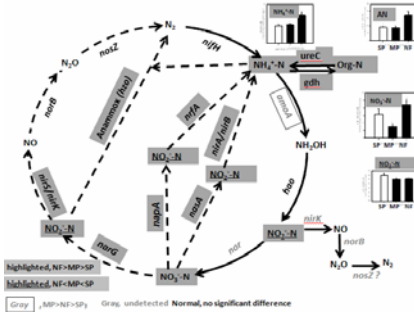


Fig.2 N cycling genes and N content

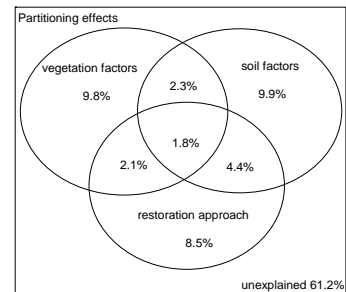


Fig.3 Variance partitioning of N cycling microorganisms

SP, slash pine plantation; MP, Masson pine plantation; NF, natural secondary forest

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## Assessment of Heavy Metals in Sediments of Haihe Basin

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With the rapid social and economic development, aquatic ecological problems in Haihe Basin are more and more severe. Heavy metals are among the most hazardous pollutants, due to its persistence, toxicity and enrichment in food chain, human has paid much more attention to such kind problems. So, this paper mainly studied the heavy metal ecological risk in sediments of Haihe Basin.

(1) According to the results of geo-accumulation index, the most hazardous heavy metals are Cd and Zn, then Cu, while Pb and Cr basically are at no polluted level. The most polluted areas are in Tianjin with developed industry, Qianxi and Laiyuan which are rich in mines. In addition, in Liuli River, in the suburbs of Beijing, Cr, Cd and Zn are also severely polluted.

(2) According to the results of Hakanson's ecological risk index, the risk levels of Cu, Pb, Zn and Cr in sediments belong to "slight" level, while the risk level of Cd is a little higher. Based on the five heavy metals' risk, the comprehensive potential risk index indicates that, most sampling sites belong to the "slight" polluted level. The most polluted also, the typical area is Laiyuan and Tianjin of Daqinghe Basin.

**Keywords:** Haihe Basin, Sediment, Heavy metal, Ecological Risk Assessment

## Comparative Analysis of Landscape Pattern Indexes for several Typical Oases in Arid area

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Landscape ecology is a powerful tool to analyze the landscape pattern change for single region in arid area, landscape pattern index is very universal for the application study to analyze the landscape change. There are many achievements about landscape pattern time series change research in one region, but without any examples for comparative analysis between region and region. In arid areas, oasis has obvious spatial heterogeneity in different regions, also there is heterogeneity environmental landscape among different oasis. For example, the better environmental landscape is spatial distributed in upper stream and the worse environmental landscape is spatial distributed in down stream. We want use landscape pattern indexes to comparatively analyze different typical oases and to recognize the environmental landscape quality. So we select three typical oases (the oasis-desert transitional belt of Qitai, oasis of Shanshan county, oasis of Wusu-kuitun-dushazi area) in

Xinjiang arid area, and use multiple periods TM/ETM remote sensing images, based on unified and relative accurate landscape classification, to calculate and analyze the landscape pattern indexes for time series and different zones. The results showed that the landscape pattern index has limited indicated significance for the evaluation of oasis eco-environment. With current landscape pattern index, it is hard to conduct landscape pattern comparative analysis, we need a comprehensive and effective index in the differential assessment of landscapes for different regions. So it is difficult or imprecise in landscape ecology comparison assessment by single landscape pattern index. The landscape spatial analysis method should combine ecological function and other data indexes which can response the real situation. By this way, the landscape pattern spatial analysis has more practical application value in landscape ecology and eco-environmental assessment.

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## **Challenges to fight fragmentation through planning practices: policies, factors and effects**

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Landscape ecology has the potential to dramatically increase the influence of environmental science on decision making and land use changes. One among many of those challenges in the transformation of scientific theory and research into practices is that the same scientific principle can be integrated with many innovative land use decision makings and the environmental impacts of those innovation and application have never being fully evaluated.

To further understand the relationships among science and land use decision making, this study focuses on one key concern in landscape ecology, “landscape connectivity”, a process remediating urban development and land use introduced disturbance and fragmentation. This study is inspired by a class discussion about how different cities are fighting fragmentation in urbanization process and whether their practices achieve their proposed goals after an introductory presentation about the application of landscape ecology in planning practices. To answer those questions, the top 50 cities in the US are selected and examined for comparison. Three research questions are addressed: 1) What are those land use decision making and policies being used by different cities to achieve landscape connectivity during sprawl? 2)

How can social economical context of different cities impact the adaptation of those policies?  
3) Can stronger policies toward connectivity lead to less fragmented landscape changes?  
Under instructor's supervision, students developed a program protocol to evaluate varied programs related with landscape connectivity. The protocol evaluation result was then correlated with social-economic status of the 50 cities to examine the potential role of social-economic background in promoting connectivity strategies. And the protocol evaluation is also correlated with vegetation index of the 50 cities to examine whether stronger programs toward connectivity can lead to higher connected vegetation pattern.

This study reveals the complications in building a solid science-practice interface of landscape ecology. The concept of connectivity is linked with a wide variety of land use programs and policies in different cities, for instance, greenbelts, greenways, green corridors, open space systems, ecological infrastructure, green infrastructure etc. And those programs show strong regional autocorrelations. Poverty rate, population density and racial percentage seem to be related with policy adaptation possibilities about landscape connectivity. Besides, this study finds that stronger policies do not link to higher connected vegetation pattern. The results of this study lead to many discussions into the science-practice interface of landscape ecology as well as future research agendas.

## **Scale Dependence of Vegetation Heterogeneity and its Relationship to Fracture Zones**

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Spatial heterogeneity has being one of the most important theoretical problems in Ecological research since nineties. It plays important role in diversity and dynamics of bio-system. Spatial heterogeneity can be defined as the complexity and variability of a system property in time and space (Li and Reynolds 1994). Fracture zones including faults, gauges and continuous joints can influence the vegetation pattern by changing hydraulic and soil conditions around the fracture zone. In the other hand, representations of spatial patterns may be different when observed at different scales, additionally, certain patterns and processes may not be observable at a particular scale or resolution. Under the above background, this study is aimed at clarifying the relationship between fracture zones and Scale dependence of vegetation heterogeneity in the Yingxiu area around the epicenter of Wenchuan earthquake (Fig.1).

Fracture zones at an extensive scale can be characterized by lineaments appeared on satellite images and aerophotographs. In this paper, a method of Segment Tracing Algorithm (Koike et al., 1995) is applied to extract lineaments and then to identify the orientation, continuities, densities, and intersecting patterns of the fracture zones. Scaled-NDVI semivariogram was employed for modeling the characteristics of the spatial heterogeneity of the landscape vegetation cover. The relationship is clarified by analyzing the NDVI  $\tilde{\alpha}(h)$ s and comparing

them with lineament density map (Fig.2).

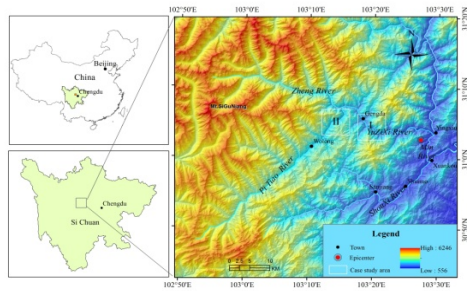


Fig.1

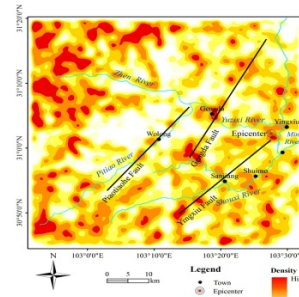


Fig.2

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## The Use of Medium Point Density LiDAR Data in Determining the Coverage of Plant Community Types in Internationally Important Baltic Seashore Meadows

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Baltic seashore meadows are internationally important sites with regard to floristic diversity and as a habitat for migratory and breeding birds (Puurmann & Ratas, 1998; Puurmann & Randla, 1999; Truus, 1999; Rannap, 2004). These meadows are made up of a mosaic of plant community types, each of which support a variety of different bird and plant species (Burnside *et al.*, 2007). The full extent of these community types is unknown yet recent studies (Burnside *et al.*, 2008; Ward *et al.*, 2010) have shown that micro-topography is a governing factor controlling the location and area coverage of 6 of the 7 main plant community types.

The study investigates the use of medium point density LiDAR data in determining vegetation community types in managed Baltic seashore meadows. Ground-truthed micro-topography data obtained using a RTK dGPS approach was used to compare the accuracy of the LiDAR derived height values in Matlab R2010a. Using the height accuracy corrections, 3 interpolation techniques were tested using ArcGIS 9.3. These were IDW, Kriging and the Delauney interpolation method to create a TIN model. Of these three only the TIN technique produced a model that adequately represented the known location of the vegetation community types.

The results showed that the accuracy of the LiDAR data varied dependent upon the community type. For example, in 5 of the 6 studied community types, the LiDAR data gave a mean altitude difference of 0.177m (0.029SD) above the ground-truthed heights.

Therefore LiDAR data without any ground-truthing did not produce an accurate model of the location and coverage of the different plant community types. Community types were observed to have mean differences in altitude between 0.04 and 0.19m dependant on the vegetation type (Ward *et al.*, 2010). When used independently, LiDAR data were shown to be too coarse to represent the suite of elevational differences necessary to identify all community types. However, with ground-truthing, the LiDAR derived TIN model was able to predict the location of the 6 community types with between 53 and 100% accuracy.

This study has developed a transferable methodology which is quick to implement and uses remotely sensed data as a modelling tool for mapping plant community types. The inclusion of dGPS validation techniques is shown to significantly improve model performance and facilitate the identification of community types on the basis of elevation. In appropriate environments, such as coastal vegetation, this may provide opportunities to model the effects of sea level rise and other environmental changes.

## **Feedbacks between Water-, Nitrogen- and Carbon Cycles across Scales**

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Since the industrial revolution carbon dioxide emissions have been enhanced and the industrialized production of nitrogen fertilizers for agriculture has accelerated the nitrogen cycle. Increased N and C availability has led to enhanced photosynthesis and plant productivity. Apart from a warmer climate and CO<sub>2</sub> fertilization, increased nitrogen availability may also be responsible for productivity increase in many parts of the world. Enhanced productivity may lead to shifts in surface albedo, surface roughness of vegetation and evapotranspiration which may feedback on heat fluxes and precipitation. On the other hand, plants respond to elevated CO<sub>2</sub> by closing their stomata or by structurally adapting their stomatal density and size. In the light of global change the above responses may influence each other, positively as well as negatively. Moreover, the numerous feedbacks between vegetation and atmosphere may originate at the local scale but might affect large-scale circulation patterns. Clearly, we are still far from understanding how the cycles of carbon, nitrogen and water interact and what the net outcome is in terms of plant competition and vegetation distribution.

Here, we present three studies in which we analyzed and modeled interacting cycles from global to local scales. First, we used a Global Circulation Model to investigate the resilience of the climate system to vegetation disturbance at regional to continental scales. We show that especially the boreal and monsoon regions are susceptible for larger scale change of



productivity and climate because local vegetation perturbations amplify in strength and spatial scale via positive vegetation-climate feedbacks (Dekker et al. 2010). Second, we used new palaeo-ecological data to develop and validate a model that links dynamic to structural stomatal adaptation via optimization of water loss with carbon gain under rising CO<sub>2</sub>. For this purpose we first reconstructed a 34% reduction in maximum stomatal conductance ( $g_{smax}$ ) per 100 ppm CO<sub>2</sub> increase as a result in the adaptation in stomatal density and pore size at maximum stomatal opening of common Florida plant species over the past 150 years (Lammertsma et al. 2011). Modeling results indicate that transpiration of the subtropical vegetation is strongly reduced under rising CO<sub>2</sub> implying that plant adaptation to rising CO<sub>2</sub> is altering the freshwater cycle and climate and will continue to do so throughout this century independent of radiative forcing (De Boer et al. 2011). In the third example we test the hypothesis that nitrogen deposition enhances the terrestrial carbon sink in forests and in this way mitigates anthropogenic emissions of CO<sub>2</sub>. We compared photosynthetic parameters at the canopy scale of different forest types along an axis of nitrogen deposition using Fluxnet forest sites and found a strong positive response of deciduous forests upon nitrogen deposition (Fleischer et al. 2011).

The identified feedback mechanisms presented in these 3 studies were used to indicate how competition between plant functional types may change upon rising CO<sub>2</sub> and N availability and how this impacts on vegetation.

## **Accuracy Evaluation of Information Extraction of Urban Wetland Using the Object-oriented Approach: A Case Study in Baoan District of Shenzhen, Southern China**

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Urban wetland show generally small size, fragmentation, much more artificial infrastructures and more water pollution due to serious human disturbance. Compared with wild wetland, their reflectance characteristics of remote sensing images have much more phenomenon of the same object with different spectra and the different objects with same spectrum. They lead to often a lot of uncertainty in the automatic extraction of wetland information. In this paper, Baoan district of Shenzhen city in the east coast of the Pearl river estuary which is a typical rapid urbanization area was taken as a case, wetland water body information extraction experiments were carried out using object-oriented approach which was implemented by eCognition8.0 software employing the Landsat TM and SPOT remote sensing data. The objective of this study is to evaluate the efficiency and accuracy for different methods of the object-oriented approach and the traditional pixel-based supervised classification in urban wetland environment. The results showed that: 1) object-oriented approach has higher efficiency and extraction accuracy than pixel-based supervised classification. As to TM, the overall classification accuracy is increased by 11.38%. As for SPOT, the overall classification accuracy is increased by 15.29%. For different types of wetlands like river, reservoir, pond and coastal water, the classification accuracy also have substantial increase. In particular, the

object-oriented method is efficient for the fish ponds and rivers subjected to high intensity artificial modification, the users' accuracy of the former and the producers' accuracy of the latter increase reached 25% or more. Object-oriented method can be used as an effective approach to increase the accuracy of information extraction of wetland in urban context.

**Keywords:** Urban wetland, Information extraction, Object-oriented, Remote sensing

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## **Role of Rainfall and Crop-rotations on Water Erosion Dynamics in the Rain-fed Loess Plateau, Northern China**

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Sloping cultivation is blamed as an important water erosion contributor in the key loess hilly area, China. Crop rotations and related field managements however, are considered to be valuable measures for soil erosion control. In this study, twenty-one experimental plots including seven crop-rotations were established in a NW facing slope in Gaoquangou Catchment, Dingxi, Gansu province. Eight years of rainfall-runoff-erosion data from 1988 to 1995 were monitored and analyzed. The following results were captured. First, different crop species play different roles inducing various erosion consequences. Herein, potato cultivation was found to cause the highest water erosion rates and risks, followed by benne, haricot, pea and wheat, then wheat (with minimum plough) and wheat (with sea buckthorn intercropping). Since large-scale potatoes were planted in this area, more powerful and specific measures targeting field erosion reduction should be enhanced. Second, traditional up-and-down cultivation with simple crop rotation was reproved to be ineffective in lowering soil and water loss, while crop rotations with contour cultivation, stiletto or crop-forest intercropping were valuable countermeasures for soil erosion control. Third, sloping-farmland abandonment and consecutive fallow can reduce soil erosion modulus effectively, especially after 3-4 years of plant succession, and the related water erosion rates were far lower than sloping croplands. Artificial grassland such as *E. Milvetch* with no human disturbance can gradually enhance their ecosystem services on soil and water conservation. Last, the effect of crop-rotation on water erosion is also greatly depended on the related rainfall features, especially the timing and proportion of erosive rainfall events in the certain periods. High occurrence of erosive rainstorms coupled with poor erosion-resistance crops and up-down cultivation types will accelerate the degrees of soil erosion and water loss, and vice versa.

**Keywords:** Rain-fed agriculture, Crop rotation, Plant succession, Water erosion, The loess plateau

# Hydrological Responses to Climate Change and Forest Disturbance at Large Scale Watersheds

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Climatic variability and forest disturbance are commonly recognized as two major drivers influencing streamflow change in large-scale forested watersheds. The greatest challenge in evaluating quantitative hydrological effects of forest disturbance is the removal of climatic effect on hydrology. In this presentation, a method was designed to quantify respective contributions of large-scale forest disturbance and climatic variability on streamflow using the Willow River watershed (2860 km<sup>2</sup>) located in the central part of British Columbia, Canada. Long-term (>50 years) data on hydrology, climate and timber harvesting history represented by equivalent clear-cutting area (ECA) were available to discern climatic and forestry influences on streamflow by three steps. Firstly, effective precipitation, an integrated climatic index, was generated by subtracting evapotranspiration from precipitation. Secondly, modified double mass curves (DMCs) were developed by plotting accumulated annual streamflow against annual effective precipitation, which presented a much clearer picture of the cumulative effects of forest disturbance on streamflow following removal of climatic influence. The average annual streamflow changes that attributed to forest disturbances and climatic variability were then estimated to be +58.7 and -72.4 mm, respectively. The positive (increasing) and negative (decreasing) values in streamflow change indicated opposite change directions, which suggest offsetting effect between forest disturbance and climatic variability in the study watershed. The implication of this result to climate change adaptation is discussed in the watershed ecosystem disturbance context. The methodology can be effectively applied to any large-scale single watershed where long-term data (>50 years) are available.

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## Landscape Ecology and Critical Watershed Processes in Canadian Sub-Boreal Forests

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In the forested watersheds of the Canadian boreal and sub-boreal regions, forests, water and

aquatic habitat are closely interacted, and those interactions operate at various spatial scales and are significantly affected by increasing forest disturbances such as wildfire, mountain pine beetle infestation and human timber harvesting. To ensure sustainable ecological services, forest and watershed management strategies must be carefully designed to consider how forest disturbance affects various critical watershed processes including hydrology, in-stream wood dynamics and channel morphology and aquatic biology at various spatial scales. In this presentation, a summary on critical watershed processes based on our various studies in sub-boreal forests of the BC interior, Canada will be provided to illustrate the importance of landscape ecology in understanding critical watershed processes and functions. In addition, management and adaptation strategies will be discussed in the watershed ecosystem context.

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## Suburbanisation in the Poznań Metropolitan Area

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Suburbanisation processes in the Poznań Metropolitan area are one of the most intensive and rapid across Poland. The residents of Poznań have become increasingly fond of moving outside the city and building their houses in neighbourhoods with often attractive nature. The urban sprawl phenomenon, which has been gaining pace over the past several years, has led to a number of adverse spatial, functional and environmental effects. The poor development of technical and social infrastructure, which has not been kept up with spatial development, is going to cause long-term negative consequences, felt by the entire population of the Poznań metropolitan area.

With the current dynamic of the development, the Poznań metropolitan area is expected to reach 1 million residents by 2020 and only half of them would reside in the city centre of

Poznań. Suburbanisation trends from the Poznań district suggests a growth of over 30 thousand households in the next decade. This would result in a population increase in the metropolitan area by nearly 100 thousand people. This certainly translates into further intensification of construction, in particular, in the scope of single-family housing within suburban zones.

Suburbanisation processes have had a huge negative impact on the environment in the Poznań metropolitan area. In the last decade the number of residential buildings in the district exceeded by ten-fold the number of such buildings in central Poznań. The spatial development of the Poznań metropolitan area includes areas primarily neighbouring highly and moderately attractive nature (edges of forest complexes, lakes and river valleys). Farming has been marginalised in the metropolitan area and pushed out to the outskirts of the city. Besides the food supplying function, farming areas shape the rural landscape and take part in the preservation of a balanced geographical environment. They are an important element of sustainable development.

## **From Landscape Structure to Landscape Functionality – the Way forward**

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The pattern & process paradigm is fundamental to modern landscape ecology and has inspired many research activities. Pattern, defined as the spatial distribution of ecologically homogenous landscape elements – often referred to as bio- or ecotopes, is mainly created by disturbance processes or the uneven distribution of environmental resources. The concept of “landscape structure” is reflecting this by not only focussing on textural attributes of images of landscapes, but by giving emphasis to the functionality of spatial units as well. As many organisms are directly responding to variables like disturbance or availability of nutrients and water, it is not surprising, that the analysis of landscape structure with GIS-tools yielded many new insights in various spatial aspects of bioecology in recent years. In addition to single species approaches, that would try to explain the spatial distribution or spatio-temporal behaviour of selected target species in a landscape, more aggregated concepts of biodiversity like “naturalness / hemerobiotic state” or “landscape functionality” appeared to be promising for large-scale assessments.

In a suite of studies and research projects our research group could demonstrate the validity of landscape structure as an indicator for ecological sustainability (Wrbka et al. 2004, Peterseil et al., 2004; Renetzeder et al., 2010) and linkages with biodiversity could be evidenced (Pino et al., 2000; Zechmeister & Moser, 2001; Zechmeister et al., 2003; Moser et al., 2002; Kuttner 2010). It therefore seemed worthwhile to further explore the potential of geometry-based landscape metrics as a proxy for the evaluation of ecological core processes like e.g. landscape fragmentation/connectivity, dispersal possibility or habitation which can be summarized under the term “*Landscape functionality*”.

Predictive modelling approaches like MSPA (Morphological Spatial Pattern Analysis) can for example functionally assess habitat suitability and hot spots of network patterns among the investigated spatial units. Cost surface models complement this approach by overcoming the dilemma of just displaying the landscape as habitat and non-habitat. Semi-natural areas and ecological barriers are also taken in consideration for estimating functional connectivity between different habitat sources (Watts et al. 2010). Therefore, least cost distance modelling in combination with habitat suitability models and wisely chosen landscape metrics allow for a more distinct and complete view on landscapes as a mosaic of interconnected habitats. As some examples from on-going research project can demonstrate, the results of such a combined approach are at the same time highlighting the ecological potential of a given landscape but also quantifying actual impacts of prevailing land use systems like land consolidation, transformation or intensification. In addition, by creating different scenarios the effects of conservation planning measures can be simulated in a broader context, which could to support future planning strategies, targeted funding and tailor-suited measures.

## **Toward Solving Beijing's Water Shortages through Evapotranspiration Management**

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Beijing is a serious water shortage city with the average water resources per capita less than 300 cubic meters. Many water resources problems, such as over-exploitation of surface and ground water, the waste and inefficient use of water resources, the blind expansion of irrigated area, land sedimentation caused by groundwater level decrease, have been concerned by the people. With the social and economic development and population increase, the conflicts of water resource demands among industry, agriculture, environment and domestic sections are becoming intense. The solution for water resource problems is a hot topic in the world. The Evapotranspiration(ET) management is to reduce the ineffective and inefficient ET or non-beneficial ET and achieve regional water balance between consumption and precipitation for sustainable water use. The paper focuses on the presentation how does the concept of ET management being used to solve some current water resources problems. As a case of Chaobaihe Basin in Beijing, ET measurement is recommended to get the reliable water consumption of different landscapes. The water consumption balance and water consumption structure can be used to analyze the situation of the water utilization. The manageable ET can be estimated to analyze the water saving potential in the farmland of Beijing through scenario analysis, such as single or combined crop consumption control. The ET quota allocation method is proposed to realize the sustainable utilization of water resources through determining target ET and estimating water saving potential.

# **Landscape Sustainability: A Hierarchical Patch Dynamics Perspective**

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The global life-support system for humans is in peril but no alternative to achieving sustainability is desirable. In response to this challenge, sustainability science has emerged in recent decades. In this chapter, I argue that to advance sustainability science a landscape approach is essential. Landscapes represent a pivotal “place” in the place-based research and practice of sustainability. Landscape ecology, as the science and art of studying and influencing the relationship between spatial pattern and ecological processes on different scales, can play a critically important role in the development of sustainability science. Global sustainability cannot be achieved without most, if not all, landscapes being sustainable. As landscapes are spatial units in which society and nature interact and co-evolve, it is more useful and practical to define landscape sustainability based on resilience rather than stability. Furthermore, the development of landscape sustainability measures can be facilitated by integrating landscape pattern metrics and sustainable development indicators. I will discuss the concept, key issues, and measures of landscape sustainability from a hierarchical patch dynamics perspective that emphasizes spatial heterogeneity, scale multiplicity, and hierarchical linkages.

## **The Relationship between Sub-landscape and Animal Biodiversity in Guanyinshan Nature Reserve, Shaanxi Province**

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Landscapes are mosaics of patches that differ in size, shape, and contents. Numerous studies have shown that the spatial pattern of landscapes may have significant influences on ecological processes, such as population dynamics, biogeochemical cycling, and aspects of biodiversity (Wiens et al. 1993, Wu and Levin 1994). Guanyinshan Nature Reserve (GNR) is located in the middle of the Qinling Mountains in Shaanxi Province. It is mainly covered with forests; however, this region had undergone a serious commercial logging during the 70-80s in the 20th century and caused strong influence on the landscape pattern. In this paper, camera trap data from 18 camera plots (named sub-landscapes in the paper) was used to analyze the animal biodiversity and four important factors namely elevation, slope, crown density and vegetation were considered to differentiate between the camera plots. With the software of Canoco, we attempted to seek the relationship between the sub-landscape characteristics and animal biodiversity. After 19 months of continuous photographing, twenty-four species of animals are detected, the top six by photographic rate are takin (*Budorcas taxicolor*), common goral (*Naemorhedus goral*), tufteddeer (*Elaphodus cephalopus*), golden pheasant

(*Chrysolophus pictus*), wild boar (*Sus scrofa*), mainland serow (*Capricornis sumatraensis*). The distribution of them is distinctly different. The result of Canonical correspondence analysis (CCA) showed that takin and tufteddeer are highly correlated and the activity areas of them are characterized with little crown density. By now, No.6 camera plot shows no activity sign of takin but it is preferably utilized by golden pheasant. The factor of vegetation contributes much on the distribution of common goral, which preferably chooses the deciduous broadleaf forests as its activity area. Elevation has positive correlation with the distribution of takin and negative with that of common goral. In addition, human impact should not be ignored because the impact caused by the daily activities of local people would be accumulated in a long term. So it is highlighted to reduce every kinds of human impact as much as possible, in order to maintain a relatively stable level of animal biodiversity.

**Keywords:** Guanyinshan Nature Reserve (GNR), sub-landscape, camera trap

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## Rodent Community Diversity and Disturbance in a Fragmenting Desert Landscape

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The relationship between biodiversity and ecosystem function are hot issues in ecological research (Yuan *et al.*, 2009). Factors which affect community composition and its diversity changes (beta diversity) have attracted great interest for biologists (Tuomisto and Ruokolainen, 2006). The beta diversity of rodent community during a process of desert landscape fragmentation was studied in the Alxa desert, China during 2002 and 2010. Four sites were selected, representing different kinds of disturbed habitats: A prohibited-grazing area, a rotational-grazing area, an over-grazing area and a farmland area. Rodent community composition was investigated using a mark-and-recapture method. There were two mark-recapture sites in every 1 hm<sup>2</sup> area. The samples were collected every month for four consecutive days from April to October every year. We used the Jaccard, Sorenson and Cody index to compare the characteristics of beta diversity between sites. All three beta diversity indices demonstrated large variation between rotational-grazing area and farmland area; and



over-grazing area and farmland area among years. Indices were found to have significant differences with other areas ( $P < 0.01$ ). The results of principal component analysis (PCA) for rodent species suggested community dominant species exhibited different roles in each area. Native vegetation fragmentation led to the disappearance of dominant species and the incidence of new species increased in the farmland area so that the beta diversity of farmland area changed greatly compared to the other three areas. These results show that the correlation between community beta diversity and landscape fragmentation, and species coexistence mechanism in this region is a productive area for future research.

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## China's Ecological Approaches to the Low Carbon Society: Challenges and Implications

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Global warming caused by the increasing emissions of greenhouse gases (GHGs) from human activities is threatening the natural and human environment. Rising concern about the impact of climate change has led to the definition of long-term sustainability of society. For China, the only way to cope with the sharp conflict between rapid economic growth and high GHGs emission is to develop the low carbon society (LCS). In addition to the energy and technology development strategies, the low carbon society also calls for effective ecological approaches to mitigate climate change problems. Terrestrial carbon pool of China comprises about 35 to 60 Pg in the forest and 120 to 186 Pg in soils (Lal, 2004). However, severe soil degradations due to rapid economic growth and poorly designed land use and land management are resulting in significant loss of carbon sinks. During the last decades, some of the depleted carbon pools were re-sequestered by several ecological restoration projects and adoption of recommended management practices (e.g. Xu et al., 2007). The total potential of terrestrial carbon sequestration was estimated in the range of 0.19-0.26 Pg per year (Piao et al., 2009), which could offset a large part of the annual fossil fuel emissions in China. These results indicated that ecological approaches are essential for low carbon society by enhancing carbon sinks. However, the Chinese government should emphasize the sustainability and comprehensive evaluation of these approaches, such as, appropriate compensation mechanisms should be established and adapted to regional social, economic and environmental conditions.

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## Study on the change of landscape pattern and valuation on the landscape ecology security of Sun Island wetland

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Due to the frequent human activities, the native vegetation in Wetland of Sun Island Scenic Area and Nature Reserve suffered heavy destroy. It is very important and urgent to carry out regeneration. Based on the Geography Information System and landscape ecology theory it did some reaches as followed: First, a study on the change of wetland landscape pattern was developed for Sun Island wetland. The TM (ETM) images of Wetland in Sun Island Scenic in 1988 and 2008 have been interpreted by using 3S method. From spatial variations and type transformation trends, the spatial changes and evolutionary patterns of land ecosystem in the source regions of the Scenic Area were analyzed using the analytical method of landscape ecological spatial patterns. As a result, land ecological spatial distribution pattern in the region is changing and the state of eco-environment declining. Second, a landscape security evaluation model and standard were developed for Sun Island wetland. According to those studies, wetland landscape security of Sun Island was divided into three levels. High security areas were belonged to a certain natural landscape such as water, lawn, and part of forests; middle security areas were located at some semi natural landscape, for example grassland, woodland, and tour area; lower security areas were main few parts of semi natural landscapes and artificial landscape such as exhausted land, residential area, and plantation. Depending on the evaluation result, the relevant protection and restoration measures were put forward for different security regions. Finally, according to the condition analysis, the planning idea emphasized on water source region protection, wetland restoration mode, the people's livelihood attention, high-standard construction and management mode was brought forward.

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## **Human-elephant Conflicts Becoming Crisis in the Human Dominated Landscape, Southwest China**

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Wild Asian elephants surviving in scattered nature reserves in Southwest China have become clever and aggressive. They sometimes encroach on neighboring populated areas and cultivated fields, eating agricultural crops, destroying property and injuring or killing people. Participatory rural appraisal (PRA) method, remote sensing message and field data were used to study the changes of human-elephant conflicts (HEC), the sustainability of human development and of elephant survivals and the strategies to mitigate the HEC.

The results indicated that HEC became crisis while sustainability degenerated in the past 50 years. (1) **Little interference** before 1975. Except for dung and footprints, there were few signs of elephant in the wilderness. (2) **Frequent encounters** in the late 1980s. With rapid agricultural growth and natural habitat fragmentation, elephants moved close to inhabited and cultivated fields. (3) **Elephant-related problem and poaching** during 1990-1995. Elephants began to eat agricultural crops, destroy property and injure people and, on the other hand, they were killed by poachers for ivory trade or by angry farmers. (4) **Protection and aggression** during 1996-2005. Wild elephants moved in the fragmented landscape when poaching and other illegal damages to elephants were put down by the strengthened policies, causing more damages to human interests. (5) **Sawing confrontation** recently.

The wild elephants have been moving between the reserves and inhabited areas and cultivated fields, creating elephant-related problems. Conclusively, people have moved into the elephant habitats and the elephants have reacted aggressively. The sustainability of human development and of elephant survivals degenerated in the wild elephant distribution areas.

Ways to mitigate HEC, for example, expelling wild elephants, separating elephants from farming fields with electric fences, and providing planted food resources and salt ponds for

elephants in remote areas, were done. But efficiency was poor. Concessions including human emigration and alternative agriculture must be made to mitigate HEC in the wild elephant distribution areas.

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## **Traditional Ecological Knowledge and Biocultural Landscape Management: Three Cases in Yunnan, SW China**

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Biocultural landscapes represent the combined work of nature and of man when natural landscapes were shaped by human beings through agricultural and forestry practices and other human activities. The content, pattern, configuration and sustainability of biocultural landscapes, however, were depended on who, with what means and ideology, shaped the natural landscapes. But with the rapid spread of mainstream culture, biocultural landscapes become simplification, causing the disappearance of indigenous culture diversity. We use 3 cases in Yunnan, southwest China, to discuss how the indigenous people perceive, use and protect the environment they live in, forming the traditional ecological knowledge (TEK), and how they apply the TEK to maintain the sustainable landscapes in the changing society. We suggest that the TEK, though is not easily quantifiable, has important contributions to the management of sustainable biocultural landscapes and development of landscape ecology.

Case I: the Tibetan enclosed farming and shifting stockbreeding landscapes in northwest Yunnan. According to the traditional belief that human beings are children of gods, people should use resources in a moderate manner. The Tibetan people enclosed farm lands and resident sites with woody hedges and pasture livestock outside the hedges. Following the seasonal changes of climate and plant growth, they moved livestock between alpine and subalpine meadows, benefiting biomass accumulation of meadows and crop (highland barley) production.

Case II: the bicultural landscapes with forest priority ecological conception in Xishuangbanna, south Yunnan. Dai people, living in the tropical and subtropical areas, have special local TEK including holy-hill sacred site culture, elephant culture and forest priority ecological conception. They reclaim wilderness, plant fuel-wood, fish in streams, and protect large or small patches of natural forests as sacred hills close villages, having a leisurely and carefree life style and forest conservation. Such TEK have being gradually neglected and abandoned when exotic self-regard consciousness prevailed and overspread since 1970s. The rapid rubber plantations replaced partly traditional biocultural landscapes and increasing wild elephant-related problems disturbed the peace before.

Case III: the management of riparian willow corridors in Han communities. Developed by Han people for more than thousand years, the east Yunnan becomes the human dominated

agricultural landscapes. People suffered from drought, flood and soil erosion and learned to protect farm lands by maintaining natural willow corridors along rivers. Such TEK as well as the riparian willow corridors were destroyed during 1970s. Fortunately, people began to restore the riparian willow corridors in the late 1990s.

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## **Research of Historical Range and Variation (HRV) of Forest Landscape Dynamics in Huzhong Forest Bureau of Great Xing' an Mountains**

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The concept of historical range of variability (HRV) in forest ecosystem management appeared in the 1990s, which was defined as "Ecological variability in the absence of human disturbance, namely the dynamic range of landscape composition and structure under disturbance of ecosystem itself". HRV can help to provide a relatively complete description of the variation of ecological conditions and process in multi-spatial and temporal scales; it can help to enhance people's understanding of the ecosystem and provide reference and targets for ecosystem management; also, it provides a theoretical and practical basis for management of ecosystems which suffer a long time and severe disturbance. So managers of ecosystem can develop effective measures to lead ecosystems to return to an approximate natural state. Due to the lack of historical data, various landscape models become main tools of estimating HRV. In recent years, the study of HRV and its application in ecosystem management has become one of the focal themes abroad. In our country, however, it has not yet attracted enough attention. The Greater Xing' an Mountain forest - one of the biggest China's state-owned forest area, which is significant to local economy and ecology, has deviated from the HRV after a long time timber harvest from 1950s to 1990s. In 1998, the government launched the Natural Forest Protection Project, furthermore, in early 2011, announced "Greater Xing' an Mountains and Lesser Xing' an Mountains forest ecosystem protection and economic restructuring plan (2011-2020)" to restore the ecological function of the Greater Xing' an Mountains and Lesser Xing' an Mountains, it is urgent to reveal the HRV of local forest ecosystem. The purpose of this research was to study the variation of the forest ecosystem of Huzhong Forestry Bureau, in Greater Xing' an Mountains by employing spatial explicit landscape model LANDIS and. We simulated the landscape dynamic under different harvest scenarios, i.e. traditional management scenario (HT), classified management scenario (HC) and non-harvest scenario (HN), different fire management scenarios, i.e. fire suppression scenario (FS) and natural fire scenario (FN), and the situation with no human disturbance in a long time to describe the original state of forest landscape (HRV) of Huzhong Forest Bureau (770,199hm<sup>2</sup>). Using Fragstats, we discussed how these management scenarios influenced the landscape both on landscape level and class level; then we evaluated the difference between landscapes under various management scenarios and HRV using Principal component analysis (PCA).

The simulation results showed that different harvest scenarios had little influence on the distribution of species in Huzhong, but had significant impact on the age structure of species. Under HT, Huzhong area was dominated by younger forest, and elder forest had a little abundance; under HN, the area of younger cohorts decreased gradually, and the area of mature and over-mature forest increased significantly; under HC, however, the characteristics of local forest landscape lied in the middle between the first two scenarios and had a relatively good recovery of the forest. Besides, compared with FN, FS brought about an obvious influence on species distribution and age structure of the Huzhong forest; it positively influenced larch and pine abundance, but negatively influenced white birch abundance; it also positively influenced the younger cohorts abundance of the above two species. Meanwhile, the fire suppression measures also extended the fire return interval (FRI), and increased the risk of catastrophic fire.

PCA showed that after a long period of timber harvest and fire suppression, the current situation lied outside the HRV. In the simulation time, all kinds of harvest or fire management scenarios (HT, HC and FS) drew the landscape away from the HRV continually, the landscape did not return to the HRV in the 300 years under all scenarios; under HT and FS, characteristics of landscape continually departed from HRV during the simulation time; under HC, some characteristics of landscape returned to HRV at about 300yr, others lied outside the HRV during the simulation time; only in the scenario which is absent of the human disturbance, the landscape of Huzhong could returned to HRV gradually with the process of simulation during 300-400 years.

This study evaluated the development of landscape in Huzhong area under various management scenarios from the perspective of HRV, the results would be helpful in understanding the causes and consequences of changes in ecosystems, providing researchers and managers with a reference to evaluate present ecosystems and guiding forest managers to develop management strategies and ultimately moving ecosystems to a sustainable state.

**Keywords:** Greater Xing'an Mountains, Forest landscape, Ecosystem management, Spatial explicit landscape model, LANDIS, Harvest, Fire suppression, HRV

## **Landscape Pattern Metrics from 2D to 3D: An Empirical Study in Mountain Area, South China**

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Landscape pattern metrics has been proven useful in analyzing and understanding landscape ecological function and process. Using these metrics correctly ultimately leads to better reasonable explanation. However, the traditional landscape metrics are calculated in 2-dimensional surface, while the landscape in real-world is in 3-dimensional space actually. Thus, there are some differences between the 2D and 3D landscape pattern metrics in

large-scale landscape analyses especially in mountainous areas.

This paper examines whether there is significant difference between the 2D and 3D landscape pattern metrics in real-world. 14 small watersheds are selected as statistic samples in mountainous area, Guangdong province of south China. The 2D landscape pattern metrics based on planimetric surface and 3D landscape pattern metrics based on 1:50000 DEM are computed respectively, and “R”s, the errors of 2D and 3D landscape pattern metrics, are compared with zero by employing GIS and statistic methods. The results indicate: the distinct difference is manifested between 2D and 3D landscape pattern metrics at both landscape level and patch level. Besides, the errors (“R”s) of various 2D and 3D landscape pattern metrics are varied. The errors of 2D and 3D landscape pattern metrics of different landscape types are inconsistent. Not all landscape pattern metrics are distinct different in 2D and 3D form. Then the errors of various landscape types are varied in the same landscape pattern metrics.

**Keywords:** Landscape pattern metrics, 2D, 3D, DEM, Mountainous area

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## Development of Custom Fire Behavior Fuel Models for the Huzhong Forest Bureau in the Great Xing’ an Mountains, Northeastern China

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Knowledge of forest fuels and their potential fire behavior across a landscape is essential in fire management (Sandberg et al., 2001; Keane et al., 2001). Four customized fire behavior fuel models that differed significantly in fuels characteristics and environmental conditions were identified across Huzhong Forest Bureau using hierarchical cluster analysis based on fuels data collected from the field (Miller et al., 2003; Poulos et al., 2007). The fuel model I was the dense and branched *Pinus pumila* shrubland with significant fine live woody fuels and mainly located at higher-mountains. The fuel model II, dominated by *Betula platyphylla* and *Populus davidiana*, was differentiated from other fuel models by higher herbaceous cover and lower fine live woody loading and distributed wildly in hills and lower-mountains. The

primary coniferous forests dominated by *Larix gmelini* and *Pinus sylvestris* L. var. *mongolica* were classified into model III and model IV that differentiated from average cover and height of understory shrub and herbaceous layers as well as distribution in aspect. The potential fire behavior for each fuel model was simulated with the BehavePlus5.0 fire behavior prediction system. The simulation results indicated that the *Pinus pumila* shrubland fuels had the most severe fire potential in low moisture scenario, and had the least fire behavior in high moisture scenario. The fuel model II presented the least severe fire danger across the three scenarios. The model IV resulted in stronger fire than the fuel model III across the three scenarios.

**Keywords:** Fire behavior fuel models, Potential fire behavior, Fire management, Northeastern China

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## The Potential Impacts of Urban and Rural Sprawl on Farmland under a "Building a New Countryside" Strategy in Northeast China

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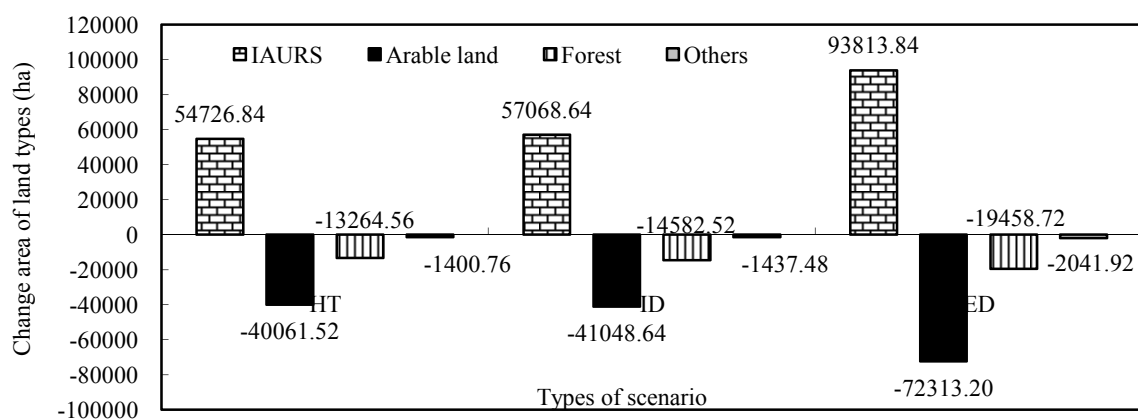
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China's development strategy, known as "building a new countryside" (BNC), is a long-term policy that will be a challenge for farmland protection. The purposes of this paper are both to compare the potential impacts of urban and rural sprawl on farmland under different implementations of the BNC strategy, and to provide scientific guidelines and decision support for better farmland protection and implementation of the BNC in northeast China. Remote sensing, geographical information systems, landscape metrics and the SLEUTH urban growth and land cover change model were applied to model and analyse urban and rural sprawl, and farmland and landscape change in 2045, assuming three BNC implementation



scenarios: continuing the Historical Trend, Intensive Development, and Extensive Development. The different implementations of BNC policy showed great impacts of policy on the anticipated urban and rural sprawl, landscape fragmentation and consequential farmland loss. The Extensive Development scenario showed the largest increase and sprawl in urban and rural residential land, the largest fragmentation of landscape and the largest loss and fragmentation of farmland. The farmland loss under Intensive Development was higher than that of the Historical Trend, but the sprawl of urban and rural residential land and the fragmentation of landscape under the Intensive Development were lower than those under the Historical Trend. Policy leading toward the Intensive Development, which coordinates farmland protection and improves rural residences, is recommended if urban and rural sprawl are to be mitigated. The study provides data useful for decision-support and policy formation for decision-makers and land managers who seek farmland protection.



The increased area of urban and rural sprawl (IAURS) and the decreased area of farmland and other landscape types in 2045. (HT: Historical Trends scenario; ID: Intensive Development scenario; ED: Extensive Development scenario)

## Simulating the Impacts of Climate Change, Land Use and Mitigation Strategies on Forest Biomass and Composition in Northern Wisconsin, USA

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Northern Wisconsin forests have been experiencing the effects of climate changing, but the collective effects are complex due to strong interactions with continuous forest growth and succession, increasing land development, harvesting, and frequent natural disturbance (e.g., fire and windthrow). We conducted a spatial simulation with LANDIS-II under future climate change scenarios, incorporating land development, natural and management disturbance, and mitigation alternatives to evaluate those complex interactions on forest live biomass over the next 100 years. We focused on the Chequamegon-Nicolet National Forest and surrounding

area in northern Wisconsin. We assumed that the future harvesting and land use patterns will resemble the recent past, and we estimated harvesting and development rates from recent land cover change data. We included modest wind disturbance within the simulations. We also considered the influences of different land ownership (i.e., public vs. private lands) on the rates of timber harvesting and land conversion. We found a net positive change trend in aboveground live biomass in comparison to the current biomass throughout all simulation scenarios. Natural disturbance, timber harvesting and land development lowered landscape forest aboveground biomass compared to the control (i.e., succession only scenario) over time and changes in aboveground biomass over time were non-linear. Our results implied that five northern tree species (*Abies balsamea*, *Betula papyrifera*, *Picea glauca*, *Pinus banksiana*, *P. resinosa*) decreased their biomass over time and a broad re-invasion of previously available habitat for *Tsuga canadensis*, which was more widely distributed and regionally dominated in the presettlement landscape, is possible under climate change scenarios. Our simulation results indicated that succession and harvesting remain the dominant drivers with climate change and land use rapidly showing strong effects. Our study demonstrated how important spatially interactive processes will affect the forest biomass of northern Wisconsin and suggested that active mitigation strategies to maximum carbon sequestration may have positive effects on the aboveground carbon storage on the national forest and surrounding area.

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## **Thoughts Concerning the Economic Valuation of Ecosystem Services at the Landscape Scale**

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Ecosystems provide a wide range of benefits to humans. The incorporation of landscape analysis into the economic valuation of ecosystem services is still a relatively new topic of discussion and research. Ecosystem services have been defined as public goods, which have non-exclusive and non-rival characteristics. This new insight can help through the use of economic tools and knowledge to value ecosystem services. In this paper, firstly, we discuss traditional approaches to the valuation of ecosystem services, such as stated preferences methods and revealed preference methods; and discuss the issues of ecosystem services

valuation methods and their theoretical basis. Secondly, we explore the limitation of economic valuation of public goods from market failure, externalities and institutional perspectives. Government policy measures to intervene in market failure and eliminate negative externalities are discussed. A number of examples are given of studies specific to the Hangzhou bay wetland. In order to give policy makers some guidance on the economic valuation of ecosystem services, economists are encouraged to develop the ecosystem services policy research. It is recommended that economists synthesize the development of ecosystem services research in geography, ecology, sociology and economics and relate these to economic valuation of ecosystem services.

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## Changing Ecosystem Services in Qinghai-Tibet Plateau

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Qinghai-Tibet Plateau (QTP), with the average altitudes of above 4000 meters above sea level, is one of the most ecologically fragile regions in the world, and its existence has great influence on the natural environment and human activities of the region and surrounding areas. For this reason QTP has been attracting the attention of the researchers and policy makers worldwide since 1980. This article systemically reviews the progress on ecosystem service research of QTP in order understand the importance and value of QTP for sustainable development of the global scientific community and decision makers. It is pointed out that integrated research on ecosystem functions and services remains weak mainly due to lack of field data, simple and sophisticated methods for evaluation and insufficient emphasis on some of the services.

**Keywords:** Ecosystem services, Valuation, Fragile, Qinghai-Tibet Plateau

## Comparing Functions of Landscape Patterns Affecting Surface Temperature in Vegetation and Impervious Surface Cover Grades: A case study in Shenzhen, China

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Landscape patterns influence energy transmission which cause spatial heterogeneity of surface temperature. We chose Shenzhen, a rapidly urbanizing city in China, as a case study to assess the influence of landscape patterns on surface temperature. Previous studies show that vegetation and impervious surfaces are two principal indicators to affect surface temperature (Xian and Crane, 2006; Yuan and Bauer, 2007; Weng and Yang, 2004), and that the correlations are piecewise linear (Yue, 2008; Zhang *et al.*, 2006). The purpose of this study was to assess the different functions of landscape patterns in affecting surface temperature, which may result in the observed piecewise linear relationship between land cover and surface temperature. Surface temperature was derived using the generalized single-channel method from Landsat-5 TM thermal infrared (TIR) data in 2005. The linear spectral unmixing method based on vegetation-impervious-soil (VIS) model was used to acquire vegetation fraction (VF) and impervious surface area (ISA) to represent land cover status. Landscape patterns were calculated by landscape metrics using Fragstats3.3 including Aggregation Index (AI), Largest Patch Index (LPI), Shannon's Diversity Index (SHDI), Patch Density (PD), and Fractal Dimension Index (FRAC). Results demonstrated that vegetation and surface temperature are correlated negatively, with the inflection of regression curves between surface temperature and VF being at 45% VF. In the areas with VF lower than 45%, they are always linearly correlated. In the areas with VF higher than 45%, AI and LPI significantly contributed to decreasing surface temperature. ISA and surface temperature were correlated positively, and the inflection of regression curves was at ISA 70%. In the area with ISA lower than 70%, ISA influenced surface temperature with a positively linear correlation. Results indicate that the surface temperature of areas with high ISA is more sensitive to landscape patterns.

**Keywords:** Urban heat island, Landscape patterns, Surface temperature, Landscape metrics, Shenzhen, China

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## **A Study on the Land Cover Classification of Arid Regions Based on Multi-temporal TM images**

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For fragile-ecosystem arid land, information about the macro and integral land cover types and areas is important for the restoration and the improvement of ecosystems. In this paper, the arid Gaotai County of Gansu Province, China was used as a case study to discuss classifying methods of the arid land based on various indexes. Taking advantage of different temporal images which reflect the different land cover types, especially vegetation, two TM images (acquired in October and June) were selected. Firstly, a series of indexes such as NDVI, vegetation coverage, ENDWI, Albedo, Wetness and texture were calculated based on the images. Secondly, combining Robert algorithms and artificial experience methods, an integrated index threshold for distinguishing vegetation from other land types was calculated. Thirdly, using the threshold and decision tree classifier developed by Friedl M *et al.* (1999), the middle-high and low coverage vegetation were extracted from the images. Fourthly, the vegetation areas from two images were combined to form the total vegetation cover types (Oasis). Using the total vegetation cover types to mask the October images, the outside of the masked area was continually classified into the types such as the salinization of land, water, bare land and wetlands and other land cover types with a decision tree classifier. Finally, combining these land cover types and vegetation cover types, the land cover classification map of the whole county was produced. Compared with the results from the interpretation on the high resolution images from Google earth, this method was found to achieve high accuracy in extracting the land cover types.

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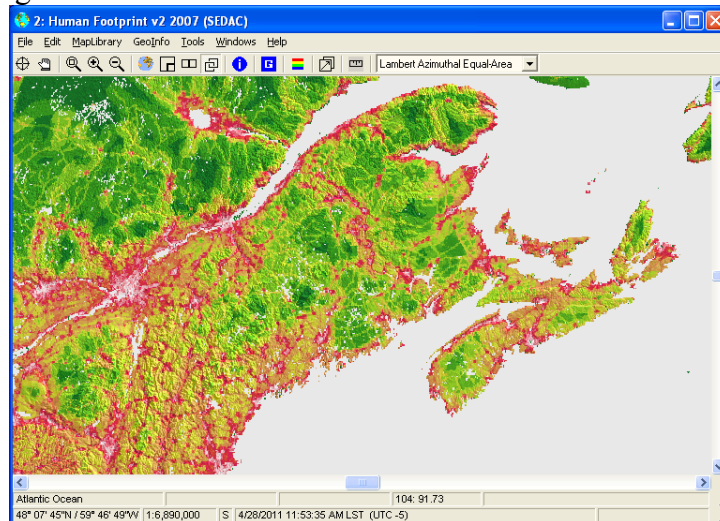
Friedl M, Brodley C, Strahler, 1999. Maximizing land cover classification accuracies produced by decision tree at continental to global scales. *IEEE Transactions Geoscience and Remote Sensing* 37(2): 969-977.

## **Data and Information Visualization and Analysis in Ecosystems Study and Education Using TerraViva SEDAC Viewer**

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Interdisciplinary earth science and ecosystem studies often require the integration of data in multiple formats and scales. Online systems have become important tools to search and acquire public domain data from distributed sources and networks. However issues with bandwidth (especially in developing countries) and relatively limited analytical function generally mean that internet mapping tools are limited for much beyond data visualization. Furthermore, preliminary data integration, visualization, and analysis with commercial geospatial packages require high technical and financial resources, often beyond what is available to many researchers and educators. TerraViva SEDAC Viewer is a standalone geospatial exploration and analysis package that comes with a complete set of data layers from CIESIN, Earth Institute, Columbia University, together with many other data sets (e.g.,

climate model outputs and multiple land cover layers). It provides a unique data visualization and analytical tool. Case studies were conducted on the uses for ecosystem assessment and conservation planning using available data layers such as Anthropogenic Biomes, the Human Footprint and Last of the Wild Data sets. Additional analyses relevant to climate impacts assessment will be investigated, including use of the observed impacts data set (Rosenzweig *et al.*, 2008) and climate scenario data from the Goddard Institute for Space Studies and the Hadley Center. An example figure below illustrates the work using the Human Footprint as a landscape-scale conservation planning tool (Trombulak *et al.*, 2010), revealing where similar human influence scores are accumulated and land transformation to human uses is most intense in an eco-region in the northeast of North America.



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## Observations of Landscape Pattern Dynamics by Remote Sensing Multi-temporal Analysis: Case Study on Selected Sites in China

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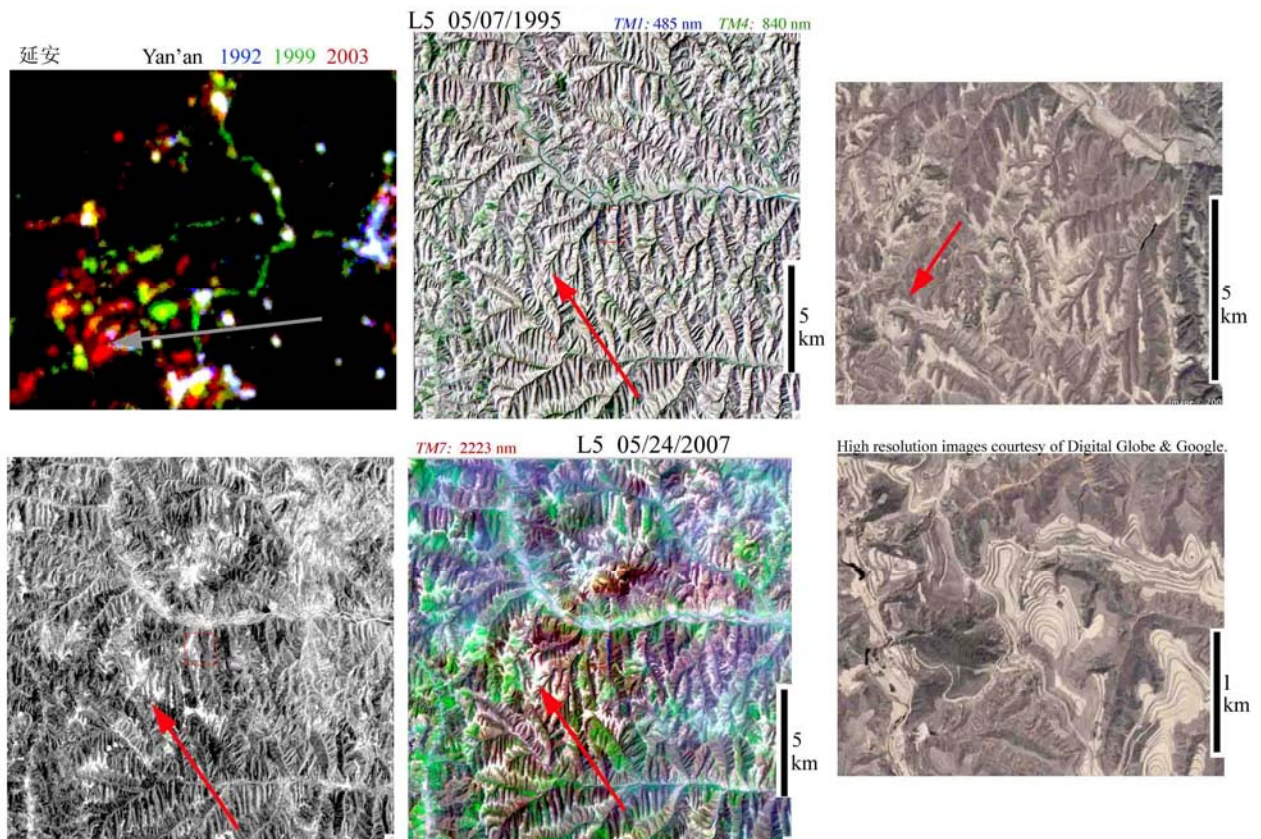
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With Chinese economy rapid growth in last two decades, the environment has experienced dynamic changes in landscape pattern at many sites. Imaging of stable night lights provides a unique observation of the development since 1992. The Defense Meteorological Satellite

Program (DMSP) Operational Line Scanner (OLS) sensors measure emitted light from natural and anthropogenic sources. Multi-temporal data from Thematic Mapper (TM) and Enhanced Thematic Mapper (ETM+) sensors carried on board of the Landsat satellites also provide a unique tool for retrospective mapping of many types of landscape change since 1982. In this research DMSP/OLS night lights at annual intervals and TM/ETM+ cloud free imagery of the selected seasons and years were analyzed in combination of high resolution images and ground photos. The selected sites were typical in landscape change associated with highway construction, hydroelectric dam construction, and regional afforestation. The results of one case in large scale landscape change in Yan'an, Shanxi Province are included below.



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## Sustainable Harvesting TCM Plants Protects Wild Giant Pandas

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Humans have used plants for medicinal purposes for thousands of years. China is the biggest traditional medicine trader in the world. Until recently, traditional Chinese medicine (TCM)

was sourced mainly from unmanaged wild harvest and a growing number of cultivated species. Traders would buy the species from anybody, without attention to sustainable harvest methods or traceability. This affected quality and subsequent supplies.

In 2008, in response to the challenges of TCM sourcing, the World Wide Fund for Nature (WWF) and EU-China Biodiversity Project (ECBP) launched a project called “Sustainable Management of Traditional Medicinal Plants in the High-Biodiversity Landscapes of Upper Yangtze Ecoregion”. The project’s goal is to develop strategic models addressing the degradation of medicinal plant ecosystems while improving livelihoods in the mountain landscapes of the Upper Yangtze ecoregion.

In the autumn of 2009, in Daping Village, Sichuan Province, an initial 500kg order of sustainably harvested *Schisandra* was sold at a much higher price than ordinary *Schisandra* to Traditional Medicinals in California, USA. This was the first such order from China based on the International Standard of TCM sustainable Harvesting and the International Manufacturer Quality Standard. In 2010, WWF helped arrange a larger order from the company; more than 20 villagers besides Daping Village were involved to sustainably harvest *Schisandra*. More than 3 tons of *Schisandra* has passed a series of tests and has been sold to US, with positive feedback from both the company and consumers. Therefore, the company adjusted their beverage formula by using the sustainably-harvested *Schisandra*. At the same time, more companies have showed interest in the sustainably-harvested products.

In 2010, the project was listed as a top 30 Action Award by the China Merchants following rigorous examination and review. One of the project pictures won high recognition Innovation Prizes co-hosted by the China Merchants and the National Poverty Relief Office, and was successfully awarded one of the five “Visual Prize” winners. (<http://gongyi.sohu.com/20101020/n276084696.shtml>)

There are many nature reserves endangered by over-harvesting of wild medical plants. Therefore, the Daping model is not for South *Schisandra* only, nor just for Pingwu. The model is applicable to the protection and sustainable exploitation of many other rare wild medical plant species. WWF is striving to protect the ecosystem in which we live through marketing.

## **Scenario Analysis of Impacts of Climate Change and Human Activities on Landscape Change in an Arid Region of Northwest China**

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For the past 50 years, the Mountain-Oasis-desert ecosystem has been strongly influenced by human activity. Large-scale reclamation of arid lands in the Oasis-desert ecosystem over the past 50 years has converted the natural desert landscape into an anthropogenic oasis (Zhao *et al.*, 2004). Moreover, grazing has resulted in grassland ecosystem degradation in the Mountains area of North-western China. These drastic human activities may have caused the



change of soil organic carbon (SOC) in the anthropogenic oasis and above net primary production (ANPP) of grasslands ecosystems in the Mountains area. However, little is known about how land reclamation and grazing have affected oasis ecosystems and grassland ecosystems in arid lands, respectively, particularly in the huge mountain-basin geographical unit with vertical climatic gradients in North-western China (Xu *et al.*, 2006; Luo *et al.*, 2008). In this study, the CENTURY model (Version 4.0) was employed to investigate the effects of land reclamation and management practices in oasis agriculture on the dynamics of SOC at the lower part of the oasis, using a typical anthropogenic oasis reclaimed at 50 years ago. The Biome-BGC model integrated with a grazing model was used to investigate the effect of grazing intensity and climate change on ANPP among the three vertical belts, the low-mountain dry grassland (LDG), mid-mountain forest-meadow grassland (MFG) and alpine meadow grassland (AMG).

Over the 50 years' cultivation (1959-2008) in the oasis ecosystem, the trend in total SOC showed an "N" type pattern, i.e. Increase, decrease, then increase. Finally, total SOC was 8.2% greater in 2008 than the original level under the natural desert shrub (Fig.1). Improvements in land management practices such as ploughing being replaced with no tillage, straw being crushed before returning it to soil, and appropriate application of fertilizers, have played a key role in the change in total SOC. The results did not support the conclusions that loss of soil organic carbon would occur due to reclamation and continuous farming in tropical forests, semiarid grasslands of northern China and Nigerian semiarid Savannah.

In the Mountains grassland ecosystem, the ANPP in the three vertical belts responded differently to various grazing intensities. Grazing can promote the ANPP in LDG generally; but decreased ANPP in MFG and AMG sharply. Negative effects increased with rising grazing intensity (Fig.2). With increasing grazing intensity, cumulative ANPP decreased steadily after a gradual increase, with grazing enhancing the ANPP mostly at a grazing intensity of about 0.5. Grazing activities can decrease evapotranspiration and increase soil water content, consequently reducing the water pressure in LDG, which may be the main reason for the increase in ANPP of LDG after grazing.

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## **Analysis and Evaluation of Landscape Pattern by Mathematical Morphology: a Case Study of Hani Terrace, Yunnan Province, China**

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Hani Terrace, Yunnan Province, China is one of the GIAHS (Global Important Agriculture Heritage System) pilot sites, is famous for its long history, traditional farming system, unique minority culture, distinct forest-village-terrace-river landscape, profound scientific value, and the spirit of harmony with nature. With this area becoming well known recently, some research has been undertaken there. Most research has been focused on analysis and evaluation of landscape patterns using landscape metrics. In this study, we used a novel theory, mathematical morphology, which encapsulates a wide range of methods that may be useful for characterizing spatial patterns in ecological research and biodiversity assessments, to analyze and evaluate the landscape pattern of Hani Terrace. Our research for the first time incorporates mathematical morphology into processing remote imagery in researching the terrace. There were two objectives: To compare previous research of Hani terrace by landscape metrics acquired from remote imagery directly (imagery without using mathematical morphology theory to process) with our research; the other is to introduce mathematical morphology theory, in the practical study of landscape metrics. Some steps are illustrated as follows. Firstly, we classified the Landsat remote sensing images (2000 and 2010) into five structural classes (core terrace, patch terrace, edge terrace, perforated terrace, none terrace) by morphological spatial pattern analysis (MSPA). Then we chose 'window' sizes of 3\*3 and 5\*5 to process the image using the following two morphological operations: erosion and dilation. Thirdly, according the revised image, we obtained statistical results of five classes in two periods from 2000 to 2010. Finally, we employed Fragstats to analyze the pattern. The results show that the new research results are different to previous studies of Hani terrace. In addition, the new theory incorporated render analysis of landscape patterns with more accuracy.

**Keywords:** Hani Terrace, Remote sensing, Landscape fragmentation pattern, Mathematical morphology, Fragstats

## Detection of Nitrate Sources in Urban Surface-Water using Isotopic and Chemical Indicators, Beijing City, China

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Isotopic and chemical indicators are widely used to identify the sources of nitrate (Kendall *et al.*, 2007). We employed  $\text{NO}_3^-/\text{Cl}^-$  and  $\delta^{15}\text{N}_{\text{nitrate}}$  to identify the sources of the nitrate in urban surface-water of Beijing municipality. The samples were collected at 10 urban-surface water monitoring sites located from upper reach and lower reaches in Beijing from 2009. The  $\text{NO}_3^-$  and  $\text{Cl}^-$  concentrations were analyzed using ion chromatography semimonthly and the  $\delta^{15}\text{N}_{\text{nitrate}}$  were analyzed using the anion exchange resin method (Silva *et al.*, 2000) on October

5<sup>th</sup> 2010 and April 6<sup>th</sup> 2011.

The results showed: (1) The nitrate nitrogen ( $\text{NO}_3^-$ -N) concentrations in the last two downstream monitoring sites (Tonghui river and Dongbianmen:  $7.01 \pm 0.88$  to  $7.58 \pm 1.49$  mg  $\text{L}^{-1}$ ) were significantly higher than that of the upper eight monitoring sites ( $1.78 \pm 0.13$  to  $3.38 \pm 0.25$  mg  $\text{L}^{-1}$ ) ( $p < 0.01$ ) during 2009-2010. (2) The  $\text{Cl}^-$  concentrations of the last two downstream monitoring sites increased with an increase in nitrate concentrations. Furthermore, the highest values of  $\text{Cl}^-$  and  $\text{NO}_3^-$ -N occurred in these two sites consistently. (3) The  $\delta^{15}\text{N}_{\text{nitrate}}$  value of the surface water ranged from  $-1.33$  to  $+26.31$  ‰ in October and  $+10.99$  to  $+17.42$  ‰ in April, respectively. Most  $\delta^{15}\text{N}_{\text{nitrate}}$  values were between  $+4$  ‰ and  $+19$  ‰ which was the typical range of manure and sewage. Combined with the information on  $\text{NO}_3^-$ -N/ $\text{Cl}^-$  and the  $\text{NO}_3^-$ -N concentration, the values of  $\delta^{15}\text{N}_{\text{nitrate}}$  showed that sewage effluent mainly influenced nitrate distribution in Beijing urban surface water especially in the lower reaches.

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## Reconstruction of Eco-climate Indicators Based on Chronologies of *Pinus tabulae formis* in Maojingba

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In order to reveal the relationship between chronology and climate, an analysis of correlation between chronologies of *Pinus tabulae formis* in Maojingba and the climate and environmental factors was established explore the different effects caused by temperature, precipitation and soil temperature.

Experimental simulation of the individual DBH growth process of *Pinus tabulae formis* was investigated using three kinds of theory growth function (Logistic, Richards and Gompertz). The DBH was obtained from the measured tree-width and the chronology in a period of 1-84. The growth trend during the period in this region was slow-fast-slow. The optimal simulation equation was:  $DBH = 395.33 * (1 - e^{-1.959 * A})^{0.984}$ . The growth trends generated by chronology were consistent with measured data and were used as substitute data.

This research applies underground temperature into dendrochronology research for the first

time. Results showed that chronologies had a strongly negative correlation with soil temperature and mean temperature in main growing season (May-August), and a positive correlation with the mean precipitation in the same period. Last October to this September is suggested as a meaningful annual scale.

Establishing the co-relationship between four eco-climate indicators and chronologies, and then reconstructing the humidity index is more practical than other methods of accurately describing the climate conditions between 1921-2009.

Compared with the disasters in Hebei, the results demonstrate significant climate cycles of 6-10 years. Due to the end of a humid period in 2009, the next few years are likely to experience local drought and a very low humidity index.

## **Impacts of Catchment Land Use Patterns on the Structural and Functional Response of Macroinvertebrates in Taiwan Streams**

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Extensive degradation of stream habitats has occurred in many parts of the world, particularly in the tropics, as a result of the rapid urbanisation and economic development of the last century. This has caused severe impacts on aquatic biodiversity and impairment of ecosystem function in streams. However, the relationship between biodiversity and ecosystem function in response to human-caused habitat alteration remains poorly understood, despite the fact that these relationships are important in assessing the potential effects of ongoing changes in land use to stream ecosystems in tropical regions.

Riparian vegetation contributes litter inputs to stream ecosystems and is thus a significant source of energy and nutrients. Litter decomposition is an important ecosystem process, particularly in native forested streams. Riparian vegetation serves several other important functions in sustaining stream ecosystem health, including protection of fluvial systems and maintenance of biodiversity. Changes in catchments resulting from agricultural practices, urbanisation and flood and erosion control measures, have resulted in not only changes to the physical habitat, hydrology and water quality in streams, but also to changes in riparian vegetation leading to lower litter inputs, increasing light and temperature fluctuations. This has thus caused changes in the structure and functions of aquatic biota, benthic macroinvertebrates in particular, due to their specialised feeding habits and lower mobility.

In this study, the hypothesis that changes in the riparian vegetation have altered the benthic macroinvertebrate community, thus ultimately affecting litter decomposition, was tested. The main objective was to investigate how community composition of benthic macroinvertebrates (i.e. structural response) and rate of litter processing (i.e. functional response) in streams responded to different riparian vegetation types and land-use patterns. The following variables were measured: (1) Allochthonous input and periphyton biomass; (2) Litter decomposition rate in three unimpacted forested stream, three agricultural, three pasture and three reprofiled stream sites. Riparian vegetation types and land-use patterns

were then mapped with biodiversity and ecosystem function, to develop their quantitative relationship with riparian vegetation and land-use patterns at various disturbance levels. Results were discussed in detail.

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## **HASM based Visualization of a 3D Landscape**

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Visualizing large scale 3D landscapes with massive datasets accurately and efficiently is an essential task in visual reality and real scene simulation. In this paper, a method that can precisely construct a 3D landscape in real time was presented. In this method, HASM(Yue et al. 2007), a high accuracy surface model, was used to construct the landscape with points datasets. The results were organized in grid form, which can be accessed randomly and quickly. Afterwards, the resulted landscape datasets were loaded into memory and stored in quadtree form. Meanwhile, the space screen errors were calculated and stored. Finally, we rendered the landscape according to the screen space error and displayed it in real-time. Furthermore, since the method fully utilized the hardware-accelerated rendering pipeline in modern video cards, its rendering efficiency was further improved. The method has been implemented in approximating and rendering 3D landscape and other height fields. The results show that it can perform consistently at interactive frame rates with high image quality and high accuracy.

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## **Ecological Risk Protection Management in an Ecologically Fragile Region of Farming-pastoral Zone in the North of China - The case of Ordos City**

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Ecological disasters have occurred frequently in recent years. 43 million persons were afflicted in 2010 by various natural disasters in China. Ecological risk management has

recently become a hot point both nationally and abroad. The emphasis of ecological construction has turned to protection before-risk from governance after-risk. Ecological risk protection management becomes an important method of ecological risk management. The technical system of ecological risk protection management includes ecological risk evaluation, ecological risk warning and ecological risk management systems. As one of the most ecologically fragile regions in China, Ordos is considered to carry a high ecological risk. Based on RS and GIS, technical route and warning system, ecological risk protection and management is built and management countermeasure is raised. Three conclusions are made: Firstly, eight warning sources were recognized including drought, flood and sandstorm. Secondly, quantitative and qualitative research was undertaken to get the spatial distribution of ecological risk in Ordos. Results showed that the majority is in the area of blue light and green light, and the minority is in the area of red light which located in the northwest and Southwest of Dalater County. Thirdly, we suggest an approach and framework for ecological risk protection and management of ecologically fragile regions based on the general ecological risk process. The results provide reference for general ecological risk protection management of similar regions.

**Keywords:** Ecological risk management, Ecological risk protection management, Ordos City

## **Spatio-temporal Patterns of Post-disturbance Tree Cover Dynamics in a Semiarid Landscape**

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Arid and semiarid ecosystems cover about 30% of the earth's land area or 4 billion hectares. The vegetation in these drylands is of great importance in supporting the world's livestock, global biodiversity, and carbon sequestration. One prominent process of dryland vegetation dynamics is the expansion of tree species into the former shrub or grass dominated areas. As drylands are increasingly affected by the rapid climate change and land use, there is a great need to monitor the long-term woodland dynamics and its response to natural disturbances and rangeland management. We studied woodland recovery process in three historical chaining (a tree-removal approach) sites across a Pinyon-Juniper (P-J) woodland landscape in the eastern Nevada, USA. We acquired 24 Landsat TM images of the dry season from year 1985 to 2008 and developed an improved spectral mixture analysis (SMA) model to quantify spatial and temporal patterns of post-disturbance P-J tree cover dynamics. In particular, we examined the spatio-temporal trends of tree cover in response to the gradient from the edge into the interior of disturbed patches. Our research found that (1) the improved SMA approach, which incorporated both a photosynthetic vegetation component and a non-photosynthetic vegetation component, was better than the vegetation index (e.g., NDVI) and conventional SMA approach in estimating woodland tree cover and its rate of change; (2) tree cover exhibited strong edge effects in recently disturbed P-J woodland patches, while no edge effect was detected in the adjacent undisturbed patches; and (3) Edge effects generally remained unchanged during the years we examined but certain sites showed stronger effects in the early post-disturbance years.

# **GAP Analysis of Vegetation for Landscape Ecological Restoration and Rehabilitation in the Upper Reaches of Minjiang River, China**

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The upper reaches of Minjiang River is an integral part of an ecological protection screen for upper reaches of the high biodiversity Yangtze River. Based on vegetation and topography data, this study classifies the vegetation of the upper reach of Minjiang River into seven types and obtains a theoretical vegetation distribution in the area by using GIS and remote sensing technology. Based on the contrast between the present situation and theoretical distribution of vegetation and the influence of human activities, we undertook a GAP analysis to classify the upper reaches of Minjiang River into eight zones which should be restored and reconstructed with different strategies:

(1) Vegetation-destroyed zone, which is located in Minjiang mainstream and its banks' watersheds, has poor environmental condition with little vegetation, severe soil and water loss and destructive human activities. Great attention should be paid to reconstruction and restoration of vegetation. (2) Vegetation-partly-destroyed zone, which lies to the west of the mainstream watershed, and lower reaches of Minjiang anabranch, has partly degraded vegetation with less damaging human activities. Restoration and reconstruction of vegetation is considered pivotal. (3) Near-headstream eco-balance zone, located in the upper reaches of Minjiang mainstream or anabranch, is a comparatively flat landform with good vegetation status and weak influence of human activities. Here, vegetation restoration and reconstruction should be focused on protecting the present vegetation and trying to reduce anthropogenic disturbance. (4) Headstream eco-zone, located on the west and north headstream of Minjiang River with an elevation from 2500-3500m, has good eco-conditions and great attention should be attached to protection of this zone's vegetation. (5) Fostered forest eco-zone/man-planted zone, which is large but with little biodiversity and hardly humus, should be "reconstructed first, restored second". (6) Degraded or restorable forest zone is mainly a large area of trace patches following felling. The strategy for this zone should be to "restore and reconstruct together". (7) Agriculture eco-zone, including two cases: human-planted fruit and economical forest zone and human habitation zone where the soil and water loss is extreme. The strategy for this zone should be one of "adjusting measures to local conditions" (8) Sparse/bare rock/arid valley zone. The former mainly consists of high elevation regions, while the latter mainly consists of cliffs and slopes with very little vegetation. For this zone, it is proposed present conditions are maintained.

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## **Response of Deep Soil Water to Land Use Change and Landscape Management in the Semi-arid Loess Hilly Area, China**

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Soil water has become a critical constraining factor for vegetation restoration in the arid Loess Plateau, China because of low rainfall and water scarcity. Large-scale forestation was initiated in the Loess Plateau in late 1990s to control soil erosion and improve environmental conditions. However, these activities may have resulted in excessive water consumption and soil water deficit in cases where no appropriate scientific guidance was offered. This in turn impacts significantly opportunities for regional ecological restoration and environmental improvement. In this study, we selected a watershed located in the semi-arid loess hilly area of the western Loess Plateau, China. The response of deep soil water to land use change and landscape management was addressed. Firstly, the soil water content of five land-use types in 0-8m soil layers was measured based on field sampling and laboratory analysis. These were slope cropland, natural grassland, pasture grassland, shrubland and forestland. Soil water content was compared between the slope cropland and the other land use types and between different landscape management styles. The results indicated that soil water content decreased drastically after slope cropland was converted to pasture grassland, shrubland and forestland, and about 30% reduction of soil water was found in the new converted land use types. However, no significant difference was found among the converted land use types, especially in the deep soil layers. This indicated that artificial revegetation may have the same effects on soil water after land use change. It was also demonstrated that landscape management techniques such as tillage and micro-topography rebuilding have the effect of redistributing precipitation and increasing rainfall water infiltration capacity, which could increase soil water content effectively both in shallow and deep soil layers. This study implies that appropriate vegetation types should be addressed based on rainfall and soil water conditions for sustainable vegetation restoration in the semi-arid loess hilly area. In addition, significant negative correlation between deep soil water content and biomass indicated that high biomass could be considered as the main reason for the drastic reduction in soil water content. The results suggest that, for sustainable vegetation restoration of the Loess Plateau, scientific management should aim to optimize density and productivity of the vegetation community. Effective landscape management practices must be employed.

## **The Relationship between Scales of Herdsman Household's Livestock and Climate Adaptive Ability**

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More than 150 herdsman households were surveyed in three areas in 2010: Chenbaerhu banner, Ewenke banner and Xinbaerhuzuo banner in Hulunbeier Region. The herdsman households were divided into six groups according to livestock numbers. Each group had 30 herders; the herdsman households also were divided into four kinds of herdsman household livestock breeding types: only bred sheep or goats (SG), only bred cow or beef cattle (CC), mainly bred sheep or goats and bred a few cows or beef cattle (SG\_CC), mainly bred sheep or goats and bred a few cow or beef cattle (CC\_SG). The results showed that: after continuous droughts for a few years and heavy snow disaster at the end of 2009, the net income of herdsman household in 2009 was still significantly positively correlated with livestock numbers ( $P>0.01$ ), and that the net income was also obviously influenced by the living conditions and the types of livestock breeding.

Tab.1 Net Benefit of Different Scales of Livestock Breeding

| scales of livestock | Mean     | Std.Dev. | Freq. |
|---------------------|----------|----------|-------|
| 1                   | -3938.3  | 11878.2  | 17    |
| 2                   | -7545.6  | 18720.9  | 27    |
| 3                   | 3961.2   | 30987.2  | 27    |
| 4                   | 54834.0  | 112022.6 | 30    |
| 5                   | 33900.8  | 76373.3  | 26    |
| 6                   | 146923.0 | 187513.3 | 27    |
| Total               | 41101.5  | 111591.4 | 154   |

F (5,148) =9.02, P=0.0000

Tab. 2 Net Benefit of Different Types of Livestock Breeding

| types of livestock | Mean    | Std.Dev. | Freq. |
|--------------------|---------|----------|-------|
| SG                 | 19140.4 | 50864.4  | 13    |
| SG CC              | 75556.4 | 153558.4 | 52    |
| CC SG              | 32004.7 | 67993.9  | 51    |
| CC                 | 13674.6 | 95811.5  | 38    |
| Total              | 41101.5 | 111591.4 | 154   |

F (3,150) =2.79, P=0.0424

In recent times, herdsman's net profits are less influenced climate disasters. During the disaster period, animal husbandry spending increased significantly leading to higher costs for the herdsman household with larger livestock numbers than for the herdsman household with smaller livestock numbers. Unintuitively, the adaptive ability and potential ability of herdsman households with more livestock was higher than those with fewer livestock. The long-term economic efficiency of herdsman with large scale of livestock did not obviously decline.

**Keywords:** Livestock scale, Adaptive ability, Climate change

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## The Assessment of River Health Using Benthic-Index of Biotic Integrity in Wenyu River

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River health assessment is very important and useful for the effective management of aquatic environments at a watershed scale. The Benthic- Index of Biotic Integrity (B-IBI) method and correlation analysis was applied to assess the Wenyu River. Based on benthic macro-invertebrate data collected at the site, the candidate biological indicators were selected to establish the B-IBI system. A criteria of health ranking was determined by using 25 percent of the B-IBI value of reference sites. The proposed criteria of B-IBI in Wenyu River are B-IBI > 1.97 is healthy, 1.48~1.97 is sub-healthy, 0.99~1.97 is fair, 0.49~0.99 is poor, and 0~0.49 is very poor. The results show 21.05% of the sample sites were classified in good condition, 10.53% were in fair condition, 63.16% were in poor or very poor condition. The results also demonstrated a strong positive correlation between the B-IBI value and water quality with a correlation coefficient of 0.85. This indicates that the use of benthic macro-invertebrates as biological indicators to evaluate river health is both rational and practical.

**Keywords:** Benthic macro-invertebrate, Biological integrity, Water quality, River ecosystem health

## **Going beyond the Millennium Ecosystem Assessment: An Ecosystem Services Dependency Index System**

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The unprecedented change of landscapes may induce tremendous consequences to short-term and long-term human well-being. It provides both risks and opportunities for a wide range of stakeholders. Yet these risks and opportunities have not been well managed due to the poor understanding of the relationship between ecosystem services and human well-being. The Millennium Ecosystem Assessment (MA) has suggested that human well-being substantially depends on ecosystem services. But it is rarely known how such dependency differs from time, space and various population groups. To well understand, monitor and manage such dependency, a quantitative measurement is urgently needed. Here, we propose an ecosystem services dependency index (ESDI) system to quantify human dependency on ecosystem services. The ESDI system includes an overall ESDI and sub-indices of ESDI for different types of ecosystem services. The overall ESDI is defined as the ratio of obtained net ecological benefits from ecosystems to total obtained net benefits, both ecosystem services related and unrelated net benefits, including net ecological, social and economic benefits. Using household net income data, we demonstrate how to develop an ESDI system. This proposed ESDI system may facilitate better understanding, monitoring and management of human dependency on landscapes and their services. It could be used for environmental impact assessment, risk management and policy making by different stakeholders (e.g., households, communities, commercial or non-profit organizations, and policy makers). It may also be combined with common ecosystem service assessment platforms (e.g., the Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) tool) to support decision making.

# Geospatial Technologies for Urban Ecosystem Research: Status and Challenges

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The concern about the environmental changes at multiple scales caused by the concentration of large population in global cities has prompted the need for a better understanding of urban systems that ecologists have not paid much attention to until very lately. While research on ecology in urban systems emphasizes the nature of the physical environment, contemporary urban ecosystem approaches have called for an integration of terrestrial, ecological, physical, and socioeconomic components. This shift of research paradigm in urban ecology demands synthesis of different theoretical perspectives, multiple data sources, and diverse analytical methods developed cross physical sciences, social sciences, and humanities. Geospatial technologies, such as remote sensing, geographic information systems, and spatial analysis and modeling, can play a critical role in advancing the contemporary urban ecological research. In this paper, I review the major developments and challenges of geospatial technologies particularly as applied to urban ecosystem research. Specifically, four major areas have been targeted: remote sensors and platforms suitable for urban areas, algorithms and methods for deriving urban attributes, developing social and environmental indicators in the urban environment, and modeling urban growth and landscape change. The paper concludes by an emphasis upon the integration of geospatial technologies that can form an invaluable technical framework for urban ecosystem research.

## Response of Matsutake Fruiting Patterns to Climate Change: 11-years of *in situ* Observations from Yunnan, China

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Global climate change has affected the phenology of plants and animals, but studies on fungi are scarce, even though they are among the organisms most sensitive to environmental change. We collected data on the fruiting of the highly prized mushroom matsutake (*Tricholoma matsutake*) in West Yunnan, China over a period of 11 years (2000-2010), and related the dynamics of the fruiting pattern with its environmental drivers, focusing on meteorological variables. For the first time, the fungal life cycle has been linked to probe the underlying ecological mechanism between the dynamics of the fruiting pattern and the meteorological variables that could have caused these changes. The results show that both fruiting dates and

production vary greatly both temporally and spatially. The first fruiting date (FFD) showed a delayed trend during the observation period. Temperature, humidity and precipitation at different periods were correlated significantly with these changes. Delayed FFD corresponded with high temperatures during fruiting preparation and reproductive stages of the life cycle. Heavy precipitation during the same stages was correlated to early FFD. Dry conditions between November and May are likely related with good productivity. For a proper analysis of climatic impact on fungal fruiting phenology, especially FFD, one should be cautious about the use of data from herbarium collection only. Research into two aspects is essential. On the one hand, long-term on-site and taxon-specific monitoring is required; on the other hand a generalised pattern or model has to be developed based on studies of site- and taxon-specific cases. A comprehensive study integrating ecology, physiology, phytochemistry, and genetic approaches should be planned in the long term.

**Keywords:** Matsutake, Fruiting, Phenology, Climate change, Yunnan, China

## **Examining the Spatial and Temporal Process of Urban Expansion in China from 1992 to 2008**

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A rapid urban expansion process has taken place in China over the last three decades, impacting both the food security and ecological security of China. Examining the spatial and temporal process effectively and accurately is helpful for understanding the urban spatial pattern and controlling the urban sprawl of China.

Remote sensing images are useful for monitoring the spatial distribution and growth of urban land because of their ability to provide timely and synoptic views of land cover. Especially the Defense Meteorological Satellite Program's Operational Linescan System (DMSP/OLS). Night time stable light data provide a credible, economical and straightforward way to map the distribution of urban land at a large scale (Elvidge *et al.* 1997). A number of techniques for mapping urban land using DMSP/OLS stable light data have been formulated, applied and evaluated. These techniques can be broadly grouped into two general types: (1) those based on the threshold method and (2) those based on image classification. The threshold method is easy to obtain urban land for many years, but without guarantee of accuracy. While the image classification method has relatively high accuracy it is difficult to extract urban data over long time periods.

The objectives of this research are: (1) to develop a new method for mapping urban land over a long time period accurately using DMSP/OLS time series data, and (2) to describe the spatial and temporal process of urban expansion in China from 1992-2008. First, by using the DMSP/OLS nighttime stable light and SPOT NDVI data, we developed a stratified support vector machine-based method (SSVM) to obtain urban land data effectively for a

single year. Second, after the systematic correction of DMSP/OLS time series data, we used the threshold method to map urban land in time series. Then the time series urban land mapped using threshold method was rectified using the urban land extract from SSVM. Based on this, the spatial and temporal process of urban expansion in China from 1992 to 2008 was presented. The performance of the new method was evaluated using multisource data. The result showed that our restored urban expansion process in China for the last two decades using the DMSP/OLS data accurately represents urban development in China.

**Keywords:** Urban expansion, DMSP/OLS, SSVM, Threshold, China

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## **Application of the Principles of Landscape Ecology on the Mild Slopes of Low Mountains and Hills in Fuzhou**

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Economic development has been restricted by the limited supply of land available for construction. Owing to the scarcity of this land and the fragile ecology of the mild slopes of low mountains and hills, it is important to ensure that the development of this land is undertaken rationally and that the protection of local ecosystems is prioritised. The current development of the mild slopes of low mountains and hills may be queried due to the seeming neglect of ecosystems in these areas.

This study uses Fuzhou city as a case study to examine development of mild slopes of low mountains and hills. Landscape ecology theory was introduced into a development scenario for the mild slopes of the low mountains and hills of Fuzhou. RS and GIS were employed to analyse the expansion of constructed urban areas on the mild slopes of low mountains and hills and assess changes in landscape pattern. By classifying the slopes of low mountains and hills into four categories, this study investigated the measures which should be taken to avoid the occurrence of the phenomenon such as landslides, on the slope of low mountains and hills.

Proposals for how to sustainably develop the mild slopes of low mountains and hills were put forward.

## **Rural Landscape Contamination by Radionuclides from the Chernobyl Fallout: 25 years Later**

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The contaminated by Chernobyl radioactive fallout territories are mostly rural. The agricultural sector was the area of the greatest economic loss caused by effects of accident. A total square of 784.3 thousand hectares of the agricultural lands were excluded from the use in three countries (Belarus, Ukraine, Russia) (The Atlas..., 2009). More than 265.0 thousand hectares of the best arable lands were excluded from the agricultural production in Belarus.

Agribusiness is currently conducted on 1.1 million ha of lands in Belarus, contaminated by  $^{137}\text{Cs}$  with a density of 37 - 1480 kBq $\text{m}^{-2}$  (0.65 million ha of them are arable lands and 0.45 million ha are forage lands).

Research has showed that the rate of vertical migration in different soils types varies for radiocaesium and radiostrontium. Rates of  $^{90}\text{Sr}$  vertical migration are lowest in peat soils. However,  $^{137}\text{Cs}$  migrates at the highest rate in these highly organic soils, but travels much more slowly in soddy-podzolic sandy soils.

In dry meadows, migration of  $^{137}\text{Cs}$  from the root zone (0-10 cm) was barely detectable 10 years after fallout. Contribution of vertical migration to the decrease in  $^{137}\text{Cs}$ -activity concentrations in the root zone of mineral soils was negligible. On the contrary, in wet meadows and peatlands, downward migration is an important factor reducing the availability of  $^{137}\text{Cs}$  for plants.

The lateral redistribution of radionuclides in catchments, which can be caused by either water, wind and agrotechnical erosion, is significantly less than their vertical migration into a soil layer. Depending on the intensity of erosive processes, the content of radionuclides in the arable layer of flat lands with small slopes may increase by 75 % (e.g. Bogdevitch et al., 2002).

The amount of radiocaesium in agricultural products in the mid-to-long term depends not only on the density of contamination, but also on soil type, moisture regime, texture, agrochemical properties and plant species.

Although inter-species variations in the transfer between soil and plant may exceed one or more orders of magnitude for radiocaesium, the impact of differing radioecological sensitivities of soils is often more important in explaining spatial variation in transfer in agricultural systems.

During the post-fallout period a total of approximately 16,000 ha of previously withdrawn agricultural lands were received into agricultural rotation. These lands are directly adjacent to populated settlements. In these rehabilitated sites, the soil fertility has been restored and various countermeasures have been used to minimise radiocaesium and radiostrontium uptake based on legal recommendations.

# Changes and Interactions of Precipitation-Landscape-Runoff in Poyang Lake Basin

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Variation in precipitation, landscape patterns and stream, and their interaction, is currently an important issue in watershed process research (Guo et.al, 2008; Vanacker et.al, 2003). Poyang Lake is the largest freshwater lake in China and receives water flow from five major rivers. When combined, this is the greatest input of water into the lake. To investigate the variation and interaction between landscape patterns and runoff volumes, this study focused on three river basins (Xinjiang River, Fuhe River and Ganjiang River) in the Poyang Lake basin as case studies. By using MODIS yearly land cover product (MCD12) data from between 2001 and 2007, five typical landscape metrics an associated Fragstats were calculated. These included; Edge Density (ED), Patch Area Mean (AREA\_MN), Contagion Index (CONTAG), Interspersion Juxtaposition Index (IJI) and Shannon's Diversity Index (SHDI). Annual mean runoff coefficient was calculated from 1997 to 2007 based on observed annual precipitation and stream runoff data. Results showed that: 1) The landscape structure in the watershed did not change much between 2001 and 2007 and forest land and crop land occupied more than 86% of the total basin area. 2) Annual stream runoff in the three basins decreased weekly. However, the runoff coefficients displayed different trends in the three basins. The coefficient calculated for the Ganging River was the most stable. The lowest runoff coefficient was calculated for Fuhe River and Xinjiang River in 2003, in which year the Poyang Lake Basin suffered from severe drought. 3) Annual correlation between stream runoff coefficients and the corresponding landscape metrics was significant in the Ganjiang River, especially NP, which had the highest value ( $R^2 = 0.96$ ). However, significant correlations were not found for Fuhe and Xinjiang Rivers for most landscape metrics. Landscape change played a less important role than climate in reducing stream flow. Therefore, if the structure of landscape patterns remains unchanged, stream runoff and precipitation trends will remain the same. Small variations in landscape patterns might result in changes to stream runoff volumes, generated in response to precipitation.

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## **Landscape Change in Typical Basins on the Tibetan Plateau using Remote Sensing and GIS Technologies**

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Landscapes on the Tibetan Plateau are changing under a prevailing warmer climate. Glacier and lake changes in the Mapam Yumco Basin (covering 7786.44 km<sup>2</sup>) were studied using a series of spatial data from topographic maps and digital satellite images, over four different years: 1974, 1990, 1999 and 2003. The results indicated that shrinking lakes, retreating glaciers, expanding lakes and advancing glaciers have co-existed in the Basin during the last 30 years. Glacier recession accelerated in recent years due to a warmer climate at an average rate of 0.21 km<sup>2</sup> a<sup>-1</sup> during 1974–1990, to 0.30 km<sup>2</sup> a<sup>-1</sup> during 1990–1999 and 0.32 km<sup>2</sup> a<sup>-1</sup> during 1999–2003. Lake area decreased at a rate of 1.42 km<sup>2</sup> a<sup>-1</sup> on average during 1974–1990, by 1.59 km<sup>2</sup> a<sup>-1</sup> during 1990–1999, and expanded by 0.64 km<sup>2</sup> a<sup>-1</sup> on average during 1999–2003. Lake area in the basin increased 0.48 km<sup>2</sup> (or 0.03 km<sup>2</sup> a<sup>-1</sup>) on average during 1974–1990, 0.71 km<sup>2</sup> (or 0.08 km<sup>2</sup> a<sup>-1</sup>) on average during 1990–1999 and 2.85 km<sup>2</sup> (or 0.66 km<sup>2</sup> a<sup>-1</sup>) on average during 1999–2003. This suggests that lake expansion accelerated in the last three decades because of higher water inflows coming from increasingly melting glaciers.

In the Yamzhog Yumco Basin in southern Tibet, glacier and lake variations were studied using a series of spatial data from topographic maps and Landsat images, over three different years: 1980, 1988/90 and 2000. The results indicated that the total glacier area decreased from 218 km<sup>2</sup> in 1980 to 215 km<sup>2</sup> in 2000; a total reduction of 3 km<sup>2</sup> (i.e. 1.5% decrease). Glacier recession rates were clearly higher in the 1990s than the 1980s due to a warmer climate. The total lake area decreased by approximately 67 km<sup>2</sup> during 1980–1990 and increased by 32 km<sup>2</sup> during 1990–2000. This suggests that the change in basin lake area was rapid, primarily because of the change in precipitation and evaporation in the basin, and secondarily, because of an increase in water supply from melting glaciers.

## **Effects of Habitat Spatiotemporal Heterogeneity on Population Dynamics and Persistence in Dynamic Landscapes**

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Understanding how habitat fragmentation and spatiotemporal heterogeneity affect population dynamics is an important area in landscape ecology. However most neutral landscape models address population dynamics are based on the assumptions of homogeneous interior habitat and constant carrying capacity (Hubbell, 2001; Chave, 2004). There has been very little theoretical work examining the influence of habitat internal heterogeneity on population



ecology (Fahrig and Nuttle, 2005). It is unclear under which circumstances the spatiotemporal heterogeneity of habitat quality may be safely ignored, especially when species are confronted with habitat fragmentation. The aim of this study was to examine the effects of spatiotemporal heterogeneity of habitat quality on population dynamics and persistence of hypothetical age-structured species with different dispersal strategies. Using a spatially explicit agent-based approach, we studied six landscapes varying in habitat amount, each with three degrees of fragmentation and three extents of spatiotemporal variations without changing the overall quality of the habitat. The results showed that habitat internal heterogeneity played an important but complex role in determining population dynamics and persistence for a hypothetical species. Higher internal heterogeneity of a habitat decreased the carrying capacity of the habitat, and consequently imposed a higher extinction probability on species. Species with limited mobility were subject to lower survivability than mobile species. With the decrease of habitat amount, habitat heterogeneity had a pronounced effect on individual's mortality of habitat specialist in a fragmented habitat, but had little effect on that of a habitat generalist. The birth-rate of generalist's population was higher in fragmented habitat with internal heterogeneity, however little change was observed for specialists. Overall, our results demonstrated that internal heterogeneity of habitat can significantly modify population dynamics and viability as predicted by neutral landscape models based on static and/or homogeneous habitat. Consequently, caution should be taken in applying generalizations derived from static habitat simulations to dynamic habitat with spatiotemporal heterogeneity.

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## Changes in Farmland Landscape Pattern and its Impact on Agroecosystem Services in Guangzhou City, China

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Farmland is an important landscape in urban areas. It provides some key ecosystem services including improving and adjusting city ecosystems, purifying air, regulating climate, conserving water and soil and beautifying the landscape (Zhang et al., 2005). Unique spatial-temporal trends in the farmland landscape of Guangzhou, located in the hinterland of the Pearl River Delta in Guangdong, have occurred because of urban expansion since the 1990s. In order to understand changes in agroecosystem services in Guangzhou in recent years, variations in farmland landscape and the corresponding changes in agroecosystem services were analysed. On the basis of TM data obtained for 1996 and 2008, and using GIS

and RS technology, the dynamic variations of agroecosystem services in Guangzhou were studied. Methods included landscape pattern analysis and the calculation of agroecosystem services through marketing valuation, shadow pricing, measuring afforestation costs, carbon taxes and industrial oxygen-production (Ouyang et al., 2004; Xu et al., 2006; Zhong et al., 2007; Zhu et al., 2010; Peng et al., 2005). The results were as follows:

1) The farmland landscape structures changed significantly. A significant change in farmland structures was observed between 1996 and 2008 and farmlands were mainly converted into gardens, water bodies and construction areas. Within the farmland landscape cultivated lands and forestlands decreased by  $8.24 \times 10^4 \text{ hm}^2$  and  $2.54 \times 10^4 \text{ hm}^2$ , respectively; and the area of water bodies and gardens increased by  $4.37 \times 10^4 \text{ hm}^2$  and  $2.90 \times 10^4 \text{ hm}^2$ , respectively. The number of patches, fragmentation degree, dispersion degree and shape index of the farmland landscape increased, however, the mean area and mean perimeter of patches decreased;

2) The value of agroecosystem services decreased from 260.73 billion to 256.41 billion from 1996 to 2008, at a rate of 0.36 billion per year. Amongst the agroecosystem services, climate and gas emission regulation contributed a large proportion of over 91%. With the decrease in forested areas, gas emission and climate regulation value was reduced by 6.12 billion and 5.89 billion, respectively. However, a notable rise in agricultural product value was observed with the increase in garden and water body areas. No obvious changes in other functions were observed. Of the different agroecosystems services, forests were a major contributor providing over 92% in service value. In general, the significant reduction in forest areas was the key reason for the decrease in agroecosystem service value. Therefore, it is considered very necessary to protect and utilise forest areas effectively in order to achieve sustainable development in Guangzhou City.

**Keywords:** Farmland landscape pattern, Agroecosystem service values, Guangzhou City

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## **Social Acceptability of Ecosystem Management for Québec's Boreal Black Spruce Forest: How are Large Clearcuts, Emulating Fire, Perceived?**

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It is now widely recognized that landscape appreciation is not made uniquely on an esthetical basis but also on ecological criteria (Bradley and Kearney, 2007). It is also acknowledged that in many cases, esthetical appreciation and ecological appreciation of landscapes can differ to the point where they become in conflict (Gobster and al., 2007). Thus, in the context of forest management, one of the major issues is to reconcile both in order to enable

managing forests with environmentally sound and sustainable practices and at the same time allowing the public enjoyment of the forest environment.

Ecosystem management (EM) aims to mitigate the impacts of forest management and preserve ecosystems' ecological integrity by emulating natural disturbances, in severity, frequency and spatial distribution (Gauthier et al., 2009). In Québec's boreal black spruce forest, where fire is the most important natural dynamic agent, this means the implementation of very large forest cuts that could vary between 30 and 250 Km<sup>2</sup> (Jetté, 2007). Because of the size of the harvested blocks involved, this strategy could meet serious social acceptability challenges.

This research project investigates the social acceptability of a EM strategy for the boreal black spruce forest using large clearcuts for three different user groups: forest users, stakeholders and the general public. As these groups experience the strategy on different levels of perception, i.e. in the field, at the planning level and as a general forestry practice, social acceptability was explored with different means for each group. Social acceptability of visual conditions resulting from the implementation of a large clearcut strategy was tested with visualizations presented to forest users. Stakeholders were interviewed individually to know their perception of the EM strategy and its alternatives (patch cut system and traditional clearcuts) and members of the general public participated to focus groups held to uncover how the strategy was received by the public. In each case, mitigating factors were identified in order to modify the large clearcut EM strategy to better meet public expectations since it does not have a strong social acceptability in its actual form.

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## **Integrated Spatial Accessibility and Equity of Urban Public Facilities: A Case Study in Baixia District, Nanjing, China**

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The welfare of communities is largely dependent upon the availability of public facilities such as schools, hospitals, police stations and sports halls. Therefore these public facilities need to be carefully planned (Ribeiro and Antunes, 2001). The spatial accessibility and equity (SAE) of public facilities is important as it effects the efficient use of facility layout and community satisfaction. In this study, Baixia District, Nanjing, China, was chosen as a case study to develop a way to measure the integrated SAE of urban public facilities. Firstly, a questionnaire was used to identify the most important types of urban public facilities. Secondly, factors which may influence the accessibility of facilities, such as the time-cost, residential area distribution and urban traffic, were evaluated in combination with the nearest-distance measure and a network analysis to determined the accessibility of each facility. The spatial equity of the facility was also evaluated, based on local community socio-economic characteristics, including age, class and income. An integrated evaluation model on SAE was finally developed according to the importance and inter-relationship between different categories of public facilities, as well as scale level variations. The results will provide a way to guide the optimisation and improvement of the spatial location of urban public facilities in the future urban planning.

**Keywords:** Urban public facilities, Spatial accessibility and equity, GIS, China

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## The Response of Ecosystems to Disturbances of Fallen Wood

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Disturbance is the external driving force in a successional forest ecosystem. Modern forest ecology and landscape ecology indicates that fallen wood has an indispensable role in a healthy and stable forest ecosystem. Current research of fallen wood is quantitatively summarised in this study and the effects of fallen wood on natural regeneration in *Tsuga longibracteata* forest ecosystems in Tianbaoyan National Nature Reserve are outlined. The investigation showed that: 1) At the stand scale, fallen wood is an important structural and functional component of forests. It plays an influential role in maintaining biodiversity in forest ecosystems and also contributes to the stabilisation of forest soil, preventing soil

erosion, contributing to the nutrient cycle. However, it also may be viewed as a fire hazard or as habitat which harbors damaging insects and disease; 2) Current studies were mostly limited to fallen wood pattern at the landscape scale. However, in modern forest management, particularly with respect to the restoration of degraded mountain forests, more attention is paid to the pursuit of sustainable development from a system perspective. Therefore, foresters need to understand how fallen wood maintains biodiversity and how management practices provide desired levels of fallen wood. Patterns and ecological processes may be coupled to establish an effective landscape model, which promotes the stable development of forest ecosystems.

## **Evaluation Method and System of Ecological Security in Cultural and Natural Heritage Sites —— Case Study in Mount Wuyi Scenery District, Fujian Province**

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Cultural and natural heritage sites are the common wealth of humanity because of their universal value. However, with the development of tourism, the environmental and landscape quality of cultural and natural heritage sites are under different threat. Their ecological security should be of high concern. The unique characteristics of cultural and natural heritage sites signifies their difference from other areas in terms of their ecological security. Therefore, it is necessary for mixed sites be assessed using a unique frame and evaluation index to indicate their ecological security status. As one of the four natural and cultural heritage sites in China, Mount Wuyi includes a biodiversity protection area, a nine-bent stream ecological protection area, a natural and cultural scene protection area (Mount Wuyi Scenery District) and a protection area for the onsite remains of the ancient Han Dynasty. Using Mount Wuyi Scenery District as an example of a disturbed site, this study assessed the site by way of a frame and index system. Tentative indices for site pressure, status and response were developed for the heritage site. To reduce the subjective arising from index weighting, three methods, including Artificial Neural Network, Support Vector Machine and Projection Pursuit, were used to assess the state of ecological security at Mount Wuyi Scenery District. The strength of this scientific method was tested and verified by comparing results using a number of different means. As part of the management of world heritage sites, the concept of Potential Menace Degree of sites (PMD) is defined to describe the extent of damage done to the heritage sites of a country that are threatened. PMD is integrated into the ecological security status of a site in order to help establish a world heritage management system, which provides a reference for distributing heritage management resources.

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## **Traffic System Planning Based on Ecological Infrastructure: A Case Study in Wulijie, Wuhan**

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Road networks are an important component of a city landscape. As a result of urban sprawl, ecological problems arising from road networks requires universal attention in both domestic and international cities. The traditional traffic planning method lacks analysis of the relationship between traffic system and ecological system. Therefore, the ecological impacts of road are not understood and can lead to the aggravation of urban ecological problems such as natural habitat fragmentation, city environment pollution and traffic jams.

This paper details the land planning of a new town, Wulijie, as an example of how to introduce a traffic planning method based on Ecological Infrastructure (EI). The paper focuses on how to apply EI to a traffic planning system on different scales: 1) Macro-Scale: Create Ecological Infrastructure before city planning is undertaken, on which the development of a new city is based and constrained. The road network should be planned according to EI requirements so as to avoid adverse impacts on natural ecosystems. 2) Medium Scale: Build Urban Greenways based on EI, which offer integrated functions such as the commuting, recreation and natural and cultural conservation: 3) Micro-Scale: Eco-design traffic infrastructure such as road paving, road cross-section, parking facilities and other aspects of traffic design.

## **Ecological Infrastructure and Land Use Strategies for Suburban Hilly Areas in Beijing**

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This paper discusses strategies for smart conservation and development of suburban hilly land in Beijing. A brief review is presented of the misconception of conventional land use planning for this area, which has been biased towards protection without a sound understanding of ecosystems. Strategies are proposed for sustainable land use of Beijing hilly suburbs. It was found that: 1) As the ecotone of mountainous and plain areas, suburban hilly land is strategic for the whole city in terms of ecological protection and land development; 2) The conflict between development and conservation of Beijing's hilly areas is caused by inappropriate and ambiguous spatial conservation strategies; 3) Under the pressure of development, an explicit spatial land use pattern should be applied in suburban hilly areas, resulting in the application of detailed land use plans and development strategies. It was concluded that "smart conservation, efficient development" land use strategies should be executed in hilly suburbs,

which require sustainable land use strategies that incorporate ecological security patterns. Land use strategies should be guided by the concept of “negative planning”, namely reversing the conventional development-oriented planning approach.

## **Reinventing the Good Earth Based on Landscape Ecology**

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The good earth is generous in providing human being with all kinds of services: it is productive, mediating, life-supporting, and culturally and spiritually meaningful. But for centuries we have invented increasingly complicated artificial systems to replace nature’s capacity to provide these free services: we call this “engineering.” We have also invented specific criteria to define beauty and urbanity that have eventually reshaped our physical landscape at the sacrifice of the good earth’s authentic beauty, and we call this “art.” Time has proven that we are now at the brink of losing our nurturing Earth. It is time now to reinvent the good earth, and the strategy is to plan and design Ecological Infrastructure (EI), where landscape ecology is the scientific core.

Ecological Infrastructure (EI) can be understood as the necessary structure of a sustainable landscape (or ecosystem) in which the output of the goods and services is maintained, and the capacity of those systems to deliver same goods and services for future generations is not undermined. What makes the concept of Ecological Infrastructure a powerful tool for the alternative ecological urbanism is its marriage with Ecosystems Services. Four categories of services are commonly identified: provisioning (producing food and clean water); regulating (managing climate, disease, flood and drought); supporting (providing nutrients and habitat for plant and animal species); and cultural (providing spiritual and recreational benefits). Ecological Infrastructure builds a bridge between ecological urbanism, the disciplines of ecology (especially landscape ecology), the notion of ecosystems services and sustainable development. It is the bridge between smart development and smart conservation.

Using Beijing as an example, this paper demonstrates the method of Ecological Infrastructure planning and the use of EI as a tool of development in urban growth.

## **Water Adaptive Landscapes across Scales**

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Climate change is nothing new to the human beings and the planet. We survived because we

have learnt to adapt and we have evolved physically and culturally. The cultural landscapes we inherited from our ancestors are the art of survival and are memories of our adaptation to the changing environment. Industrialisation and urbanisation in past centuries have removed the process of adaptation and our memories of survival are fading. It is time now to recover these memories and to continue the process of adaptation and evolution. In this process, landscape architecture is an opportunity to take leadership in reconstructing water adaptive landscapes for both flood and drought, to live with water and to treat water as a precious resource. The key is to build ecological infrastructure based on water processes across a variety of scales, from the national and continental scale to the local and site specific scale.

## **The Correlation between Global Cultural Landscapes and Global Ecological Landscapes**

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Global cultural landscapes can be divided into Christian culture, Buddhist culture, Islamic culture and other culture, while global ecological landscapes can be divided into tropical rain forest, tropical savannas, tropical desert, subtropical evergreen broad-leaved forest, subtropical evergreen sclerophyllous forests, subtropical desert landscape zone and others. Studies have shown that there seems to be some correlation between the two types of landscape. To fully understand the relationship between the two sets of landscapes, the formation and trends of global cultural landscapes were investigated.

A landscape distribution map was created which directly showed the distribution characteristics of the two sets of landscapes. A spatial analysis method was then used to determine the types and areas of ecological landscapes located within each cultural landscape. The results showed that the Christian culture is widely distributed, which corresponds with a variety of ecological landscapes. Buddhist culture is mainly distributed throughout Mongolia, Tibetan China and South Asia, which corresponds with temperate grasslands and tropical rainforests. Islamic culture is distributed mainly throughout West Asia and North Africa, which corresponds with arid and semi-arid desert grassland. Other cultures are scattered over a small area throughout the world.

Comparing the distribution of the two sets of landscapes we can find that cultural landscape distribution is consistent with ecological landscape distribution in some places. Ecological landscapes have a number of effects on cultural landscapes. Islamic culture, for example, is mainly distributed in arid and semi-arid desert grasslands. Cultural landscapes can reflect and preserve ecological landscapes. The diet common in Islamic culture is modestly vegetarian, and this may be contributing to the preservation of the local fragile ecological environment. Buddhist culture is more concerned with the inner world of human beings, which suggests that local products have satisfied the basic material needs of local populations. More attention should be paid to the fact that global cultural landscapes are also affected by culture itself. The characteristics of global cultural landscapes are not totally influenced by the ecological



landscape in which they are located. Christian culture, for example, is widely distributed across the American continent, which is not consistent with the majority of global ecological landscapes. This phenomenon is closely related to the Great Discoveries of Geography and the activities of European missionaries.

## **Evaluation and Enhancement of Rural Landscapes in Beijing**

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Beijing has undergone rapid urbanisation and economic growth since recent economic reform has taken place. Unprecedented land use and landscape changes have caused a decrease and fragmentation of farmland, a reduction in biological habitat and in ecological services. In this paper, maps of land use and Normalized Difference Vegetation Index (NDVI) were interpreted based on remote sensing images. The ecosystem service values of green spaces in plain areas of Beijing, in 1999 and 2007, were calculated based on land use and NDVI maps. The results show that the total amount of ecosystem service value of the central urban area of Beijing and the first green belt increased between 1999 and 2007. However, ecosystem service value greatly decreased overall across all plain areas of Beijing. The ratio of green space ecosystem services contributed by arable land and orchards increased with decreasing distance to the urban fringe. A loss of 58.76% of ecosystem service value from the Beijing plain areas was due to land use transformations, mainly the expansion of construction land into arable land and woodland. A loss of 41.24% was due to the degradation of landscape quality, mainly of the agricultural landscape, and in peri-urban areas in particular. The agricultural landscape was mapped and evaluated based on high-resolution remote sensing images and field surveys at the village scale. Due to a lack of management and maintenance, paved street areas and public green spaces were both observed to be in poor condition. Most of the abandoned or dilapidated structures and piles of waste seriously impacted on landscape quality. In the linear landscape, road construction was of high quality, however, 16.8% of field roads still required paving and together with uneven dirt field roads these conditions have affected the rural landscape. 21.27% of shelter belts were incomplete and needed repair. Both country roads and shelterbelts have resulted in a lack of structured shrub-grass plant growth. Basic construction of irrigation canal and ditch networks were poor and 46.02% of ditches were partially damaged and abandoned and needed to be repaired. These studies have indicated that more attention should be paid to the construction of agricultural infrastructure and environmental management to improve Beijing's rural landscape and the associated ecological service. To achieve this purpose, a policy and rural development scheme has been developed to enhance overall agricultural production capacity, and ecological and landscape services.

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## **Partitioning the Effects of Environmental and Spatial Heterogeneity on Plant Diversity Distribution in the Yellow River Delta**

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Successful biodiversity conservation and restoration rely on a better understanding of how diversity is regulated. The extent of variation in plant species richness and composition is explained by environmental variation (niche-based model) relative to spatial processes (neutral theory), and is currently of considerable interest in the field of ecology. The Yellow River Delta is a complex wetland ecosystem influenced by both the Yellow River and Bohai Bay. Partial redundancy analysis showed that the variations in species richness and composition were explained jointly by environmental and spatial factors. The majority of these variation were attributable to local environmental factors. Soil salinity contributed the most to species abundance and composition within environmental variables and became the most important factor in the Diaokou Estuary. Soil moisture, however, was the most important factor influencing species richness in the Qingshui Estuary and Chahe Estuary. The coupling effect of soil salinity and moisture is what determined species richness and composition in the wetlands. Sites with high-diversity assemblages were likely to be occupied by specialists with a narrow niche breadth, whereas low-diversity assemblages were dominated by generalists. These results provide an understanding of the organisation and assembly of estuary plant communities.

**Keywords:** Ecological niche, Environment, Spatial variation, Species composition, Species richness, Variation partitioning

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## **Research of Flux Footprint of Shanghai's Peri-Urban Forest Based on the FSAM Model**

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Carbon studies of urban ecological system play a very important role in global climate change research. The research of carbon flux in urban ecological systems can help to explain the function of and changes in carbon (C) sources or sinks. In this study, the distribution of a carbon footprint was analysed under different atmospheric conditions, including wind

direction, land use and the diurnal dynamics of the footprint, based on the eddy covariance system of Shanghai's peri-urban forest and a FSAM model (the Flux-Source Area Model). Results showed that: (1) The footprint in unstable atmospheric conditions was smaller than in stable atmospheric conditions; (2) Wind direction influenced the footprint and the range of source areas was 94~1047 m in the prevailing wind direction (90~180°), and 335 m in vertical upwinds. Other wind directions influencing flux source distribution varied from the above and the range of source areas were 103~1146 m, 122~1337m and 110~1256m. (3) Land use types also influenced the flux footprint. The contributions of buildings, transportation land use (e.g. roads) and urban vegetation to the carbon footprint were 12%, 23% and 45%, respectively, and other land use types contributed 20% overall. (4) The diurnal variation of the carbon footprint suggested that contributions to the carbon footprint were higher at night than during the day. This study will be useful for future carbon cycle studies and urban forest management.

## **Spatial Analysis of Ecological Carrying Capacity Patterns in Northwestern China in 2000**

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Regional spatial analysis of Ecological Carrying Capacity (ECC) patterns is an important area of research in ecological economics and sustainable development (Yue, 2006). To obtain a better understanding of the state of ECC in a given region, it is necessary to evaluate the quantitative ECC gap between demand and supply and analyse its spatial pattern. In this study, northwestern China was chosen as a case study to estimate the difference between ECC demand and ECC supply, and analyse the spatial distribution of ECC supply and its related indices at multiple geographic scales in the region. A modified Ecological Footprint (Wackernagel and Rees, 1996; Rees, 2006) methodology was employed on the basis of remote sensing and geographic information system techniques, using high resolution remote sensing data from 2000. The results showed that the total ECC demand was less than the total ECC supply and total ecological budget was negative overall. This implies that natural capital consumption had exceeded the available ECC and northwestern China was experiencing an ecological deficit and unsustainable development. The degree of exceedance of ECC supply varied among five provinces and 358 counties within this region. The spatial distribution of ECC supply was significantly uneven in this region, and tended to decrease from the east to the centre of the region and gradually increase from the centre to the west of the region. Further comparison of ECC supply between different landscape types was also undertaken. ECC availability was best reflected in Guanzhong Basin, Yinchuan Basin and some oases in arid areas. Overall, the difference between ECC demand and supply in the region was caused by differences in geographical characteristics, environmental condition and land use and land cover.

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## **An Optimum Control Method for the Simulation of Climate-Oriented Land-Cover**

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To simulate climate-oriented land-cover on global, national and local levels, an optimum control method of high-accuracy surface modelling (HASM-OC), based on the fundamental theorem of surfaces, was investigated (Yue, 2011). The fundamental theorem of surfaces ensures that a surface is uniquely defined by first and second fundamental coefficients. The first set of fundamental coefficients were used to calculate lengths of curves, angles of tangent vectors, areas of regions and geodesics on the earth's surface. The second set of fundamental coefficients reflected the local warping of the surface, namely its deviation from the tangent plane at the point under consideration, which can be observed externally from the earth.

HASM-OC takes remotely sensed data and simulated data generated from the climate model as its inputs and uses both observed data and spatially sampled data as its optimum control constraints. Changing trends and land-cover scenarios on different spatial levels were analysed in Jiang-Xi province and in the Dongzhi tableland in China, from which three adaptive strategies for land management were proposed. These three strategies included active adaption, conserving adaption and passive adaption.

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# Understanding of the Landscape of Yakushima Island, Japan

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Yakushima Island (area of ~503 km<sup>2</sup>) is a granite island located approximately 70 km south of Kyushu, Japan (30° 20'N, 131° 30'E). The highest mountain in the Kyushu area (Mt. Miyanoura, 1935 m a.s.l.) exists on this island. Primary forests at altitude less than 800 m a.s.l. on Yakushima Island are warm-temperate evergreen broad-leaved forests (Aiba et al. 2001), mainly consisting of Fagaceae, Hamamelidaceae, Myrsinaceae and Lauraceae (Agetsuma, 1995; Tsujino et al. 2006). Although large areas of forests have been artificially disturbed and transformed into secondary and plantation forests (Aiba et al., 2001; Agetsuma, 2007), large areas of undisturbed broad-leaved forests can still be found. Primary forests located between 800 m and 1500 m a.s.l. are mixed coniferous and broad-leaved forests with very old sugi cedar, *Cryptomeria japonica*, which sometimes exceed 2,000 years old. However, many of these aged forests were logged between the 17<sup>th</sup> and 20<sup>th</sup> century.

Annual precipitation is extremely high: 2,500 mm along the western coast and more than 8,000 mm at higher altitudes. Vertical vegetation zones with these very humid conditions accommodate 388 species of pteridophyte and 1,136 species of spermatophyte, of which approximately 50 are endemic species or varieties em. In addition, endemic subspecies of the Japanese sika deer, *Cervus nippon yakushimae*, and the Japanese monkey, *Macaca fuscata yakui*, are present over most of Yakushima Island. Because of its important value, approximately 20 % of Yakushima Island was designated a Natural World Heritage area by UNESCO in 1993. Thirteen thousand people currently inhabit this island, although a maximum population of 24,000 was present in 1960, when logging activity reached its peak.

Intensive interviews were conducted during 1986 - 1988 to record the recognition and utilisation of plants in Miyanoura village, one of the largest and oldest villages on the island. Surveys included questions on the name of useful plants, their habitat (especially their altitudinal zone), the purposes of use and historical change in use (before and after the 1960s).

Results showed that people utilised plants that were mainly distributed at lower altitudes, less than 800 m a.s.l. Edible wild plants and mushrooms were few in number. After the 1960s, many plant usages declined, especially for clothing, shelter, tools and medicines. On the contrary, plants used for horticulture or plants with special industrial uses increased after the 1960s.

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## Satoyama Mosaic for Sustainable Development

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The word *Satoyama* in Japanese literally implies the mountains nearby human settlements. In fact, *Satoyama* is a heavily human-impacted ecosystem which people have long used for harvesting firewood, making charcoal, collecting litter and leaved-branches for manure and for obtaining wild plants and fungi for food. In the other words, *Satoyama* can be defined as an ecosystem which has been modified by humans for the purpose of obtaining the “blessing of nature”, or providing services in sustainable ways. Also, *Satoyama* connotes not only the landscape itself, but also traditional wisdom or knowledge surrounding sustainable ecosystem services as well as the culture which has developed under the presence of rich flora and fauna in the Japanese Archipelago.

The landscape of *Satoyama* is characterised by a mosaic of different land uses, which provide different ecosystem services. In the Archipelago, paddy field cultivation begins in small basins, alluvial fan and fluvial terraces and not in large deltas. Owing to the tiny and fragmented topographic areas, monoculture has not developed in Japanese agriculture until recently. So agriculture in *Satoyama* in hilly areas are typically multi-crop cultures, including not only annual crops such as rice, wheat, barley, beans and vegetables, but also perennial plants such as fruiting trees, bamboo, firewood.

As *Satoyama* provides various materials, people have intentionally maintained the high diversity of useful plants and animals. Also, as *Satoyama* is a mosaic of various land uses and provides various habitats, including ecotones, high biodiversity has also unintentionally been maintained. Evergreen broad-leaved forests in western Japan have been transformed into deciduous woodlands by coppicing so that many plant undergrowth species have survived. Grasslands maintained to harvest manure have provided habitats for plant and animal grassland specialists. Paddy fields and irrigation systems provides habitats for lentic fish and insects. Even species specific to primeval forests have survived in sacred forests. An increasing amount of evidence for the ecological roles that this landscape plays is being collected, because the abandonment of *Satoyama* management in Japan is leading to the extinction of plants and animals which depend on the *Satoyama* landscape.

A mosaic landscape which provides various ecosystem services can be found not only in Japan, but also in other regions in the world. This landscape is called *Satoyama* in Japan, *Maeul* in Korea and *Munoo* in Sarawak (Iban), Malaysia, amongst others. In regions based on subsistence agriculture, using paddy fields in particular, it is important that their own TEK (Traditional Environmental Knowledge) is maintained to utilise various plant materials sustainably and move towards the intentional and unintentional conservation of biodiversity. The *Satoyama* studies do not suggest nostalgic “going back to the past” conclusions regarding the maintenance of ecosystem services, but a highly contemporary one: that TEK in each region is maintained to ensure the sustainable use of ecosystem services. This knowledge provides clues as to how to build new lifestyles focusing on health and sustainability and on how to establish compatible ways of both conserving and utilising biodiversity.

## **Development of an Artificial Neural Network Model For Estimating Interception of Different Forest Stands**

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Labor-intensive land measurements are required in order to calculate interception. Stream gauge measurements, however, can be very difficult to obtain and can damage trees. Interception was estimated in this study through the assessment of precipitation in open areas, undergrowth pluviometries and through the use of an educational algorithm, without taking stream gauge measurements. Using an educational algorithm based on an artificial neural network increases the success of modelling the interaction of environmental variables.

In this study, precipitation measurements in open areas, undergrowth and in streams were recorded for two years at the study site, at four different types of stands. These were leafed mixed stand, black pine stand, maritime pine stand and monteri pine stand. Using these measurements, the interception was calculated applying a conventional interception equation. An artificial neural network algorithm was also applied for each stand and a model was developed using open area and undergrowth precipitation data only. Of the total data set 70% was used for modeling and 20% for estimation. The models were subjected to a performance assessment and to interception values that were calculated conventionally before they were developed. No statistically significant difference was found between the estimated and measured values and the mean-square errors (MSE) calculated between these two values were found to be low. It was also observed that the most successful modelling using the artificial neural network was undertaken for the monteri pine ( $r^2:0,9968$ ; MSE:0,16) and leafed mixed stands ( $r^2:0,9964$ ; MSE:0,08). They were followed by maritime pine ( $r^2:0,9405$ ; MSE:1,27) and black pine stands ( $r^2:0,843$ ; MSE:17,36), respectively. This modelling revealed that rainfall data recorded in both open areas and undergrowth can be used to estimate interception in ecosystems, in stands that have similar characteristics.

## **Valuing Ecosystem Services of Vacant Land in a City: A Case Study of Poznan, Poland**

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Land surface is a non-renewable resource which should be used in an efficient way. In cities, large areas are permanently or temporarily in disuse by communities – they are vacant lands, often as a result of changes in land use. These areas usually undergo ecological succession and become a part of city's ecosystem. Sometimes they are the only green areas remaining in a neighborhood. They provide ecological services for the inhabitants of their neighborhood and a whole city. These areas are subjected to increasing human impact, thus it is necessary to protect them because of their important ecological and social roles. In order to demonstrate

the important role of a city's vacant lands, the ecological services of this landscape were valued in this study. The city of Poznań (Poland) was chosen as the study site. Vacant areas greater than 10 ha were inventoried for the whole city and examined in detail. Results showed that vacant areas occupy large areas of Poznań and most of them have undergone ecological succession; more than half were covered by trees and shrubs. They have become part of the city's ecosystem and many areas retain high ecological value. The following types of ecosystem services were identified in Poznań: recreational, aesthetic, regulation of local climatic conditions and improvement of air quality. To value these services the Substitute Cost Method and Travel Cost Method were used. The Substitute Cost Method analysed the costs of establishing and operating city parks. The Travel Cost Method determined how far people were required to travel to take advantage of the recreational services of vacant lands, and how far people would have to travel to reach the nearest park, in the absence of vacant lands. The results showed that vacant lands may provide highly valuable ecosystem services, and in Poznań, these services have significant economic value. This confirms the necessity of preserving the ecological functions of many of these areas.

## **Study of Sustainable Development Strategies for the Urban Ecological Environment in Hunan Province, China**

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Urbanisation is the inevitable trend resulting from the development of human society and the economy. However, in China it brings with it a series of serious urban environmental problems. For example, according to the results of a 2009 comprehensive pollution index from the Hunan Environmental State Bulletin, environmental air quality in Yongzhou is the best and in Zhuzhou it is the worst. This is because Zhuzhou, as an industrial city, has experienced high pollution growth and energy consumption over a long time to maintain rapid economic growth, at the sacrifice of the environment. From 2003 to 2004, Zhuzhou was labeled one of top 10 national polluted cities. Natural scenery has also been seriously polluted and the ecological environment badly damaged because of the accelerated development of urban tourism. If tourism develops too quickly, the carrying capacity of the ecological environment may be exceeded. Damaging behavior of tourism operators has included discharge of untreated sewage and overuse of tourism resources, which has severely disrupted the ecological balance of urban area in the region. Analyses of the urbanisation process in the cities of Hunan Province has identified the major urban environmental problems in the region. In order to increase urban grading and improve community quality of life, economic, social and environmental development needs to be coordinated, This paper discusses and puts forward countermeasures for the sustainable development of the urban ecological environment in Hunan Province.

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## **Coupled Relationship between Landscape Patterns and Eco-hydrology Processes in the Xitiaoxi River Basin, Upstream of Taihu Lake**

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Current human activity and land-use change is driving great changes to the landscape. Landscape patterns and its effect on hydrological and ecological processes has been paid more attention (Jones et al., 2001; Janauer, 2000). Landscape shape and spatial distribution can influence precipitation-runoff processes and lead to changes in runoff yield (Fu et al., 2005). In this study, Xitiaoxi, small watershed located upstream of Taihu Lake and an important water source, was selected as a pilot basin. Based on DEM using ArcGIS, the basin was divided into sub-watersheds in consideration of hydrological station locations. Remote sensing images of Xitiaoxi basin from 2008 were processed and geographic information tools were used to obtain land-use and land-cover data. The landscape patterns of the sub-watersheds was analysed by FRAGSTATS software, to calculate variables such as patch density, edge density, fractal index, contagion, diversity index and evenness index dominance index. Precipitation and runoff data was collected from different sub-watersheds and analyzed. The relationship between runoff coefficients and landscape indices was investigated. The results of this study could provide some useful information for landscape design and ecological construction.

**Keywords:** Landscape pattern, eco-hydrology, remote sensing, land use

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## Vertical Patterns and Climate Change in the Malizhai River Basin of the Hani Terrace Landscape in SW China

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The Yuanyang Hani terraces of Yunnan province have become one of the world's important agri-cultural heritage sites. Landscape pattern research is one of the most popular topics in landscape ecology. Climate change can impact on landscape patterns and land use/cover. The Malizhai River basin of Yuanyang County, located in Yunnan province in southwestern China, is situated in a core area of the Hani terrace landscape. This research uses the Malizhai River basin as the study site. Using Spot-5 images (resolution: 2.5m) from 2009 as the original data set, and with the support of ArcGIS, Fragstats and field surveys, the following was analysed: (1) Landscape patterns of Malizhai River basin at the patch, class and basin scale; (2) Vertical patterns of Malizhai River basin in combination with a digital elevation model; (3) Changes in landscape vertical patterns due to climate change at the basin scale; and (4) The relationship between landscape patterns and climate change in this area.

**Keywords:** Hani terrace, Landscape pattern, Climate change

## Primary Evaluation of Potential Occurrence of Grasshoppers in Xianghuang County, Inner Mongolia

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Grasshoppers plagues have become more severe in the last ten years in Xilinguole League, Inner Mongolia, China, mainly resulting from a warming climate and heavy grazing activities. Grasshopper plagues pose a serious threat to the health and sustainability of grassland ecosystems and their services to local communities. The climatic suitability for the occurrence of grasshoppers was evaluated in 2010 in Xianghuang county of Xilinguole League. Based on 234 field data measurements collected in early-to-mid July, 2010 (Figure 1), habitat factors were selected for analysis, including elevation, aspect, soil type, soil sand content, vegetation type, vegetation coverage and land cover type, to estimate habitat suitability for the occurrence of grasshoppers at the study site. Fuzzy evaluation methods were used in combination with 3S technology. A Rank of Potential Occurrence of Grasshoppers (RPOG) (Figure 2) was estimated through use of an integrated evaluation model of climatic and habitat suitability. The results showed that the overall accuracy for RPOG could reach 76.3%, the accuracy of the highest and lowest RPOG was higher than 80% and 70—80% for the middle RPOG. The absolute and relative errors between the simulated potential area infected by grasshoppers and the possible infected area without any implementation of preventive measures, over the last ten years, ranged from  $0.3 \times 10^4$  ha to  $1.9 \times 10^4$  ha and from 1.9% to

18.1%, respectively. The total errors for the last ten years can, however, be ignored. The climatic suitability for the occurrence of grasshoppers was homogeneous over the entire area, the vast majority of which was ranked “Suitable”. The spatial heterogeneity of the potentially infected areas was mainly related to habitat factors. The RPOG was highest in areas with 1300—1400 m elevation, a flat or eastern or southern aspect, typical chestnut soil, 60% — 80% soil sand content, and 30—50% vegetation coverage in temperate bunchgrass steppe. This study can supply basic data for precisely predicting the occurrence of grasshoppers, thus providing a crucial scientific foundation for effectively preventing and controlling grasshopper plagues.

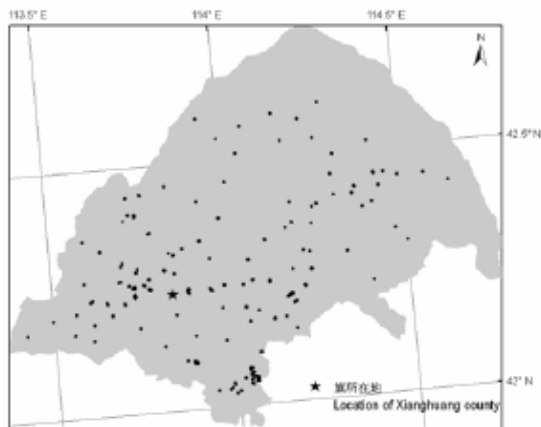


Figure 1 Field plots in Xianghuang county, Inner Mongolia

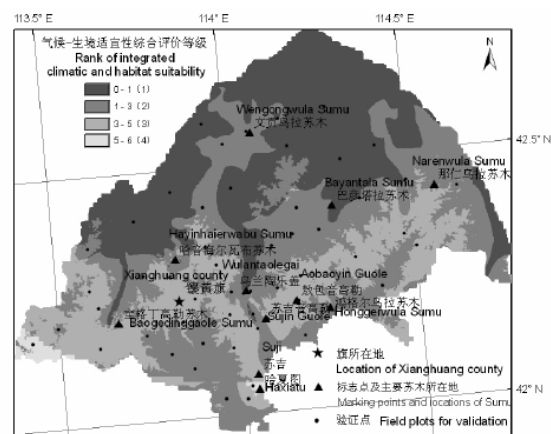


Figure 2 Rank of integrated climatic and habitat suitability for grasshoppers in Xianghuang county, Inner Mongolia

## Spatio-temporal Dynamic Analysis of Land Use Change and Ecological Carrying Capacity in Zhouqu County, China

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The measure of Ecological Carrying Capacity (ECC) (Yue DX, et al,2011) is an important method for the evaluation of the sustainable development of regional eco-economic systems. Based on the SPOT data, remote sensing techniques and GIS, this study calculated the ECC of each town in Zhouqu County belonging to the Bailong River Basin in 1995, 2000 and 2008. Spatio-temporal dynamics were also analysed using the Ecological Footprint method (Rees and Wachernagel, 2006). The results showed that: (1) The per capita ECC of all towns in Zhouqu tended to decline, but had obvious differences. The per capita ECC of towns in Zhouqu were lower than in other towns in the Bailong River Basin, indicating strong human activity in the area; (2) Over 1995-2000 the ECC of forest and pasture transformed mainly into arable land and built-up areas. Between 2000-2008, however, arable land and built-up area transformed into mainly pasture and forest. This means that land use/cover change after 2000 was driven by the State Grain for Green Project introduced in 1999, and the spatial heterogeneity reflected this (Yue DX, et al, 2006); (3) The ECC of the total county continued

to reduce from 3.189 gha in 1995 to 2.458 gha in 2008, but overall ECC was higher than the global average, almost at a level considered ecologically sustainable. It is also important to consider that changes in ECC in Zhouqu County were also caused by human activities and natural disasters.

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## Landscape Changes in the Loess Plateau Based on RS/GIS —— An the Example in the Malian River Watershed

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Quantitative Landscape Ecology research on landscape change in the Loess Plateau was undertaken by means of Landsat ETM + (2000) and Landsat TM (2007) satellite images, and supported by GIS and RS technology and methods. Using landscape pattern analysis software (Fragstats3.3), two levels (plaque type level and landscape level) of landscape indices were calculated and landscape pattern change was analysed. The outcomes were as follows: (1) Arable land and grasslands were the major plateau types from a class metrics analysis. Woodland was also present in large areas. Low areas of grassland cover sharply decreased and then increased to become areas of medium-high cover. Woodland areas gradually increased while arable lands tended to decrease. (2) A land metrics analyses showed that patch number, patch density and landscape diversity decreased. This reflected the degree of reduction in patch fragmentation and also the stabilisation of ecological systems and gradual strengthening of ecological functions.

**Keywords:** Malian River, Landscape Change, RS/GIS

## **Promoting Good Water Governance under Climate Change at a Landscape Scale: Lessons from China**

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Over the past five decades, China has experienced a dramatic change in administrative systems and economic development, which has resulted in an acceleration in rates of landscape change and stability. A typical situation has arisen in west China, where water resources are scarce and ecology is vulnerable. The landscape has been significantly affected by the intensification of climate change and human activities. In particular, water management is a major driving force that determines land use patterns and riparian ecosystem development. This paper investigates the Tarim River Basin as an example of exploring the relationship between water management regimes, land use patterns, changes in riparian ecosystems and landscape stability, through field investigations and analysis of remote sensing imagery. The study also focuses on water governance issues in terms of accountability, participation and transparency. In particular, the first two issues were considered to have a great impact on water resources planning and allocation practices, resulting in changes in landscape and its stability.

The research revealed three stages in landscape change corresponding to different water governance practices in Tarim River Basin, in chronological sequence. The first stage was characterised by centralised water governance with poor accountability due to fragmented management by various governmental departments, and limited participation by these departments. Irrigation areas generally increased and natural ecosystems were reduced and degraded in the landscape. The second stage was a transition period where the centralised water governance was weakened by new open policies and legislation. The need for a stable landscape was recognised as an important basis for economic growth and a number of successful measures were initiated. The third stage was characterised by the restoration and rehabilitation of the landscape through improved water governance. However, the development of sound landscape practices with effective water governance is still a challenge for all stakeholders. Based on this investigation of the causes and effects of landscape change, some approaches for promoting effective water governance at the landscape scale were suggested, taking into consideration tradeoffs between economic growth and environmental security in the Tarim River Basin.

## **Vegetation Change in Southern China after “Grain-for-Green”**

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In the wake of the severe Yellow River drought in 1997 and massive flooding in 1998, the

Chinese government launched a huge project, “Grain-for-Green (Sloping Land Conversion Programs)” in 1999, to promote afforestation and reforestation to reduce runoff and erosion. It is of great importance to understand how vegetation has changed over the ten years of the project as well as the effects of the project. In this study, the Normalized Difference Vegetation Index (NDVI, MODIS-1km) and climate data were used to analyse the vegetation dynamics in southern China from 2000 to 2009. The results of NDVI trend analysis showed that 18.83% (49.85 million ha) of the study area significantly increased ( $P < 0.05$ ) in NDVI value and 3.97% (10.52 million ha) significantly decreased. Based on Global Land Cover 2000 (GLC2000) and Shuttle Radar Topography Mission (SRTM) data analysis, the total area of farmland with significant NDVI increases was distributed on slopes greater than 25 degrees and included an area of 1.47 million ha. The area of forest with significant NDVI increases was approximately 5 million ha. The patterns in annual NDVI curves of farmland on steep slopes revealed that land cover types had been altered. The results of climate trend analysis showed that both annual average temperatures and annual average precipitation did not fluctuate significantly from 2000 to 2009 ( $P < 0.05$ ). From 276 weather stations, 8.7% (24 stations) significantly increased in precipitation while 2.5% (7 stations) significantly decreased ( $P < 0.05$ ). This indicated that climate did not have significant influence on vegetation dynamics. These results suggested that the “Grain-for-Green” project improved vegetation cover in this region. This study provided a complete picture of vegetation change during the period 2000-2009, an assessment of the impacts of the “Grain-for-Green” project on vegetation change and direction for revegetation in southern China, in the future.

**Keywords:** Climate change, Ecological restoration, Grain-for-Green project, NDVI, Vegetation dynamics

## **Relationship between Animal Activity Level and Habitat Use across Space - a Pioneering GPS Collar Study on Giant Pandas**

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The exploration of factors driving the distribution of animals across their heterogeneous environments is a fundamental area of inquiry in landscape ecology. However, most studies on animal-habitat relationships involve the use of dichotomous representations of animal habitat use (e.g. presence-absence), which leaves little understanding of how animals may be using different types of habitats because of different behaviors or functions. An analysis of the relationship between individual animal activity level and underlying habitat characteristics is presented in one of the first GPS collar studies on the endangered giant panda (*Ailuropoda*

*melanoleuca*), a national treasure to China and an international conservation icon. In this spatially-explicit analysis, field surveys and remotely sensed imagery with GPS collar data on individual panda locations and activity levels (measured using vertical and horizontal activity sensors) collected over a one year period were integrated. It was found that pandas selected different types of habitats when active versus when resting, suggesting that pandas responded to different habitat characteristics to meet their diverse survival needs. This study has implications for appreciating the multi-faceted nature of habitat use of the wild giant panda in a way that has not been done before, in addition to enriching an understanding of the complexity of habitat use across other animal species.

**Keywords:** Giant panda (*Ailuropoda melanoleuca*), Activity level, Habitat characteristics, GPS collar

## **Responses of Karst Ecosystem Service Values to Spatial-temporal Variation in Landscape Patterns in the Northwest of Guangxi, China**

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The responses of ecosystem services values to spatiotemporal variation in landscape patterns were examined from 1985 to 2005 in the Karst area of northwest Guangxi, China, using remote sensing and geographic information system techniques. Total ecosystem service values declined significantly from 1985 to 1990, and then slowly increased from 1990 to 2005, almost equal to the level observed in 1985. The ecosystem service values tended to decline from west to east and from mountainous regions to peak-cluster depression areas in 1985, 1990, 2000 and 2005. During the period 1985 to 2005, the ecosystem service values increased in the middle and eastern areas of the study site. Landscape pattern indices, such as total area, largest patch index, contagion, aggregative index, effective mesh and proportion of like adjacencies, were significantly correlated with ecosystem service values. This suggests that ecosystem service values tended to increase with the growth of patch area and patch connectivity. However, negative correlations between ecosystem service values and landscape pattern indices, such as division index and patch richness, were observed. This indicated that ecosystem service values decreased with patch fragmentation and patch size shrinkage. Ecosystem conditions in the typical Karst area improved because of measures controlling rocky desertification. It is important to protect key landscape types, such as woodland and shrub, and to increase patch size and connectivity to avoid further fragmentation. Furthermore, it is necessary to reduce disturbances to ensure the growth of ecosystem service values and to facilitate the sustainable development in this region.

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## Landscape Changes in Upstream, Midstream and Downstream of Menlu River Wetland in Northeast China

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Wetlands protect biodiversity and improve local, and even global climate. They are one of the most ecosystems and are broadly distributed throughout the world. Menlu River wetland covers an area of 275 km<sup>2</sup> and is located in the municipal nature reserve near the Menlu River, which belongs to the Nenjiang River system located in the Songnen plain, Northeast China. With an influx of local farmers settling in the wetland, large areas of vegetation have been replaced by fields and villages, which has damaged the original wetland ecosystem. In order to detect the severity of damage to the wetland nature reserve and to better manage the local wetland ecosystem, 19 class metrics indices and 20 land metrics indices were calculated using FRASTAS and ArcInfo software.

The ratio of village and farmland areas to section areas reveals that the wetland nature reserve was affected by humans most seriously upstream (UW) of the wetland, then downstream (DW), and least in the midstream (MW) area, along the Menlu River. A matrix was created using a largest patch area (LPA) and connectivity index, identifying grasslands in MW areas and wetlands in both UW and DW areas. The matrix for UW and DW areas was different to that for MW areas because the majority of grasslands were farmed, leading to changes in ecological processes. In MW areas, PLAND was 57.0% in grassland, 21.4% in wetland and 12.4% in forests from class level metrics. In DW areas, PLAND was 40.4% in wetland, 38.4% in grassland and 7.8% in forests. In UW areas, PLAND was 29.5% in wetland, 36.4% in grassland, and 13.3% in forestland. The PARA\_AM variable for MW areas was highest in forests and was lowest in grasslands. PARA\_AM in both UW and DW areas was highest in forest and lowest in wetlands, suggesting that forest areas contained the most complex type of



vegetation. COHESION was the greatest in grasslands of MW areas and in wetlands of UW and DW areas. The index was lowest in forests in all vegetation types, thus the connectivity of patches was greatest in grasslands in MW areas, and in wetlands of UW and DW areas. SPLIT was found to be a sensitive variable and results were very similar to those obtained from COHESION. However, SPLIT was lowest in grasslands of MW and UM areas, and in wetlands of DW areas. Landscape level metrics showed that COHESION was greatest in UW areas, followed by DW areas, and was the lowest in MW areas. The COHESION index indicated that the connectivity of grasslands and wetlands was highest in MW areas and lowest in UW areas. The changes in SHDI and SPLIT were same in UW, MW and DW areas, and indicated that landscape diversity was highest in UW areas, followed by DW areas, and least in MW areas. It was concluded that the energy balance of wildlife was disturbed in the Menlu River wetland, and that wildlife would encounter more difficulty to move between different patches. Thus, in order to protect and sustain the development of a stable ecosystem, local fields and villages in UW and DW areas should be restored to grasslands as part of the natural landscape, particularly in UW areas, to recover original ecological processes.

**Keywords:** Grassland, Wetland, Forestland, Class metrics, Land metrics

## **Do Smaller Trees receive Better Defense Services from their Partner Ants?**

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Ant-aphid mutualism has important ecological impacts on the host plant. Theoretical models argue that the protective effect of ants on plants can vary with the ontogenetic stage of the plant. In addition, plants living near ant nests often receive stronger protection from ants than other plants that live further from ant nests.

Honeydew feeding ants (*Lasius fuliginosus*) often nest in holes at the base of large trees. The protective effect of ants is expected to be stronger for those trees compared to smaller ones that do not host ant nests. This hypothesis was tested by investigating the behavior of *L. fuliginosus* and its interaction with the host oak tree *Quercus liaotungensis*.

It was found that more than 60% of ant nests were located under trees whose diameter at breast height (DBH) was >25 cm, while no ant nests were found under smaller trees (DBH <5 cm). The abundance of ants on canopy increased linearly with leaf area. *L. fuliginosus* showed significant protective effects on host trees, but the effect was not influenced by tree size. Furthermore, the protective effect did not convert to enhanced fruit production of the plant during the two years study period. Ants showed significant positive impact on aphids, negative impact on caterpillars and no impact on gall density, however, those effects were not influenced by the size of the host tree.

Contrary to our prediction, this study demonstrates that in communities, trees at different ontogenetic stages may be equally protected by their partner ants. The effects of ants on other

herbivores are not influenced by the ontogenetic stage of the host tree. Considering the nesting spaces that large trees offer for defensive ants, those large trees should be better protected from the reduction in protective ant-plant interaction in communities.

**Keywords:** Ant-aphid mutualism, Ant-plant interaction, Herbivory, Ontogeny, Biotic defense

## **Making Landscape Ecology Matter to the Public - Designer's Role and Lessons Learned in Two Case Studies in China**

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As 'human domination' of the ecosystems is growing significantly (Vitousek et al., 1997), public awareness and stewardship of our environment's ecological quality become more critical. Landscape ecology has advanced progressively in understanding landscape pattern and process, yet its influences in society have been less significant (Nassauer and Opdam, 2008), or even invisible to the public. The gap between the science and landscape practice is further amplified in China due to its dramatic landscape alteration fostered by the rapid industrialization and urbanization of the last three decades. Landscape and design of landscape are crucial for social and cultural understanding of ecological quality and change.

Nassauer and Opdam (2008) concluded that besides pattern:process, design is an integral component of the landscape ecology paradigm. Designers should undertake the responsibility and opportunities to bridge the gap between the science and landscape practice. In this paper I discuss the designer's role in applying and promoting public understanding of landscape ecology through two landscape architecture cases in China completed by Sasaki Associates.

The two chosen cases represent the landscape projects that are altering today's urban landscapes in most Chinese cities. Since the clients were local governments, designers could make recommendations that would have direct impacts on not only the specific design but also landscape policy making, which created potential research opportunities to propose, execute and measure the consequences of landscape modification.

The first case is a 80 ha central urban park in Shanghai that is currently being built partially on a brownfield. Only native species are planted in the park to promote local identity and biodiversity awareness. By demanding a large quantity of diverse native species, we also helped create the market for native landscape practice in the region, prior to which limited commercial availability of native species had discouraged native planting design. Selecting native wetland plant communities, we restored wetlands to provide environmental amenities and ecological functions including stormwater management. The second case addresses a strategic land planning and ecological restoration effort for a 60 km<sup>2</sup> coastal sand dune and lagoon in Beidaihe China. We advocated a cautious development plan with strategic roads layout to regulate urban growth. We identified a concentrated development area with the smallest ecological footprint that would also offer accessible recreational amenities.

Public awareness and appreciation of an ecological environment is a critical driving force to achieve a more sustainable society. In this long-term process, designers can make ecology visible, tangible, and easily understandable to the public.

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## Nitrate in Shallow Groundwater of Typical Terrestrial Ecosystems in China, 2004-2009

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The Chinese Ecosystem Research Network (CERN) has become one of the largest long term monitoring and research networks in the world. CERN consists of 40 field stations, covering almost all of the typical ecosystems in China including cropland, forest, grassland, desert, marshes, lakes, bays and urban ecosystems (Fu et al., 2010). Nitrate-N ( $\text{NO}_3^-$ -N) concentrations in 38 shallow groundwater wells situated in 31 of the 40 CERN field stations, representing typical terrestrial ecosystems, were assessed using monitoring data collected between 2004 and 2009.

The results showed that the average values of  $\text{NO}_3^-$ -N concentrations were significantly higher in agricultural ( $4.85 \pm 0.42 \text{ mgL}^{-1}$ ), desert (oasis) ( $3.72 \pm 0.42 \text{ mgL}^{-1}$ ) and urban ecosystems ( $3.77 \pm 0.51 \text{ mgL}^{-1}$ ) than in grassland ( $1.59 \pm 0.35 \text{ mgL}^{-1}$ ) and forest ecosystems ( $0.39 \pm 0.03 \text{ mgL}^{-1}$ ). Nitrate-N was the major form of nitrogen and between 56 to 88% of nitrogen in shallow groundwater of desert (oasis), urban and agricultural ecosystems was present as Nitrate-N. Nitrate-N concentrations for some agricultural ecosystems (Changshu (CSA), Yingtan (YTA), Fengqiu and desert (oasis) ecosystems (Cele (CLD), Linze (LZD) and Akesu (AKA)) exceeded the  $10 \text{ mgL}^{-1}$  World Health Organisation drinking water standards between 14.3 and 84.6 % of the time. Significant seasonality was found in some agricultural ecosystems and the Beijing urban ecosystem, from assessment of the relatively high frequency monitoring data. Higher nitrate concentrations were usually found during summer and winter months. The monitoring results indicated that the shallow groundwater of agro-ecosystems was contaminated by agricultural management practices such as fertilisation, while the shallow groundwater of forest-ecosystems was present under natural condition with no contamination from human activity.

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field stations are sincerely acknowledged for their sampling and analysis work.

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## **Research of the Design of Children's Space for Environmental Education - A Comparison in the Design of Children's Space in China and Japan**

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With the development of industry, population growth and urbanisation, the natural environment is being degraded and urban green spaces are shrinking. This has led to the reduction of children's outdoor activity areas, a reduction in natural experiences and a weakening in the environmental awareness of children. Because of these trends, environmental education programs in urban areas in particular, have been proposed in many countries. The aim of environmental education is to promote environmental consciousness and the contribution to a sustainable future through the conservation of natural resources. This study has made comparisons in the design of children's space in China and Japan and has investigated some effects of environmental education on the design of children's space.

This research made comparisons between China and Japan on the following: a) Equipment, plants and other characteristics of activity space for children. Data on these characteristics were compared; b) The movements of children when they were involved in physical and outdoor activities. Movements were recorded by video equipment; c) Subjects of children's interviews and identification of common thoughts.

By comparing the design of children's space in these two countries, it was found that environmental education has an influence on the design of children's space. In addition, environmental education also has a definite impact on the activities of children.

This research provides a reference on how to implement an environmental education policy in China, to help support the development of environmental consciousness in the country. It also provides reference data for the future design of children's space. It was necessary to compare the design of children's space in both China and Japan to obtain certainty on the effect of environmental education.

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## **Mountainous Vegetation Change Quantification and Analysis by Using Surface Landscape Metrics in Lancang Watershed, China**

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Land cover change is one of the most important aspects of environmental change and represents the largest threat to ecological systems for this century (Foody 2003). Land cover and vegetation change can be quantified by landscape pattern indices (LPIs). However, in mountainous areas, the landscape is represented by planar land use/land cover maps, obtained through the projection of a non-flat surface into a two-dimensional Cartesian space. Especially in steep mountains, the vegetation and land cover changes quantified on a planar map can be underestimated. A method to compute LPIs in a surface structure has been developed by Hoechstetter et al. (2008), where landscape patch surface area and surface perimeter are derived from digital elevation models (DEM). The objective of this research is to (1) choose a LPIs method (surface metrics pattern analysis or common planimetric metrics pattern analysis) for vegetation change quantification in a time span about 10 years in the two mountainous study areas; (2) employ the selected LPIs method (surface LPIs method) to assess vegetation pattern change; and (3) analyze the impacts and consequences of vegetation pattern change (specifically forest fragmentation) on the mountain ecosystems and biodiversity conservation in the two rich biodiversity areas.

In general, based on the results of the class area (CA), mean patch area ( $A_{MN}$ ), and mean Euclidean Nearest-Neighbor distance (MENN), the surface approach can obtain more realistic results for vegetation change quantification when applied in the steep mountain areas. Hence, the surface LPIs were used to quantify the vegetation change in the two study areas. Moreover, in the both mountainous study areas, the forest fragmentation significantly increased over time. The patches of agriculture land and low density forest and tall shrub became more aggregated and less fragmented in the northern study area. In the southern study area, the rubber plantation increased considerably in size and became more aggregated. The changes of fragmentation of forest, agriculture and rubber plantation had strong impacts on ecosystems and biodiversity in the two study areas (Xu and Wilkes, 2004; Li et al., 2007).

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## **Tradeoffs between Water, Carbon and Other Ecosystem Services: A Case of Poplar Plantations in Northern China**

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Poplar trees have been widely planted in northern China and around the world for multiple purposes. Yet the possible negative effects on water resource availability are poorly understood, even though the relationship between well established forests and water resources indicates that forest plantations uses more water than other shorter crops. Carbon and water balances of a young (<7 yr old) poplar plantation in a suburb of Beijing, China, were quantified for the period 2006 - 2009, using the eddy covariance, soil respiration, sapflow, and associated hydrometric methods. It was found that the Gross Ecosystem Productivity (GEP) of the plantation was 1384.79, 1319.30, 1653.68, and 1380.05  $\text{gCm}^{-2}\cdot\text{y}^{-1}$ , while the annual Net Ecosystem Exchange of carbon (NEE) was -403.72, -372.74, -790.10, and -563.18  $\text{gCm}^{-2}\cdot\text{y}^{-1}$  for 2006, 2007, 2008 and 2009, respectively. In line with the high level of GEP, it was also found that the plantation had higher evapotranspiration (ET) ( $1.60\pm 0.04$  mm/day) than that reported in the literature. Overall, annual water use (mean = 561 mm/yr, ranging from 414-672 mm/yr) of the forest was close to annual Precipitation (P) (mean = 580 mm/yr, ranging from 482-662 mm/yr), and irrigation was required during the spring season (March-June) in three of the four years to supplement precipitation during the study period. The four-year mean of the ET/P ratio was 97%. Thus only 3% of P entered the local groundwater system. The large seasonal variability of GEP, NEE, ET and transpiration (T) was due to the high inter-annual and intra-annual variability of precipitation and the leaf area index (LAI). The mean annual ratio of T/ET ranged from 0.77 to 0.87, indicating the dominance of water consumption by trees at the study site. It was therefore concluded that poplar plantations have a high carbon sequestration capability but can consume water supplied through precipitation on both seasonal and annual scales. The sustainability of establishing poplar plantations in water stressed regions should be assessed by investigating the tradeoffs between carbon sequestration, wood production and other ecosystem services as a whole.

**Keywords:** Tradeoffs, Poplar plantation, Gross ecosystem productivity, Net ecosystem exchange, Evapotranspiration

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## **Simulating the Transport and Fate of Nutrients in the Upper Mississippi River Basin Using an Integrated Modeling System**

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Nutrient concentrations and discharges from the Upper Mississippi River Basin (UMRB) have increased substantially over the last century because of changes in climate, hydrology, and land use practices. In addition to the local impacts, the transport of nutrients both naturally present and introduced through anthropogenic activities from Upper Mississippi river watersheds have significantly degraded the water quality and ecological health of the Gulf of Mexico. We use an integrated watershed and riverine modeling approach to evaluate the transport and fate of nutrients in the UMRB. First, we developed a SWAT model to quantify nonpoint source nutrient loads from the UMRB to the Mississippi River and determine how hydrology and agriculture practices affect the nutrient discharge loading. The SWAT model accounted for dynamic land use changes, incorporated key elements associated with agricultural crop production, and provided flexibility simulating land use management scenarios. Coupled HEC-RAS (Hydrologic Engineering Center – River Analysis System) and NSM (Nutrient Simulation Sub-Model) models were used to track the contributions of point and nonpoint sources within the UMRB and the transport and fate of nutrients. HEC-RAS/NSM simulates hydraulics, sediment transport, the phase distribution and biogeochemical transformation fluxes for each water quality constituent including algae, dissolved oxygen, and various components of the nitrogen and phosphorus cycles. This model determines the amounts of nutrients lost or retained in the rivers by a variety of biogeochemical processes. We are coupling the HEC-RAS/NSM and SWAT to link the transport of nutrients into the Gulf of Mexico and the agricultural practices in the UMRB.

In many catchments of the UMRB, precipitation and surface flow show large pulses. As a result, pulsing behaviours cause a wide range of soil erosion and nutrient transport. Hydrologic pulses also increase spatial heterogeneity of nutrient distribution, which further influences vegetation and ecosystem patterns in some locations. It is a challenge to accurately model the spatial and temporal variation of sediment and nutrient losses and their fates, nevertheless, integrated watershed and riverine modeling approaches provide great insights to the spatial influences of pulsing events and land use changes within the UMRB.

# **Landscape Ecological Risk Assessment Based on Geological Disasters in Longnan Mountainous Area — A Case Study of Zhouqu and Wudu in the Bailong River Catchment of Southern Gansu**

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In this paper the Zhouqu and Wudu areas of Bailong River Catchment, in Longnan Mountainous Area, were selected as a case study for a landscape ecological risk assessment of geological disasters. Typical geological disasters (such as earthquakes, landslides, debris flow and collapse) were selected as risk sources and six types of landscapes (including farmland, forestry, grassland, water bodies, construction land and unused land) were selected as risk receptors. Based on remote sensing TM images and landuse data from 1995, 2000 and 2007, and RS and GIS techniques, the potential risks caused by the four geological disasters were analysed for each landscape type. The loss of each landscape type was determined by calculating the index of fragmentation, isolation and dominance. The integrated weight of geological disasters variables was decided by AHP. A landscape ecological risk assessment model was set up and the temporal and spatial changes and reasons for variation were studied, based on the landscape ecological risk index and landscape ecological risk rating map. The results indicated that: (1) The scope of highest risk area increased from 1995 to 2007, with increasing fragmentation degree caused by human activity; (2) A spatial difference in ecological risk is apparent. Low risk areas were mainly located in the south, further away from the Bailong River and in areas with a higher degree of landscape dominance. Medium risk areas were located mainly in the southwest of Wudu, where the landscape pattern was more fragmented than in others. The higher and highest risk areas were mainly located in the Bailong River valley, especially in the valley area between Zhouqu and Wudu counties. (3) The Bailong River valley is a high ecological risk area and has an unstable geological environment, a higher incidence of collapse, debris flow and landslides, and a presence of intense human activity. Human activity has an important effect on the diffusion of landscape ecological risk.

**Keywords:** Landscape ecological risk assessment, Geological disaster, Bailong River Catchment, Longnan Mountainous Area

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## **Effects of Plantation and Seed Dispersal on Forest Landscape Dynamics under Different Management Plans in Changbai Mountain**

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Seed dispersal is an important ecological process affecting rates of tree recruitment, species range expansion and forest regeneration. In forest management, planting is another important process influencing forest regeneration in harvested patches. Both processes play a significant role in managed forests at the landscape scale. Since planting is a time and resources consuming endeavor, evaluating the combined effects of seed dispersal and planting on forest landscape dynamics, and understanding their relative importance, becomes necessary in designing forest restoration plans which may potentially reduce the investment in planting. In our research we intend to answer the following questions. 1) What are the combined effects of planting and seed dispersal processes on forest composition and structure of the Changbai Mountain landscape? 2) What is the relative importance of planting and seed dispersal on forest regeneration and forest landscape dynamics? 3) Does their relative importance vary under different management plans (e.g. different harvest intensity levels)? 4) Does their relative importance vary over time? The quantification and analysis of the relative importance of planting and seed dispersal on forest regeneration and forest landscape dynamics, under different harvesting intensities and variations with time, can help us to determine how to more effectively manage forests in the future.

**Keywords:** Seed dispersal, Planting, Changbai Mountain, Forest Management

## **Habitat Landscape Heterogeneity Analysis at the River Corridor Scale**

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A method of evaluation and analysis of habitat landscape heterogeneity at the river corridor scale were developed. A habitat classification system combining land classification and the geomorphologic units of a river was established. Characteristics of river geomorphic units such as point bar and eyot, were considered, and landscape pattern analysis and 3S technology were applied to develop quantitative analysis methods of landscape heterogeneity at the river corridor scale. Landscape pattern analysis focused on the analysis of spatial characteristics and the changes in landscape patterns. Analysis of spatial characteristics included statistical analysis of landscape elements, area transfer analysis and change analysis. This also included landscape fragmentation analysis, landscape shape analysis and landscape diversity analysis.

These analysis methods were applied to the Oujiang River Basin in Zhejiang province to investigate habitat landscape heterogeneity. The results indicated that the habitats in the target river area were mainly occupied by forest, built-up areas and farmland, to form the landscape mosaic. Other landscape elements such as water bodies, point bar, eyot and shrub variably replaced each other during 2004-2009. During this time the landscape pattern also changed dramatically in the target area. Landscape spatial heterogeneity decreased and landscape shape and habitat patterns became more uniform. The aggregation of landscape elements tended to accelerate, accompanied with a decrease in diversity and uniformity. In summary, the results presented evidence of the degeneration of habitat quality in the target river area.

## **Spatial Distribution and Variability of Chongming Island, China's Peri-Urban Forest**

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Chongming Island, the world's largest alluvial island, is located within the municipality of Shanghai, China and is being subjected to increasing pressure from urbanisation which will substantially alter the Island's existing peri-urban urban forest structure and composition in the very near future. Coupling Geographic Information Systems (GIS) and field data provided an opportunity to explore a peri-urban forest in China lacking spatial land use data. Using permanent, random plots located in forest, residential, agriculture, and transportation landscapes we explored spatial patterns of peri-urban forest composition and structure in the 1,041 km<sup>2</sup> of Chongming Island adjacent to Shanghai, China. A total of 2,251 trees were measured, comprising 42 different species in 37 genera. Most trees were located in a forest landscape (1,708; 75.87%) and average diameter at breast height, total height, crown width, and crown light exposure were quantified. With the exception of the species richness index, diversity indices for the four landscapes were not significantly different. Spatial trends and patterns for species diversity in agriculture and forest landscapes were similar, as were residential and transportation landscapes.

Results from this study can be used to establish baselines for future studies and assessments of the effects of rapid urbanisation and climate change on the sustainability and ecosystem services of peri-urban green spaces in China.

## **Modification and Application of the Soil Loss Evaluation Index - a Case Study in Yanhe Watershed, Loess Plateau of China**

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Attempting to develop new methods to examine the influence of land use on soil erosion is a popular topic in contemporary research. The multi-scale soil loss evaluation index is a new simple soil erosion model that can be applied to evaluate the relationship between land use and soil erosion. This index was yet to be applied and modified for comparison with other soil erosion models.

Yanhe watershed, located on the Chinese Loess Plateau, was chosen as a case study to test the methodology of and modify the soil loss evaluation index at a small watershed scale ( $SL_{sw}$ ). The index was used to determine which land use patterns needed to be optimised in the study area.

In order to modify the  $SL_{sw}$ , three indices were added or revised to the model, including distance index, soil and water conservation measure factor, the coefficients of shallow gully erosion and gully erosion factor. After revision of these indices, the distance index was found to correspond to the distance curve of sediment transport relating to soil erosion, which reflects the actual state of soil loss. The soil and water conservation measure factor showed the change in soil erosion after the recent implementation of soil and water conservation measures in the watershed. The coefficients of shallow gully erosion and gully erosion factor were corresponded more with the complex topography in the hilly and gully area of the loess plateau of China.

From the calculation and modification of the soil loss evaluation index for Yanhe watershed, it was concluded that the average value of the revised soil loss evaluation index ( $SL_{sw}$ ) in the Yanhe watershed was 0.4415. Erosion is more serious in Yanan city and most areas of Yanchang country, where land use structures still need to be optimised.

**Keywords:** Soil loss evaluation index, Soil erosion, Land use, Loess Plateau of China

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## **Using Remote Sensing and Landscape Metrics to Analyze Urban Heat Island Evolvement and Related Industrial Allocation in the Context of Urbanization**

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Urban heat island (UHI) impacts the local climate through the city's compact mass of buildings that affect exchange of energy and levels of conductivity (Kato and Yamaguchi 2007; Memon et al. 2008), increases air conditioning demands, raises pollution levels, and may modify precipitation patterns (Yuan and Bauer 2007). As a result, its pattern and evolvement with the process of urbanization have been major concerns in many urban environmental and climatological studies.

This study quantitatively analyzed the spatiotemporal changes of the UHI in Xiamen City, China in the context of urbanization, using Landsat TM/ETM+ thermal images acquired on similar dates in the winter of 1987, 1992, 1997, 2002 and 2007. Landscape metrics were utilized to quantify the landscape pattern changes of UHI. Results showed that, with the rapid development of urbanization, the thermal landscape became more fragment, the number of patches(NP), class area(CA) and patch area(AREA\_MN) of high-grade thermal landscape classes increased gradually; the new high-grade thermal patches were found close to the old ones, leading to the increase of proximity index(PROX\_MN) for high-grade thermal classes;

the aggregation index(AI) of the whole landscape descended while the high-grade thermal classes increased; the contagion index(CONTAG) of the whole landscape also descended. A transition matrix analysis showed that the area of thermal patches converted from low-grade into high-grade was increasing during the process of urbanization. All the high-grade thermal classes experienced three kinds of development, including number increase, area expansion and grade increase, at last formed 5 high temperature patch clusters in industrial parks, sea port and airport.

An investigation showed that, the evolvement of high-grade UHI classes reflected the changes of industrial allocation in this coastal city. With the emergence and extension of those industrial parks, those high grade patches increase in number and extend in area.

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## **Assessment and Analysis of Ecological Security in an Oasis Landscape in the Middle of Heihe River**

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In this paper, the temporal and spatial dynamic trends of ecological security in the middle of Heihe River, from 2000 to 2006, were analysed on the basis of landscape ecology theory and landscape stability. Land sat TM images from 2000 and 2006 of the middle of the Heihe River Basin were acquired to create landscape distribution maps. From these a landscape stability index was constructed, in combination with the use of a landscape disturbance index (Chen P, 2003; Li XY et al., 2005; Jing YP et al., 2008). A landscape vulnerability index was then calculated from which a landscape Ecological Security Index (ESI) was established. A systematic sampling method was used to create spatial variability. Semivariogram analysis and block krigging was conducted from 243 collected samples to study the spatial characteristics and inherent causes of regional ecological risk in the study area (Zen H, 1999).

The results showed that: (1) Landscape change trends differed in the study area between 2000 and 2006 and a persistent increase in farmland and unused land was observed, while a substantial decrease occurred in other landscapes. (2) Landscape indices, including patch number, landscape fragmentation, fractional dimension and diversity index, all showed a decreasing trend in the study area. (3) Human activity has much influence on the ecological security index, giving rise to an uneven spatial distribution of ecological security across the

whole study area. (4) The Ecological Security Index (ESI) can be used to quantitatively evaluate the ecological environment and its evolution direction. The ESI generally decreases from the centre and the edge of the Oasis.

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## Using a New Index to Indicate Water Quality in Agricultural Watersheds by Integrating Watershed Size, Flow Length, Rain Characteristics and Land Use

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Many ecologists apply landscape metrics as indicators for several ecological processes. However, most of the metrics are only based on statistical descriptions of geometric characteristics without considering ecological functions and mechanisms. As a major environmental concern, non-point source pollution was investigated by many landscape ecologists from landscape ecology viewpoints. Traditional landscape metrics used as indicators of water quality focus on the composition and spatial configuration of landscape types, with little consideration of rainfall characteristics and flow pathways.

In this study, a new comprehensive landscape index named the Flow Accumulation Index (FAI) was constructed to indicate the variation in water quality among different rain events of an individual and group of watersheds. The index was integrated with hydrological response effects, cost flow length, nutrient inputs, rainfall characteristics and river density.

Five torrential rain events in six agricultural watersheds located in Hailun County, Heilongjiang Province, Northeast of China, were used as a case study. Results showed that FAI, without consideration of rainfall characteristics, had a significant positive correlation with mean concentrations of TN, NO<sub>3</sub><sup>-</sup>, TP and PP in the five rain events. FAI also had a significant positive correlation overall with concentrations of TN, NO<sub>3</sub><sup>-</sup>, NH<sub>4</sub><sup>+</sup>, TP and PP.

This suggested that FAI could explain contaminations variation not only in different watersheds, but also in different rain events occurring in several watersheds. Therefore, this new index could be a good indicator for water quality in agricultural watersheds.

**Keywords:** Flow accumulation index, Land use, Flow length, Water quality, Rain events

## Effects of the Spatial Scales on Land-cover Mapping Using Multi-resolution Satellite Data

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In recent years, identifying the relationship between pattern and scale has emerged as a central issue in ecology and geography (Levin 1992). Scale has been characterized by grain and extent (Turner et al., 1989), but bias in the results will occur if the scale is selected differently relevant to the land-cover mapping and landscape evaluation. In this research, satellite data of varying resolution, QuickBird (2.5m), ALOS/AVNIR-2 (10m), Terra/ASTER (15m) and Landsat/ETM+ (30m), were employed to analyze the scale effects of grain size. The research was implemented at Azeta, a typical rural landscape located in Sakura City, central Japan. To assess the relationships and the effects between landscape spatial pattern and errors in the estimates of cover-type proportions as land-cover data are aggregated to coarser scales, a non-parametric ridge regression model (Hoerl and Kennard 1970) was built. As our results, random errors of each satellite data have significantly increased as its resolution become coarser. And the results have also revealed that effects on the land-cover proportion errors became higher when landscape becomes more complex and aggregated. Moreover, the model has been verified as a useful quantitative method for understanding the information loss and errors of coarse-scale remote-sensing-based land-cover mapping procedures.

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# Simulation of Ecological Risk due to Urban Expansion in Beijing-Tianjin-Tangshan Urban Agglomeration, China, using a GIS-based Assessment Model

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Ecological risk represents a scenario when the normal function of species, ecosystems or landscapes may be damaged by stress, and the health, production, genetic structure, economic value and aesthetic value of these may decline in the present and future (McDaniels, 1995). Urban expansion has become an significant interference factor altering landscape patterns and impacting or even threatening the function of the ecosystems. Since the reform and opening-up policy of 1978, rapid urbanisation has taken place in China. Beijing-Tianjin-Tangshan (BTT) urban agglomeration, located on the northeastern coast of the Chinese mainland, is one of the biggest urban agglomerations in China. Triggered by a steady population increase and fast economic development, it also experienced tremendous and rapid urban expansion (Tan et al., 2005). Understanding the ecological risk due to urban expansion in BTT urban agglomeration is therefore necessary for the effective protection of regional natural ecosystems.

The paper discusses the development of a geographic information system (GIS)-based model that can be used to assess the current and potential landscape ecological risk of urban expansion to regional ecosystems. Based on the spatial analysis of GIS and the assumption that urban expansion is the ecological risk source by altering the landscape pattern, the new model can simulate the current ecological stress caused by ongoing urban expansion and the potential ecological risk resulting from future urban expansion. Firstly, the urban expansion process was analysed using land cover maps of BTT urban agglomeration from 1990, 2000 and 2008. Urban expansion patterns from 2008 to 2030 were simulated using the Urban Expansion Scenario (UES) model developed by He et al. (2006). The developed model was then implemented for a landscape ecological risk evaluation by simulating the current stress due to urban expansion, during the periods of 1990-2000 and 2000-2008, and the potential ecological risk owing to urban expansion during the periods of 2008-2020 and 2020-2030. Finally, the BTT urban agglomeration was divided into zones of high ecological risk, moderate ecological risk and low ecological risk. The results indicated that the future urban expansion would lead to the ecological risk of a number of ecosystems, such as the crop ecosystem and water ecosystem, in varying degrees. It is suggested that measures should be taken to govern the urban expansion in BTT urban agglomeration to protect regional ecological security.

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## **Impacts of Changing Ecosystem Services on Human Well-Being in the Loess Plateau of Western China**

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Changes in ecosystem services could impact all elements involved in human well-being in a direct or an indirect way, showing a non-linear relationship between each other. In the present work, we have examined the interaction between changes in ecosystem services and well-being of people in 4 villages located in Ningxia Hui Autonomous Region of western China. Data were collected by a questionnaire survey in conjunction with the participatory rural appraisal (PRA) method, spatial analysis method was applied to explore ecosystem changes of the region. Key ecosystem services related to human well-being in the study area were identified, i.e., food, fresh water, firewood and on-land work opportunity. Results indicate that on-land work opportunity and food supply function dropped significantly. Climate change and land use change caused by Grain for Green Policy were found to be two major affecting factors from the local farmers' view. From 1999 to 2009, the well-being increased from 31.5 to 48.6, still at a low level. Though the well-being did not exhibit remarkable differences between regions, some elements, such as income, production inputs supply satisfaction, resource accessibility and nutrient acquisition capacity, varied greatly over regions. Furthermore, differences between ecosystem services change and well-being were generally induced by provision of ecosystem services, income sources and transportation conditions. An increasing income was considered a key reason affecting well-beings. Decreases in agricultural inputs supply satisfaction was thought of a constraint. With an increasing pressure from income improvement, farmers need more income sources like off-land work opportunities. This study provides a useful base for studying interactions between ecosystem sustainability and well-being improvement.

## **Impacts of Land Use Management on Ecosystem Services and Their Regulations – A Case Study in Hainan Island, China**

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Nature provides a wide range of benefits to people. However, how to balance the trade-offs between satisfying human need and ecosystem regulating services is a key challenge for ecosystem management. We analysis the land use and land cover changes, and use a spatially



explicit modeling tool, Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST), to predict changes in ecosystem regulating services, including nutrient (total phosphorus (TP) and total nitrogen (TN)), sediment retention, storm peak mitigation, carbon sequestration the three watersheds (Nanduijiang watershed, Wanquanhe watershed and Changhuajiang watershed) in Hainan Island, China. We found that from 1998 to 2008 the area of rubber plantation increased from 17.3% to 36.1% in the three watersheds. The rubber plantation expansion increases the ecosystem provisioning services at the expense of ecosystem regulating services. In the three rivers, the TP, TN and sediment increased by 236.8 t, 2968.3 t and  $229.6 \times 10^3$  t between 1998 and 2008. The natural habitat, carbon sequestration and storm peak mitigation function also decrease. Adaptive management (from monoculture to complex culture) is an effective approach to maintain ecosystem provisioning services and improve regulating services. It will decrease TP, TN and sediment by 129.8, 1841.5 and  $364.8 \times 10^3$  t and increase the storm peak mitigation function in the three watersheds in 2008. Adaptive management, scientific policy design and payments for ecosystem services will help balance the tradeoff between ecosystem provisioning services and regulating services. The case study provides a methodology for managing several ecosystem services.

## **Study on Natural Ventilation in Urban Environment**

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Lots of huge buildings and crowded narrow streets are two key features of urban landscape in China's urbanization, which result in serious urban environmental problems, such as urban heat island, noise pollution, atmospheric pollution. Natural ventilation in urban environment is an effective way to alleviate the Afore-mentioned urban environmental problems, but suppressed by unscientific urbanization in nowadays, the local calm wind and local moderate gale formed from urban environment even exacerbate the Afore-mentioned urban environmental problem. For this reason, we monitor and analyzed the natural ventilation in urban environment of Xiamen, and assessment the current situation of natural ventilation in Xiamen, then given some suggestions on urban planning and architectural design in order to promote the natural ventilation potential in urban environment.

The current studies on urban wind field used three methods: theoretical analysis, field monitoring and simulation (wind tunnel test and CFD), all of which have the shortages when used use alone. We monitored the meteorology data (include: wind, temperature, moisture and irradiance) with automatic weather station as fixed monitoring sites and monitoring vehicle as mobile monitoring sites in Xiamen once a month, and analysis based on relevant theories, simulated the regions with salient features, then assessment the efficiency of natural ventilation in urban environment and analysis the natural ventilation potential based on the basic theories and results of CFD simulation.

At last, we aimed to improve the natural ventilation potential and passive cooling potential in

Xiamen by urban planning and architectural design. natural ventilation potential may be defined as the possibility of ensuring an acceptable air quality and wind speed through natural ventilation only. Passive cooling potential can also be defined as the possibility of ensuring an acceptable indoor thermal comfort in summer by solely using natural ventilation.

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## Ecotourism Development in China: Progress and Prospect

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With the rapid development of tourism industry and the continued concerns of tourism environment, ecotourism has been paid attention since its introduction from overseas. “Shengtai Luyou” which is Chinese pronunciation for ecotourism has been nameable in this country. And from the year of 2000, ecotourism becomes a subject for more and more Chinese researchers, and lots of papers and monographs are published. According to literature statistics of this study, there are 1040 or so paper which listed “ecotourism” as keyword and almost 60 academic books in Chinese language up to the end of 2010. Beside most of papers just have presented detailed destinations, there are still quite a few academic papers referred to many aspects of ecotourism, such as definition, resources, products, marketing, planning, management, ecotourist.

Therefore, this paper provides an overview of available information and questionnaire on the development of ecotourism in China. Efforts have been made to develop an understanding of the size, nature and policy of ecotourism within one big developing country and identify the issues which it faced at national level. This research indicated that there are still exiting many stresses in the process of ecotourism development. These include: environment deterioration, misunderstanding concepts, incoherent management, lack of qualified staff, lack of authorized planning, weak scientific support. Based on the information reviewed, the authors have given some suggestions briefly for ecotourism sustainable development.

**Keywords:** Ecotourism, Development, China

# Researches on Carbon Sequestration Capacity of Two Forest Types in Ruxi Watershed in Three Gorges Reservoir Area

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Terrestrial ecosystem of the Three Gorges Valley is a huge carbon pool in all ages. With the continuous construction progress of Three Gorges Dam which is world-renowned, human's disturbance and destruction inevitably brought to the natural terrestrial ecosystems of Three Gorges Valley. (Xiao et al, 2004) However, the destruction of forests, grasslands and other vegetation have great effect to the Carbon absorbing ability of the terrestrial ecosystem. Restoration of vegetation, especially restoration of forest in Three Gorges Reservoir is an important basis for ecological environment construction and sustainable development of the reservoir area and even the whole Yangtze River. In recent years, the government has taken a lot of measures to repair and improve the forest coverage and improve environmental quality of the reservoir area. These measures include returning the grain plots to forestry or grassland, closing hillsides to facilitate afforestation and so on. The conversion of different vegetation or different ecosystems, will lead to changes in terrestrial carbon sink, and the changes in the carbon sink capacity is also a reflection to the vegetation restoration situation of Three Gorges reservoir area.

This shows that the research on carbon sequestration of the reservoir area will help us to understand the state of ecological landscape of Three Gorges reservoir area better. Besides, it can also give us some important reference to our land use planning and vegetation restoration in watershed.

In this study, we will construct a model of carbon storage with a combination of field survey data and remote sensing data, and calculate the Biomass and carbon stock quantity of two types of forests, *Cupressus funebris* Endl and *Pinus massoniana* Lamb, in Ruxi River watershed in the Three Gorges Reservoir Area, based on standard area investigation and 3S technology. Based on the analysis of carbon sequestration pattern changes in space and time, we can provide with some beneficial references to the construction and restoration of forest vegetation and land use planning, management, policy decision-making and corresponding forecast in the reservoir area in the Three Gorges Valley in twenty or thirty years.

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# Soil Warming Effect on Net Ecosystem Exchange of Carbon Dioxide during the Transition from Wintertime Carbon Source to Spring Carbon Sink in a Temperate Urban Lawn

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The significant warming in urban environments caused by the additive effects of global warming and heat island has widely stimulated the development of urban vegetation for surface cooling through direct shading and indirect evapotranspiration. However, the climate feedback due to change in the carbon cycle of urban lawn in a warming environment is less understood. In this study, the soil warming effect on the Net Ecosystem Exchange (NEE) of carbon dioxide during the transition from winter to spring was investigated in a temperate urban lawn in Beijing, China. The NEE under soil warming decreased by six times, compared with the control site, indicating that the net ecosystem CO<sub>2</sub> change would provide a negative feedback for climate warming (Fig.1). There was no significant effect of soil warming on nocturnal NEE (i.e. ecosystem respiration) (Fig.2), although the soil temperature sensitivity ( $Q_{10}$ ) of ecosystem respiration under soil warming treatment was 3.86, lower than that at the control site (7.03). The CO<sub>2</sub> uptake significantly increased with soil warming treatment (Fig.3) that was attributed to the increase in  $\alpha$  (apparent quantum yield) and  $A_{max}$  (maximum rate of photosynthesis) by approximately 1 fold under the warming treatment. It can be inferred that the response of urban lawn photosynthesis to soil warming is much more sensitive than respiration in the transition period.

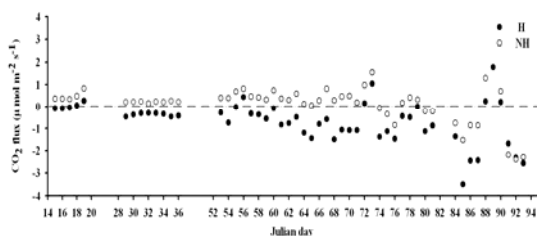


Fig.1 The daily NEE under heating treatment and control.

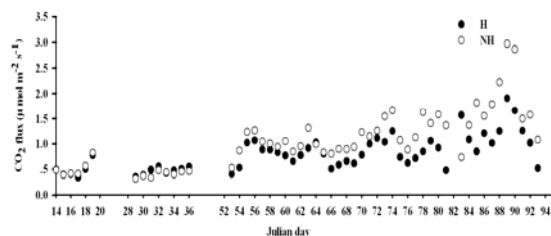


Fig.2 The nocturnal NEE under heating treatment and control.

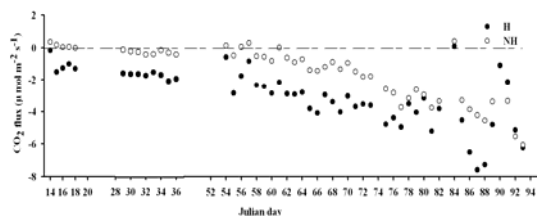


Fig.3 The diurnal NEE under heating treatment and control.

# Vegetation Ecological Risk Assessment along Bohai Bay Based on Natural Disasters

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Ecological Risk Assessment (ERA), a rising field in regional research, is of great significance in environment renovation, nature conservation and biodiversity conservation. The vegetation risk of 14 counties around Bohai Bay was evaluated in this essay on the basis of Relative Risk Model (RRM) and we attempted to explore a method of ERA under multi-stressors and multi-pathways. From a perspective of natural disasters, earthquake, flood, drought, snow disaster, hail, freezing, sandstorm and storm surge were incorporated as risk source. Only the original loss of natural ecosystems under risk shall be taken into consideration and Net Primary Productivity (NPP) of 2000 as an indicator. When it comes to the complex interaction between multi-stressors and multi-receptors, the first step was to analysis the vulnerability of environmental background using principal component scores derived from synthesizing natural factors such as topography, land cover and meteorology and human impact factor. And then risk exposure from different sources upon different receptors was assessed by applying expert scoring method. The base map for the assessment was the land use map of 2000. All data was converted into 1km \* 1km grid image and calculated on ArcGIS platform. We evaluated the vegetation ecological risk and mapped the result. According to the total risk value, the study area was divided into five levels of risk zones. Results show that higher and highest vegetation risk areas mainly distributes in the center of the counties, Tianjin especially. Most of the lowest risk areas are along the Bohai Bay. The general trend is that the vegetation risk declines from land to sea, from center to surrounding in the counties and the south area has a lower risk than that of the north. It is in accordance with the distribution of NPP. Region with a higher and more concentrated vegetation coverage often has lower risk; while in the contrast, intensive areas of urban and industrial land usually take more risk. The high risk values along National Highway 103 indicate the negative effect of transportation corridor on ecosystem. It would make sense if we take good protection of natural vegetation during urbanization, scatter construction land (such as build satellite town), pay attention to the greening of inner city and especially along transportation corridor.

**Acknowledgment:** This work was funded by the key project of Natural Science Foundation of China (40830746).

**Keywords:** Vegetation ecological risk assessment, Natural disasters, NPP, Explosion analysis, Bohai Bay

# Application of Atmospheric Effects Guidelines to Shenyang Urban Green Space Planning, China

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With the rapid growths of cities, the importance of green space to our environment is increasingly recognized. In order to contribute to the sustainability of urban ecological environment, knowledge about the urban atmospheric effects such as urban heat island, air pollution, wind flows should be taken into green space planning (Alcoforado et al., 2009). One of key tasks of planners is how to apply atmospheric effects to optimize green spatial structure. The study introduces a framework for developing green spatial structure through: (1) obtaining optimum locations for urban parks and open spaces based on Multi-objective location model (Neema and Ohgai, 2010); (2) analyzing the rationality of current status of urban green spaces by simulating the three-dimensional spatial dispersion pattern of atmospheric effects factors, such as temperature, wind, pollutant based on Computational Fluid Dynamics (CFD) model which provides results of the flow features at every point in space simultaneously and the numerical results performed well for factors distribution in urban space; (3) designing five different structures of urban green space from three aspects of the location, size, efficiency, and evaluating urban atmospheric environment effects of different green space structures in the appropriate location; (4) applying landscape ecological principles in organizing optimized green space structure in urban areas. A case study was made for Shenyang, China and its results show that the 12 m<sup>2</sup> green area per capita seems not to be enough to maintain the urban ecological balance for many green spaces independent each other were distributed in city as green isolation islands, and can not effectively alleviate urban heat island effect and prevent air pollutants dispersion. From this perspective, we propose that Shenyang should set aside an extra green area from 5,842 to 8,228 ha, and that the green structure plan at regional, city and neighborhood scales includes six green wedges, three green belts, various parks and other green ways to create an optimized green ecological network to solve atmospheric problems. This green space network and the combined model approaches used here will simplify and systematize the complex landscape, form a skeletal framework to help to optimize green space structure more scientifically and guide green space planning for alleviating urban atmospheric problems.

**Keywords:** Atmospheric effects; Multi-objective location model; Computational fluid dynamics (CFD) model; Landscape-ecology principles; Green space structure

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# Urban Green Space and Public Health: A Comparative Case Study of Sydney, Australia and Shanghai, China and an Exploratory Discussion based on Active Living and Landscape Spatial Pattern Research

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Urban green space may mitigate the public health problems that typically emerge with high-density urban development, and promotes health and well-being of urban-dwelling residents. It can (1) provide fresh air and physical activity settings to improve *physical health*, (2) offer stress-reducing nature to improve *mental health*, and (3) encourage social interactions and thereby increase *social health*. However, it is still unclear how physical features of urban green space influence urban residents' use of and benefit from such space. This exploratory study addresses this gap of knowledge through two phases.

The first phase is a comparative case study of urban green space in Sydney, Australia and Shanghai, China, using behavioral observations and survey. Three major types of green space were studied in both cities (Table 1). Results showed that each type has its unique values and a well-balanced and diverse system of green space may help maximize the health benefit.

**Table 1 Information about the case study**

| Types of urban green space                    | Sydney, Australia<br>(1,430 square miles; 4 million population) | Shanghai, China<br>(2,448 square miles; 13 million population) | Characteristics of usage  |
|---|---|--|---|
| Large-size urban park on the edge of the city | Royal Botanic Garden and Domain                                 | Century Park   | Largest amount yet lowest density of users; most types of activities; least accessible; least frequent use  |
| Medium-size central city park                 | Hyde Park   | Yanzhong Green Field   | Medium level of all characteristics   |
| Small-size pocket/street-corner park          | Macquire Place<br>Richard Johnson Square                        | Xujiahui Park<br>Taipingqian Park                              | Smallest amount yet highest density of users; least types of activities; most accessible; most frequent use |

The second phase is an exploratory discussion of key elements of urban green space that promote frequent use and optimize health benefits for urban residents. Concepts from *Active Living Research* (2011) and *landscape spatial pattern studies* (Gustafson, 1997) were examined for their relevance on this topic. *Connectivity* is an important principle that can benefit both environmental and human health—by providing uninterrupted habitat for wildlife and by providing continuous and protected infrastructure for utilitarian walking and biking on daily basis (e.g., to work or school) and reducing automobile dependence. *Diversity*, when used appropriately, may also serve both environmental and human health. *Accessibility* is an important factor in boosting the benefit on human health, yet needs to be carefully balanced with ecological protection (environmental health). *A well-connected system of diverse green space, including continuous greenways that are compatible with the original landscape,* will help optimize the public health benefit of urban green space.

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## **Trends of Wildfires in the United States in Relation to Fuel Distributions**

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Wildfire occurs frequently in many forest, shrub, and grassland ecosystems of the United States. Recent statistics show an annual average of 80,000 wildfires accounting for 3.5 million ha burned and 180 Tg CO<sub>2</sub>-eq emissions. Fire mapping provides critical information to land management, fire research and other science and policy needs. Landsat imagery at 30-meter spatial resolution represents an ideal landscape tool for mapping key parameters such as fire size, severity and frequency. In the United States, these fire parameters were mapped on an ongoing basis by an interagency monitoring program (Monitoring Trends in Burn Severity) using Landsat spectral bands. Burn severity is characterized using two indexes: differenced normalized burn ratio (DNBR) and relative differenced normalized burn ratio (RDNBR). Both of the indexes are derived based on Landsat spectral bands near infrared and shortwave infrared. Recent analysis showed that the two indexes performed similarly for different vegetation types, fire types, and time since fire. Results of the fire mapping effort made it possible to analyze recent fire distributions over space and time. For a five-year period between 2004 and 2008, 628 fires or 3.1 million ha fire areas were mapped using DNBR and RDNBR. The number of fires and fire areas represented less than 1% of total reported fire events during the five-year period, but 88% of the total areas burned, respectively. Majority (86%) of the mapped fire areas may be characterized as low to moderate severity, only 13% of the fires on average were severe or stand-replacement fires. Fire behaviors exhibit a strong relationship with key fuel parameters. For the United States as a whole, the fire regime may be characterized as small fires with low to moderate severity (surface rather than canopy); fires burning large areas and producing severe effects remained rather rare. However, regionally there remain significantly variations for different ecosystems and fuel types.

## **Urban Green Space Pattern Affecting the Diversity and Abundance of Avian Community in mid-to late Breeding Season in Jinan city, China**

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The importance of biodiversity in urban green spaces has been increasingly emphasized. In this study, we focused on the avian community in different patterns of urban green spaces and aimed to elucidate its characteristics and affecting factors. Here, we study urban green space properties affecting the diversity and abundance of avian community in Jinan city, China. Our study examined avian communities in five patterns of urban green space (public park, plaza-green space, nursery, attached green space, and campus green space) in the mid-to late



breeding season, 2009. Diversity, abundance and evenness of birds recorded at the plots which were randomly selected in the green space. Urban green spaces was mapped using field observation and ALOS images (2009) in a Geographic Information Systems (GIS). The pattern of urban green space analysis was made using GIS and Fragstates software. We used field data and multivariate statistical techniques to examine the effects of urban green space pattern, here we measured factors in three aspects: non-biological (slope and elevation), biological (area of urban green space, vegetation structure, connectivity et al) and human attributes (human disturbance), on bird community diversity and abundance. Slope orientation and elevation appears to have a negligible effect on bird assemblages. Urban green space patterns, particularly those related to vegetation, were most important in structuring urban bird communities. Urban green spaces can harbor a high species richness, especially if they consist of different more or less semi-natural habitats. The finding supports the importance of urban green space with natural structures to maintain high ecological diversity. As increasing the size of parks is difficult in cities, enhancement of habitat diversity and resource availability for birds within parks appears to be a straightforward way of increasing urban bird diversity.

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## **Increase Protected Landscape's Connectivity with Other Protected Areas in Regional Urbanization Background: Case Study on Huangshan National Park of China**

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Protected areas should not be protected as an isolated island. It should be regarded as one part of the regional protected area network. This kind of thinking has been accepted widely. Island biogeography theory, meta-population theory and the corridor and network-related theory of landscape ecology are the theoretical basis of this understanding. However, in practice, especially when facing with the ever-accelerating process of urbanization, how to

establish corridors and networks is a big Challenge. This paper takes Huangshan National Park of China (also the world mixed heritage) as a case, in the context of urbanization, to research on the process and methods to establish the corridors and networks between Huangshan and the surrounding protected areas.

The paper first introduces protection and management situation of Huangshan National Park, including animal and plant resources, boundaries of national park and buffer zones, development of tourism, as well as community land use.

Secondly, analyzes the protected areas system around Huangshan, in multi-scales (including Huangshan District, Huangshan City, and southern Anhui Province), and according to the relevant species composition, habitat requirements, home range, diffusion and migration scope, the potential linkages between Huangshan and region area have been discussed.

Thirdly, makes clear about the regional urbanization situations and landscape changing trends around Huangshan, by analyzing and comparing two satellite images in 1990's and 2000's, together with the regional urban development planning.

Fourth, overlays the potential linkages with the regional landscape and urban development planning, and then determine the distribution and form of the corridors and networks to connect Huangshan and surrounding protected areas. The corridors can be divided into 3 types according to the landscape character of its location: natural areas type, agricultural area type, and city or town built-up areas type. Each has its own structure.

Fifth, chooses a typical corridor from each corridor types, to research on the design methods and possible forms. So it can be better understood by local managers and communities.

Finally, the paper proposes the implementation of corridor should be regularly monitored, the purpose for it, on one hand, the accumulation of data for scientific research, on the other hand, the correction of corridor planning and design.

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## **Spatio-temporal Dynamics of Landscape Pattern in Urban Agglomeration – A Case Study of Su-Xi-Chang Region**

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Formation of urban agglomeration is a significant result of urbanization and accompanied with enormous land use and land cover change. The Yangtze River Delta became one of the largest urban agglomerations in the world during the past 30 years. Su-Xi-Chang region is a sub-agglomeration in Yangtze River Delta, which located between Shanghai and Nanjing. Quantification of land use pattern and its change helped to discover the effects of urbanization

on land use as well as the formation mechanism of urban agglomeration. Landscape metrics were computed along a 126\*18 km<sup>2</sup> land use transect cutting across Su-Xi-Chang derived from TM images in 1985, 1995 and 2005 with a moving window.

The results showed that urban land use increased in all the three cities, but most rapidly in Suzhou. Suzhou, became the new center of the agglomeration in 2005 instead of Wuxi, highlighting the effects of Shanghai on the urbanization procession of Su-Xi-Chang. Meanwhile, landscape indices behaved irregularly along the transects from 1985 to 2005, landscape pattern of the study area became more fragmented in the past 20 years. The indices changed most significantly in urban fringe, where land use also changed most rapidly. The results indicated that land use change of a single city was strongly affected by the urban agglomeration, especially the central city. And the urban fringe was the key area of land use change in the process of urbanization.

## **Vertical Pattern and Impacting Factors of Village Landscapes in Yuanyang County**

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The Yuanyang terraces, famous with its large area, wide distribution, astonishing construction and infrequency in world, was appointed as the core area of the cultural landscape of Hani terraces by the government of Honghe district, Yunan province, China. The terraces were the physical basis of Hani peoples' life and the symbolization of Hani peoples' spirit. And the cultural landscape of Hani terraces was the model of sustainable land-use and harmonious human ecosystem between culture and nature. In this paper, the Hani's village in the landscape of Yuanyang Terraced Fields of Ailao Mountain was taken as the object. The distribution pattern and its impacting factors of village landscape were analyzed using ArcGIS via DEM and social statistics. The main contents are: 1) the vertical distribution of villages in different elevation zones. 2) The spatial pattern of villages with different ethnic groups, such as Hani, Dai and Yi groups. 3) Impacts of farmland pattern on villages patterns. 4) Impacts of road density on village patterns.

**Keywords:** Village landscape, Vertical pattern, Farming radius, GIS, Ailao mountain

## **Study of Ecological Instream Flow in Heihe River Based on the Hydrological Change**

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Climate changes and human activities can lead to hydrological change. And then the hydrological ecological systems will be destroyed violently. Distributions of the samples before and after hydrological change are significantly different. It means the local hydrological condition has changed, which breaks the ecological balance. The hydrology is closely related to ecology. This study uses the difference plot curve-combined method of rank test to analyze hydrological changes and their causes. Then, L-moment is used to evaluate the parameters of generalized extreme value (GEV) distribution of the monthly flow series before hydrological change, and to calculate the maximum probability density flow, as the ecological instream flow. We use this method to calculate ecological instream flows of Yingluoxia stations in the Heihe River Basin. The result shows that ecological calculating method which considers the hydrological change is practicable. After the hydrological change, there is a decreasing in the frequency of water demand for natural service in hydrological station of the main flow in the Heihe River. What is more, the extent of flood season is bigger than non-flood season. The main cause of the hydrological ecological systems in Heihe River Basin is climate changes, which is mostly influenced by precipitation. Human activities have less effects on the hydrological change and hydrological ecological systems.

## **Revealing Order and Disorder in Social-ecological Landscapes for Sustainable Natural Capital Flow**

Giovanni ZURLINI<sup>1</sup>, Nicola ZACCARELLI<sup>1</sup>, Bruce K. JONES<sup>2</sup>, BaiLian LI<sup>3</sup>, Irene PETROSILLO<sup>1</sup>

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Predictions of climate change suggest major changes in temperature, rainfall, and in frequency and timing of weather extremes. The impact of climate change will affect human decisions and behavior, as well as all types of land use, and species ranges, reducing the capability of ecosystem service providers to provide natural capital flow. Such disturbances are going to overlap and interact in varying degrees and patterns in social-ecological landscapes (SELs) around the world with those from local-scale disturbances. SELs are complex, dynamic and adaptive social-ecological systems in the real geographical world, characterized by historical dependency, nonlinear dynamics, threshold effects, multiple basins of attraction, and limited predictability. Climate change is going to add complexity making harder and harder to predict how SELs might evolve/react to additional land-use and climate alterations. This would be critical to any action to changing landscapes to accommodate for climate change impacts. In this paper we further develop a cross-scale framework for the analysis of disturbance patterns in SELs, by adding a time dimension and integrating tools derived by information theory and entropy measures. We introduce the normalized spectral entropy ( $H_n$ ) as a valuable index to describe the degree of order (or predictability) within an ecological time-series of observations. To describe the time trajectory of landscape dynamics for the SELs of the Apulia Region (South Italy) we compiled and analyzed a time-series of 16-days maximum value Normalized Difference Vegetation Index (NDVI) images from the

TERRA and AQUA MODIS platform from 2000 to 2010 at a spatial resolution of 250 m. An  $H_n$  map shows spatially the predictability of patterns for each pixel trajectory. Human-managed areas like olive groves and arable lands, and natural areas like forests result in general more predictable than natural semi-arid grasslands and urbanized areas. When the  $H_n$  is related to a cross-scale disturbance map of the study area, we can point to regions with different combinations and degrees of disturbance and predictability. Such integration can shed light on spatial-temporal configurations of landscape land-uses and habitats to support any planning and management strategy in SELs. To ensure the sustainable maintenance of natural capital flow we can point to areas where it is predictable, because of both human and natural mechanisms at work, and areas where to consent contagious disturbances (i.e., which disturbance and where to disturb) with no significant effect on it. Such insights are essential to provide a more ecologically effective information to planners and decision makers, as well as a more effective additional value and stability to ecosystem service providers and resulting natural capital flow in light of rising human disturbances and climate change impacts.

## Application of Landscape Ecology in the Science-Practice Interface

**Principal organizers:** Zhifang WANG<sup>1</sup>, Joan Iverson NASSAUER<sup>2</sup>, Paul OPDAM<sup>3</sup>

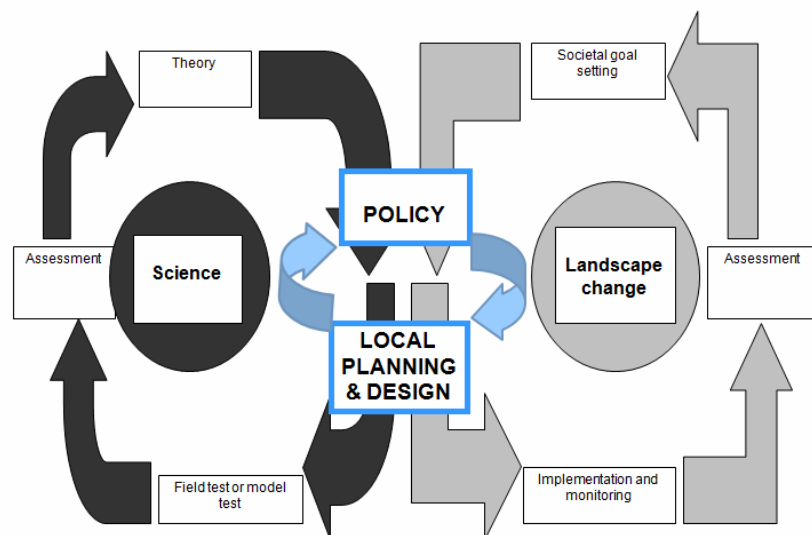
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This symposium focuses on the potential for landscape ecology to further strengthen the exchange between science and practice. Scientific knowledge has yet to be effectively employed in landscape planning and management, and landscape ecology has the potential to dramatically increase the influence of environmental science on societal awareness and decision making. There is a growing understanding that innovation and application should be part of the scientific domain because scientific knowledge can have a much greater impact if scientists not only calibrate their tools on scientific evidence but also tune their research questions and methods to problem solving in practical cases. This symposium examines the science-practice interface at two levels: policy or local planning & design (fig. 1). Contributors will address: 1) Is the role of science different in the policy or local planning & design parts of this model? 2) Is integration of knowledge on landscape functions different for the two levels of science-practice interactions, and what does this imply for the transfer of knowledge to affect landscape change? We will critically review what can be learned from projects that have intentionally bridged research with practice in landscape planning, design, management and conservation.



**Figure 1: Our Model of Science-Practice Interface: Policy or Local Planning & Design (adapted from (Nassauer and Opdam 2008)).**

This symposium will have two 2-hour sessions with complementary themes. The first session will have 6 presentations including an introductory discussion of the science-practice interface. The second session will have 3 presentations followed by a one-hour discussion of what we can learn from this symposium and what we should do to reinforce science-practice interactions in the future. Each participant will be expected to attend both sessions to ensure we can have

effective discussions by the end. Presentations will focus on subjects ranging from broadly applicable landscape ecological principles that aim to inform practice, to gaps in the science-practice interface, to case studies and comparisons of applications or opportunities for application. We expect to gain insight on how to tune scientific information and tools to essential differences in the use of science in different decision making processes. As a whole, this symposium will contribute to developing landscape ecology into a more effective science

## **Benchmarking Biodiversity towards a Sustainable City**

**Principal Organizer:** Yukihiro MORIMOTO

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**CO-organizers:** Masashi KATO, Norbert MÜLLER

Benchmarking biodiversity and natural resources has a long tradition in nature conservation and is an important tool for political decision making. With the worldwide growth of urban areas, there is an increasing concern for biodiversity in cities. Urban biodiversity is providing numerous ecosystem services for urban dwellers and might play an important role in holding the global loss of biodiversity. This was taken into account recently by the United Nations Convention on Biological Diversity with the decision of the “Plan of Action on Cities for Biodiversity”.

This session is based upon the recent implementation in the program of Convention on Biological Diversity and related activities including the URBIO (Urban Biodiversity and Design) conference 2010, as well as the City Biodiversity Summit 2010, held in Nagoya, Japan, from 24 to 26 October 2010. In this session, points include the original natural profile of the city, the scale and mosaic patterns for evaluation, the effective index to encourage good practices will be discussed. The session will address current CBI, but it will further explore implications from theories of landscape ecology useful for the elaboration and case studies in some urban settings.

## **Beyond REDD+ : a Landscape Approach for Setting up Climate Change Mitigation and Adaptation Strategies at the Tropical Forest Margin.**

**Principal Organizer:** Valentina ROBIGLIO

*International Institute for Tropical Agriculture, ASB- Partnership for the Tropical Forest Margin, Yaoundé, Cameroon*

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**Co-organizer:** Peter MINANG

Human destruction of tropical forests is estimated to contribute up to 17% of global carbon dioxide emissions, resulting in accelerated global warming. As part of an international move to include emissions from habitat change in a more comprehensive agreement under the UN Framework Convention on Climate Change (UNFCCC), Reducing Emissions from Deforestation and Forest Degradation (REDD+) could become operational in 2012. At the present the proposed mechanism is designed to reward forest based emission reduction derived from deforestation and degradation, the conservation and enhancement of carbon stocks and the sustainable management of forest.

The objective of the symposium is to assess the potential of REDD+ to promote landscape design and restoration. Emphasis will be given to a landscape approach that maximizes the synergies between carbon sequestration function and other ecosystem functions in fragmented forest and agricultural landscapes with degraded forest remnants and agro-forests. To do that, we will discuss the conventional assumption of a positive relation between carbon sequestration and other ecosystem services, in particular biodiversity, and identify in which landscapes and at which spatial/ temporal scales this does apply (or not).

The symposium will consist of 4 presentations preceded by a general introduction to the REDD+ mechanism/conceptual framework with a particular focus on the opportunities to establish better landscape management practices in forest-rich countries (possibly with references to the poster session). Invited speakers will present the analysis of synergies/tradeoffs between carbon sequestration and biodiversity conservation functions analyzed at different scales and for different types of deforestation frontier (or forest/non forest interfaces/typologies), in a mix of scientific-based and applied approaches from different tropical regions. Peter Minang, Coordinator of the ASB Partnership, will moderate the final discussion and draw the conclusions integrating issues raised during the poster and symposium sessions.

## **Biodiversity as an Indicator of Sustainability in Cultural Landscapes**

**Principal Organizers:** Sun-Kee HONG<sup>1</sup>; Qingwen MIN<sup>2</sup>, Jan BOGAERT<sup>3</sup>

<sup>1</sup>*Institution for Marine and Island Cultures, Mokpo National University;* <sup>2</sup>*Institute of Geographic Sciences and Natural Resources Research, CAS, China;* <sup>3</sup>*Université de Liège, Gembloux Agro-Bio tech*

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Landscape history is directly related to the long-term dynamics of the natural environment and to the sustainable use of landscape biodiversity. People have created new landscapes by changing land use policies and through a wise use of biodiversity based on ecological knowledge. In this symposium, we will discuss the role of biodiversity as an indicator of sustainable landscape use and to deepen our ecological knowledge on sustainable landscape management.



## Biogeochemical Fluxes in Landscapes

**Principal Organizers:** Ülo MANDER<sup>1</sup>, Martin WASSEN<sup>2</sup>, Xiuzhen LI<sup>3</sup>

<sup>1</sup>*University of Tartu, Estonia;* <sup>2</sup>*Utrecht University, The Netherlands;* <sup>3</sup>*East China Normal University, Shanghai, China*  
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Ecosystems world-wide are exposed to global change caused by humans such as climatic change, nutrient loading and water distribution disruptions. Landscape ecology studies patterns and processes across scales ranging from local to global. A prominent landscape ecological process connecting systems on various scales is the flux of matter, energy, organisms and information. Disturbances of these fluxes can originate from changes in the use of land and water and climate change and can in turn feed back to the rate and direction of biogeochemical cycles and changes in the global system. Thus better understanding of the relations between patterns and fluxes at landscape level would help elaborate strategies for adaptation to global change and mitigate actual and potential consequences of overexploitation of land and water and global climate change. This symposium concentrates on research into fluxes of water, nutrients, carbon, and hazardous materials within landscapes, but case studies on energy and organism fluxes are also welcome.

The main goal of the symposium is to bring together researchers, specialists, planners and decision makers representing various fields of both the natural and social sciences to highlight the main principles and modelling approaches in studies on biogeochemical fluxes in landscapes. Exploration of innovative approaches and methods for the analysis and prediction of the spatial and temporal dynamics of biogeochemical fluxes at landscape level and feedbacks across scales is also planned. There will be a special focus on global change and its consequences.

The symposium deals with research into the relations between landscape patterns and biogeochemical fluxes, with a focus on the actual and potential impact on various landscape processes that are related to global change topics. Both the natural and anthropogenic factors of these relations will be considered.

In particular, the following aspects will be highlighted:

- the relation between landscape pattern and material/energy fluxes;
- the role of territorial ecological networks (natural and semi-natural ecosystem patches within a matrix of agricultural landscapes) in the regulation of biogeochemical fluxes;
- molecular and microbiological advances in biogeochemical studies at landscape level; feedbacks between different cycles across scales;
- landscape genetics and material fluxes in landscapes;
- landscape-level experiments and models of biogeochemical fluxes in landscapes;
- consequences of regional, continental and global disruptions of fluxes of water and matter.

## **Bridging Science and Action in Landscape Ecology: the European Approach**

**Principal Organizers:** Veerle Van EETVELDE, Emilio PADOA-SCHIOPPA, Isabel L. RAMOS

*Geography Department, Ghent University, Krijgslaan 281 - S8, B-9000 Ghent, Belgium*  
E-mail: veerle.vaneetvelde@UGent.be

**Co-organizers:** Carlo MAGNANI, Matelda REHO, Elena GISSI  
*IUAV University of Venice*

This symposium will be organised by IALE - Europe, the European chapter of the IALE, and aims a variety of fields of landscape ecological theory, methods, practice and education at a European level. The specificity of European landscapes, their history, use, conservation and constant change needs a more inter- and transdisciplinary approach, dealing the multiple interactions and interpretations of landscapes and within the framework of overarching European conventions and directives like the European Landscape Convention, Water Framework Directive, Common Agricultural Policy and Natura2000.

The goal of the symposium is to provide a platform for a European approach to landscape ecology with the specific issues, challenges and policy oriented goals. All kind of landscape types, methods and approaches, fitting into a European context are welcome in the symposium.

The following relevant science questions will be addressed :

- What are the main challenges for landscape ecology in the Europe of the 21st century?
- How to address the integration of the multiple dimensions of landscape, like the interaction between people and nature?
- What approaches are at hand to assess landscape values in an operational way?
- How to fill the gap between landscape ecological knowledge and policy making?

How geo - information technology can respond to specific landscape ecological questions in Europe?

## **Climate Change Adaptation – New Perspectives in Managing Change in Landscape Ecology**

**Principal Organizers:** Burghard Meyer<sup>1</sup>, Sven Rannow<sup>2</sup>, Jiebin ZHANG<sup>3</sup>

<sup>1</sup>*Technische Universität Dortmund, Fakultät Raumplanung, Lehrstuhl Landschaftsökologie und Landschaftsplanung, August-Schmidt-Straße 10; 44227 Dortmund, Germany;* <sup>2</sup>*IOER Dresden;* <sup>3</sup>*Xinjiang Institute of Ecology and Geography*  
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Landscapes are generally managed with an implicit assumption of stable conditions. However, gradual and abrupt change, including climate change and changes in land management, can have profound impacts on the landscape, and in the services it provides to society. Successful landscape management will therefore require ways to adapt to future change, to moderate harm or exploit beneficial opportunities in response to actual or expected change. In landscape ecology, adaptation processes as reaction to climate change should be linked to the known processes of landscape change and urban change. Planned adaptation and management of the change are geared towards the maintenance of environmental integrity as well as the protection against unwanted or even hazardous processes.

Knowledge from landscape ecology will help not only to guide the process of management from a static equilibrium view to a more adaptive, actors and participation oriented approach. The analysis of pattern and processes should be combined with the modelling of complex measures in environmental, economic and social systems on landscape and regional scale level. It will be an essential progress to understand the dynamic interlinkages between nature and society and to derive the scientific and applied input for the adaptation on climate change.

Goal of the symposium is to explore approaches and methods for studying the change in landscapes. The symposium will derive common rules and principles for the analysis, modelling and measures to prevent unwanted processes of change and to assist the adaptation processes in a transdisciplinary context.

The symposium deals with research about changes with the objective of the extraction of guidelines for adaptation processes. The examples can be derived from any process relevant for landscape ecology, such as climate change, landscape change or urban change. Common principles for the development of guidelines for adaptation and managing of change shall be discussed.

This includes studies and presentations in the workshops context about

- the state of the art by examples of adaptation planning in landscape ecology,
- the adaptation to change with special focus to fast developing and urbanised regions,
- the landscape and regional scale level with special emphasis on natural hazards in different time horizons,
- the dynamic interlinkages between nature and society in the context of adaptation and the inclusion of the multifunctionality of landscapes,
  - the exploration of the behaviour of landscape systems under change,
- the application and problems of modelling approaches to project changes,
- the uncertainty of future impacts and how to manage uncertainty,
- the prioritisation of contradicting goals and measures for adaptation,
- the decision support for adaptation management and planning by including actors perception,
- the formulation of general landscape adaptation principles.

# Climate Change, Landscape Ecological Infrastructure and Urbanism

**Principal Organizers:** Kongjian YU<sup>1</sup>, Kelly SHANNON<sup>2</sup>

<sup>1</sup>*Architecture and Landscape Architecture College, Peking University, China;* <sup>2</sup>*Department of Architecture, Urbanism and Planning, University of Leuven, Belgium*

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In 2010, 3.5 billion people were living in urban areas. By 2030, this is expected to swell to almost 5 billion. The overwhelming urbanization and uncontrollable urban sprawl of the past half century are the primary forces of landscape change and fragmentation. Urbanization has also brought great challenges to the health of regional ecological systems, the protection of cultural heritage, as well as sustainable urban development. Those problems will severely worsen due to global climate change. Thus, there is an urgent need for a new paradigm of urbanism and landscape planning and management.

Landscape ecology is one of the most important disciplines that provides a sound scientific base for the planning and design of territories. And landscape architecture makes concrete and tangible the discipline of urbanism (the science of the city and the act of intervening in the city) since it is the profession that most consciously deals with nature; it has the capacity to organize the constructive interplay between city and nature, or for that matter, between culture and nature. Hence, landscape architecture appears to be at the heart of sustainability. In the last decades of 20th century, the principles and methods of landscape ecology have been extensively integrated into nature conservation and landscape planning. Concepts such as ecological networks, greenways, green infrastructure, ecological infrastructure, habitat networks and wildlife corridors, have been employed in different places with different emphasis in the context of a stressed landscape.

Among the emerging concepts of today, “landscape ecological infrastructure” (as well as “green infrastructure”) embodies the most comprehensive meaning and *agency*. “Landscape ecological infrastructure” may be defined as a structural landscape network which secures the integrity and identity of natural and cultural landscapes by building upon both the existing and potential natural, biological and cultural processes, as well as securing natural capital that supports sustainable ecosystem services and urbanization.

## Goals

- To promote international communication and understanding of landscape ecological infrastructure and related topics
- To promote application of landscape ecology in landscape architecture, urban planning and land use planning

## Featuring

- Presentations by global top experts on the future of ecological infrastructure, urbanism and related themes
- Panel discussions on strategically advancing ecological infrastructure, landscape urbanism, and their current barriers and opportunities
- Gathering of leaders and professionals interested in ecological infrastructure theory, applications and tools.

## **Climate Optimized Land Use – a Sustainability Strategy between Adaption to and Mitigation of Climate Change**

**Principal Organizers:** Thomas HAUF<sup>1</sup>, Tianxiang YUE<sup>2</sup>

<sup>1</sup>*Institute of Meteorology and Climatology, Leibniz University Hannover, Herrenhaeuserstraße 2 , D-30419 Hannover, Germany;* <sup>2</sup>*Institute of Geographical Sciences and Natural Resources Research, Chinese Academy of Sciences, 11A, Datun Road, Anwai, 100101 Beijing, China*  
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The symposium focuses on the problem of sustainable land-use management under the conditions of climate change and will discuss the idea of sustainable and *climate optimized* land-use. There is a broad consensus that man have altered climate already in the last 150 years and will continue to do so in the next future. Local and regional climate conditions will change significantly and will impact agriculture. Water availability, crop related temperature thresholds, enhanced risk of erosion, prolonged growing periods for certain crops, to mention but a few, will additionally govern future land-use. Any sustainable agricultural planning, therefore, has to take climate change and its impact into account and has to develop adaption measures. Key questions are (1) What is the expected climate change for a given region and what are the impacts on the local scale for agriculture? And even more essential: (2) Who will provide the needed information about climate, impacts and required adaption strategies to local farmers and policy makers? With any of such adaption strategies there is, however, a competing objective on the larger and national scale: How will large-scale land-use changes affect in principle global climate (3) and how will land-use contribute to the greenhouse gas budgets (4)? To answer that question quantitatively for a given country, (5) detailed studies for perspective land-use changes have to be done and (6) the related contributions to the national greenhouse gas budgets and climate change contributions have to be calculated. Typically such studies need to be done on a small scale and then up-scaled to the national scale. In order to contribute to mitigation of climate change on the global scale, policy makers need that type of information to develop suitable and efficient mitigation measures. How can the required planning technology and tools be provided (7)? Conventional land-use planning tools, obviously, have to be extended to account for the related accompanying effects of anthropogenic climate impacts (8). Sustainable land use planning, therefore, will have to find a way between the adaption to climate change on the local scale and mitigation of the latter on the national scale, a path which is referred to as climate optimized. The concept of climate optimized land use is applied to test regions within China. The symposium will discuss these issues (9).

## **Controls and Effects of Ecosystem Disturbances at Landscape Scale**

(Sym. 35 - Zhiliang Zhu)

**Principal organizers:** Zhiliang ZHU<sup>1</sup>, Matt ROLLINS<sup>2</sup>

<sup>1</sup>*USGS, Reston, VA;* <sup>2</sup>*USGS, Sioux Falls, SD.*

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A symposium of presentations and discussion is proposed to focus on the most current research activities studying behaviors and effects of wildland fires and their relation with critical driving forces such as climate change, fire management, and fuel conditions along both spatial and temporal dimensions.

Wildland fires are a natural process in many ecosystems of the world. Human actions coupled with changing temperature and precipitation regimes have significantly increased fire frequency, intensity, severity, and areal extent of wildland fires in many fire-dependent ecosystems, thus increasing risks to natural resources and human developments. Wildland fires are highly related to properties of topography, vegetation and fuels, and climate/weather systems. As the result, wildland fires tend to possess distinctive temporal and spatial patterns and characteristics at the landscape scale, making it an ideal study to apply landscape ecology research methods and tools. Research in landscape ecology helps improve the biological, physical, social, and ecological underpinnings of fire science and improve understanding of the ecological role of fire in concert with other natural and anthropogenic disturbance regimes at varying spatial and temporal scales. Under this context, speakers of this symposium will discuss their latest research results on a range of topics including:

- Fundamental information about fire behavior by different ecosystems, fire regimes, fuel conditions, and driving forces (e.g. climate change, fuel management). Designed experiments using fire behavior models focusing on landscape interactions will yield insights into complexities of relationships of fire behaviors over space and time.
- Short- and long-term effects of fire to properties of soil, vegetation, wildlife, and carbon dynamics. There is a lack of science synthesis concerning how specific fire characteristics distributed across landscape affect sustainability of ecosystem goods and services. Specific characteristics include fire size, flame heights, depth of burn, and return intervals. Synthesis is also needed to summarize lessons learned in characterizing these fire attributes using remote sensing and other landscape ecology tools.
- Landscape modeling and prediction capabilities that inform managers about how fire regimes will change in response to human land use, increased wildland-urban interface, increased fire management, and climate change through space and time. For example, managers need to be able to predict when, where, and how to treat fuels to achieve the maximum effectiveness and to protect other resources. To do this, they will need to understand potential fire distributions as a function of future climate change scenarios.

## **Design for Biodiversity in Cities – a Global Overview**

(Sym. 20 - Norbert Müller)

**Principal Organizers:** Norbert MÜLLER<sup>1</sup>, Maria IGNATIEVA<sup>2</sup>, Zhenghong KONG<sup>3</sup>

<sup>1</sup>URBIO, Department of Landscape Management & Restoration Ecology, University of Applied Sciences Erfurt, GERMANY; <sup>2</sup>The Unit of Landscape Architecture, Department of Urban and Rural Development, Swedish University of Agricultural Sciences; <sup>3</sup>URBIO, Department of Landscape Management & Restoration Ecology, University of Applied Sciences Erfurt, GERMANY; After 1. July 2011 Quan Feng Investment CO. LTD., Shanghai, China

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The main challenges of this century such as loss of biodiversity, climate change, and the growth of urban world population - - are all strongly connected. The 10<sup>th</sup> Conference of the Parties of the Convention on Biological Diversity in Nagoya (Japan) in October 2010 acknowledged the fact that cities can be an important contributors to global efforts to protect and enhance biodiversity by the adoption of the “Plan of Action on Cities and Biodiversity 2011-2020”,. This significant political milestone was prepared through activities in Japan during 2010 including the City Biodiversity Summit and the second Conference of the URBIO network (Urban Biodiversity and Design).

In principle, there are two complementary ways for cities to play their part in meeting the target of stopping biodiversity loss, namely the sustainable use of ecosystem services and biodiversity and the design of all urban areas to maximize their ability to support biodiversity and mitigate climate change.

This symposium will explore existing theories and approaches (case studies) of sustainable urban design for improving biodiversity. This will be done by researchers from different countries around the globe and at different scales. This symposium is related to the symposium "Benchmarking biodiversity towards a sustainable city" - both organized by URBIO.

## **Designing Multi-functionality in Local Landscapes**

**Principle Organizer:** Gary BENTRUP

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**Co-Organizers:** Mike DOSSKEY<sup>1</sup>, Yong WANG<sup>2</sup>

*<sup>1</sup>USDA National Agroforestry Center; <sup>2</sup>Alabama A&M University*

The concept of multifunctionality is gaining attention within landscape ecology and is often viewed as a prerequisite for sustainable land use. There are three general types of multifunctionality which can be applied at different scales: 1) spatial combination of separate land units with different functions, 2) different functions dedicated to the same land unit but separated in time, and 3) the integration of different functions on the same land unit at the same time (Brandt and Vejre 2004). While the first type has received the most attention by ecologists in recent years, increasing demand for multiple ecosystem services is necessitating a stronger look at the second and third types, that is, the need to design each land unit to simultaneously enhance functions that provide the desired services.

In this symposium geared for scientists and land managers, we will explore the science and strategies for accomplishing the third type of multifunctionality. Designing for several functions on the same land unit requires multi-criteria decision aids (MCDA) for comparing function compatibility, weighing tradeoffs, and developing a final plan. This is particularly challenging when considering functions ranging from economic production, water quality, biodiversity, recreation and aesthetics. We will provide a brief overview and typology of

MCDA that may be suitable for this task. With this foundation, presenters will address specific challenges, approaches, and tools for designing multifunctionality in local landscapes. We expect to gain insight on how design can play a critical role in creating multifunctional solutions.

This symposium will have one 2-hour session of organized presentations. A second session can be added by the conference organizers if there are contributed papers to this symposium. Our hope is that second session could be added with a diverse selection of international presentations on this topic.

## **Ecohydrology: Theories and Applications Underpinning Climate Mitigation and Adaptation**

**Principal Organizers:** Ge SUN<sup>1</sup>, Liding CHEN<sup>2</sup>, Shirong LIU<sup>3</sup>

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Global climate change is gradually recognized around the world as the largest environmental challenge in the 21<sup>st</sup> century. The impacts of climate change on ecosystems and society are local, but largely uncertain, and current scientific knowledge cannot answer all emerging questions. However, we know climate change will directly alter the water balance: a key control of ecosystem structure and functions. Understanding how climate change, and other natural and anthropogenic stressors, affect ecohydrologic processes is the basis to develop novel mitigation and adaptation strategies and design sound landscapes reflecting future conditions. Ecohydrological science has advanced rapidly in the past few decades in response to many of the immediate needs of solving modern environmental and resource issues, especially water shortages due to population rise. This symposium provides an opportunity for international experts in ecohydrology and global change hydrology to share recent advances in understanding the interactions between climate, water, carbon sequestration, biogeochemistry, and land management practices such as reforestation, ecological restoration, and bioenergy development. This symposium is most interested in discussing following topics:

1. Case studies of dynamic interactions among climate, hydrology, vegetation, and soil, at watershed to regional scales.
2. How can ecohydrologic processes be quantified and dynamically up-scaled from plant, community, watershed, to regional scale?
3. What are the advances in new technology applications in ecohydrologic research such as integrated simulations models, remote sensing, GIS, isotopes, eddy flux towers?
4. How can ecohydrologic principles and theories be applied to simulate future impacts of climate change and other stressors (climate variability, reforestation, land use change, population growth, air pollution etc) on water quantity and quality at a regional scale?



5. What are the tradeoffs among water resources and other ecosystem services of existing climate mitigation and adaptation strategies?

## **Forest Ecosystems, Air Pollution and Climate Change**

**Principal Organizer:** Yusuf SERENGIL

*Istanbul University and IUFRO 7.01.08 Hydroecology coordinator*

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**Co-organizer:** Andrzej BYTNEROWICZ

*USDA Forest Service, USA*

Forest ecosystems are affected by many anthropogenic stressors around the world, and among them air pollution and climate change are two major ones. Adaptation of forests to changing climate and air pollution is a key scientific and management issue that should be discussed from a perspective of potential future landscape changes. The Research Group 7.01 "Impacts of Air Pollution and Climate Change on Forest Ecosystems" of the International Union of Forest Research Organizations (IUFRO) deals with such issues. As the coordinators of this group we would like to have the opportunity to bring the issue of the climate change and air pollution on World forests to the attention of participants of the IALE conference. The suggested symposium will potentially include papers on various aspects of the subject including social, economic, and legal issues as well as considerations for forest water resources, atmospheric deposition and nutrient cycling, forest health monitoring, forest genetics and other issues. Emphasis will be given to the management and sustainability of forest ecosystems and ecosystem services.

## **Global Biodiversity and Ecosystem Services Monitoring as an IPBES challenge**

**Principal Organizer:** Rob H.G. JONGMAN

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**Co-organizer:** Dr Xuehua Liu

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The International Panel on Biodiversity and ecosystem Services (IPBES) has been agreed upon in 2010 in Busan, Korea and formalised by the UN in September 2010. Now the scientific community involved in ecology has to show that it is capable to feed it with knowledge, models and data at the level of continents, at the level of oceans and at global level. This is a real challenge as most ecological information is spatially and topically fragmented. IPBES should have formal relations not just with the Convention on Biological Diversity, but also with other biodiversity treaties, agencies of the United Nations,

international environmental NGO's, global scientific organizations and the private sector.

The panel has the backing of the UN Environment Programme, which oversees the IPCC and therefore has great interest in coordinated with biodiversity information. It should also require relations with FAO and especially with the global scientific organisations.

What is now needed is to focus on standards and infrastructure for biodiversity science. This means that international cooperation, capacity building and gap-analysis reports must be developed. There are over 100 governmental and other organizations that already share their data and analyses of biodiversity. But the present group involved in data harmonisation, indicator development is still biased and further enlargement and completion is needed. Landscape Ecology must show that it can contribute to this global initiative and that it has specific knowledge to offer.

The symposium is open for additions both from Asia and the rest of the world, but we would like to keep the content well balanced. We intend to turn the symposium into a special issue of a journal, but then we first have to know if it is accepted.

This symposium will the developments at present especially within and around the Group on Earth Observations Biodiversity Observation Network (GEO BON), WCMC, GBIF and research projects all over the world.

## **Key Concepts and Research Priorities for Landscape Sustainability**

**Principal organizers:** Laura R. MUSACCHIO<sup>1</sup>, Jianguo WU<sup>2</sup>

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One of the grand challenges of operationalizing sustainability is to translate and implement sustainability principles in landscape research and practices. Meeting this challenge requires that we directly address the problem of landscape sustainability through the integration between sustainability science and landscape ecology and design. This symposium will address three key questions about landscape sustainability:

1. What are the key issues, concepts, and priorities most important to landscape sustainability?
2. How is landscape sustainability influenced by spatial heterogeneity and human(culture)-nature interactions across scales?
3. How can natural and design sciences be better integrated to contribute to landscape sustainability?

These key questions are a beginning point for operationalizing additional topics, principles,

concepts, issues, and research questions about landscape sustainability as a bridging concept among sustainability science, landscape ecology, and sustainable design. Each symposium participant will reflect on one or more of these questions and provide their perspective about the state of science and practice of landscape ecology in their part of the world; and how landscape sustainability might improve the relevancy and importance of sustainability science to the theory and application of landscape ecology to major environmental challenges.

Landscape sustainability is becoming an increasingly important topic in landscape ecology; yet it remains not clearly defined in theory, methodology, or application. For example in 2002, the synthesis article by Wu and Hobbs (2002) identified landscape sustainability as one of ten key topics for landscape ecology in the 21st century. Sustainability science emerged at about the same time as this article and seemed to be highly compatible with landscape sustainability, but sustainability science's potential has never been fully realized in landscape ecology because it too remains undefined and abstract.

The special issue *The Ecology and Culture of Landscape Sustainability* (Laura Musacchio, Guest Editor, 2009a) begins the process of conceptually framing the scope and boundaries of key concepts, mental maps, and research priorities for integrating sustainability science into applied landscape problems, situations, and practices. In addition, key papers like Nassauer and Opdam (2008), Wu (2008, 2010), Musacchio (2009b), Termorshuizen and Opdam (2009), and Wiens (2009) all suggest stronger integration of scientific, design, and management approaches is essential for operationalizing the ideals of sustainability science into landscape ecology and into concepts like landscape sustainability.

The major outcome from this symposium will be a special issue of *Landscape Ecology* that will be based on the symposium's presentations.

This symposium will be five hours (not including breaks) with 11 speakers from Europe, Pacific Rim, and North America. The format includes time for a brief introduction to the symposium's purpose and objectives and two round tables with the speakers to allow for 40 minutes of discussion and questions with audience. Each speaker will have 20 minutes to give their presentation. The tentative time schedule for the symposium will have this organization:

## **Landscape Connectivity and Its Implications for Conservation Management and Planning**

**Principal Organizer:** Sandra LUQUE

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**Co-organizer:** Peter VOGT

*Institute for Environment and Sustainability, JRC; Land Management & Natural Hazards  
Unit (LMNH). Institute for Environment & Sustainability. (IES)European Commission - Joint  
Research Centre, ISPRA, Italy*

Landscape connectivity needs to be considered as a dynamic property at the landscape scale and not a simply aggregate property of a set of individual patches. Movement across the landscape is a key process for the survival of plant and animals' species that needs to be further investigated in the context of heterogeneous human dominated landscapes. In particular, we need to learn more about the scale dependency of inferences regarding the strength and nature of processes governing movement and the functioning of habitat networks. Recent advances in graph theory and habitat availability metrics need to be further developed, compared and integrated with other methods, with emphasis on identifying those key habitat areas and linkages that most efficiently uphold landscape connectivity at different scales.

This symposium will center the attention on connectivity as a complex process: By focusing on i) the relationship between potential and functional connectivity in such a way to contribute towards the identification of the most important aspects of habitat network structure. ii) Look at the effect of increasing pressures and barriers on a spatio-temporal framework. iii) Present and discuss operational tools and harmonized methods to integrate landscape-scale-metric-processes to support planning at different scales.

At the end a panel discussion will be organizer to highlight key issues that will help to develop a roadmap for future research in order to provide recommendations for future studies. Proposed symposium' structure: A 3 to 4 hours symposium (depending on final speakers confirmation) with a half hour for panel discussion.

## **Landscape Ecology and Critical Watershed Processes**

(Sym. 32- Xiaohua Wei)

**Principal Organizer:** Xiaohua (Adam) WEI

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**Co-organizers:** Shirong LIU<sup>1</sup>, Jeff CURTIS<sup>2</sup>, Jim TANG<sup>3</sup>

*<sup>1</sup>Chinese Academy of Forestry, Beijing, China; <sup>2</sup>University of British Columbia, Okanagan Campus, Canada; <sup>3</sup>President, SINO-ECO (SINO-Ecologist Association of Overseas), USA*

Our world is composed of watersheds. In watersheds, water flow acts as a unique ecosystem linkage to connect various components (aquatic, terrestrial, wetlands, lakes etc.) and processes / functions (e.g., morphological and aquatic habitat, hydrology, water quality, biology) through stream networks and hierarchical structures. For these reasons, watersheds may arguably be “the best landscapes” to test or study spatial patterns /heterogeneity and processes, importance of scales, interactions between terrestrial and aquatic systems, coupling of ecology and culture, disturbance ecology and climate change. A recent paper on global threats to human water security and river biodiversity by Vorosmarty et al in “Nature” is a good example in this regard.

Very few conferences have addressed such a scientific theme. The purpose of this symposium is to discuss how landscape ecological theory and principles can be applied to some critical ecological processes in watershed ecosystems. We expect the proposed symposium will attract

participants with interests in watershed processes (hydrology, channel morphology, soil erosion, carbon budget, water quality and biodiversity) and their relations to watershed disturbance, spatial patterns and climate change. Researchers who have interest in application of landscape ecology on integrated watershed management will also likely be interested.

In short, we think this symposium will be unique at the Congress, and will likely attract significant participants from China and outside of China.

### **Goals of the Proposed Symposium**

1. To provide an opportunity for communicating the recent research on watershed processes from a landscape perspective
2. To exchange ideas on future research priorities and directions in the proposed research theme
3. To promote watershed-based approaches to study landscape ecosystems
4. To use this symposium to encourage more young scientists and graduate students to study watershed-related environmental issues

## **Landscape Ecological Approaches to Develop the Low Carbon Societies in East and South East Asia**

**Principal organizers:** Nobukazu NAKAGOSHI<sup>1</sup>, Bojie FU<sup>2</sup>, Sun-Kee HONG<sup>3</sup>

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Ongoing rapid economic growth and degradation of ecosystems, such as abandonment of cultural landscapes and rapid urbanization, are creating the loss of carbon sinks within those impacted environments in East and Southeast Asia Region. This decrease is mainly due to strong socio-economic dependency on natural resources, lenient management schemes and poorly designed land use and land management both in urban and rural areas. To counteract these arising problems, it is necessary to set up the baseline condition of each region and to conduct research to understand driving forces and relationships concerning these issues. This symposium will discuss the development of low carbon societies and the strategies on changing landscapes, multiple technologies of landscape restoration, alternatives for creation of new landscapes and better land use planning for balancing natural resources usage and carbon sink protection in Asia's rapidly developing regions.

## **Landscape Ecology, Infectious Diseases and Toxicant Transfers in a Changing World**

**Principal Organizer:** Pr. Patrick GIRAUDOUX

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**Co-organizer:** Francis RAOUL, Renaud SCHEIFLER

*University of Franche-Comté*

Understanding and predicting the effects of anticipated global and regional changes is currently one of the big challenges of science. The principal concern lying at the interface of health ecology, ecosystem health and landscape ecology is to understand how environmental events, such as habitat alteration, loss of biodiversity, biological invasion, climate change and pollution, alter the risks of emergence and sustainable transmission of pathogen organisms and the transfer of pollutants. Landscape ecology mainly concerns a high level of biological organisation, such as large ecosystems and spatial arrays of interacting communities that Lidicker (2008) proposed to term "ecoscape". This perspective therefore also applies to complex transmission/transfer systems in both terrestrial and aquatic habitats (and combinations). Methodological advances can be expected from exchanges between landscape specialists dealing with pathogen transmission and toxicant transfers.

Transmission ecology of infectious diseases as well as the transfer of chemical pollutants (heavy metals, organic chemicals, etc.) in food webs are inherent ecological processes involving interactions of at least two and often many species. Thus, the distribution of both pathogenic organisms and potentially toxic chemicals is dependent on population dynamics, herbivory, prey/predator and host/parasite interactions, individual dispersal, and on the heterogeneity of physical and chemical conditions at various space-time scales, all being controlled by landscape organisation to a large extent. The term "landscape epidemiology" was coined in the early works of Pavlowski (1964). Rioux et al. (1990) coined the term "eco-epidemiology" for systems approaches, integrating methods inherited from both ecology and epidemiology. His approach focused on the definition of a spatial risk, a temporal risk and a population risk (related to population age structure, immunology, etc.). He also stressed the importance of spatial and temporal scales relative to parasite transmission issues. However, modern landscape ecology concepts, especially the nested hierarchy of relevant time-space scales at which processes must be studied, the effect of landscape on these processes and the anthropogenic origin of landscape change were little if not at all incorporated in those early studies (Giraudoux et al. 2008). Cairns & Niederlehner (1996) advocated developing a field of "landscape ecotoxicology" and recommended incorporating tools such as remote sensing and spatially explicit simulation models, and then calibrating these models using data from long-term biomonitoring of large areas. Further integration into combined socio-economic-ecological models was also considered.

The aim of this symposium is to explore the current issues related to landscape ecology in the fields of infectious disease ecology and ecotoxicology, e.g. how spatial arrangements of various habitats and their anthropogenic changes can impact transmission/transfer processes and provide a background for exposure and risk assessment at multiple scales.

# Landscape Ecological Perspectives on Biocultural Diversity and Sacred Landscape

**Principal Organiser:** Dr Gloria Pungetti

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**Co-organisers:** Sunkee HONG<sup>1</sup>, Yuanmei JIAO

<sup>1</sup>*Mokpo National University, Korea;* <sup>2</sup>*Yunnan Normal University, China*

This symposium builds for the advances of the participants on biocultural landscape and from the 3S Initiatives on Sacred Species and Sites (CCLP & IUCN) expanding the concept to landscape ecology. Main goal is to offer a perspective from landscape ecology on biocultural diversity conservation and sacred landscape.

Objectives:

- To support the link between cultural and ecological diversity
- To demonstrate ways in which biocultural landscape can contribute to conservation biology
- To improve recognition and understanding of the cultural and spiritual values of species, sites, landscapes and their ecosystems
- To promote the integration of these values into policy, planning and management
- To set up a world-wide working group in the subject and publish the results

Topics:

- Biocultural diversity and landscape ecology
- Biocultural landscape: diversity in concepts, languages and cultures
- Sacred species, sites and landscapes
- Ecological, cultural and sacred corridors
- Traditional ecological knowledge, cultural and spiritual aspects of ecosystems and their communities
- Integrated assessment of multiple functions and values of biocultural landscapes, and their cultural and socio-economic changes
- Earth observation for biocultural landscape survey and protection from natural hazards and extreme natural effects of climate change
- Ecosystem services, human wellbeing and socio-ecological production related to biocultural landscape
- Resilience and future sustainability of biocultural landscapes in ancient and modern contexts
- Tools to integrate biocultural landscape heritage and values into policy, planning and management at different governmental levels

The understanding of the link between natural, cultural and spiritual values of landscape and the cultures that shaped it is an essential component for the healthy and sustainable management of our planet. However, we cannot manage our natural and cultural landscapes if we do not understand their cultures and vice versa. With this symposium advances in biocultural diversity, sacred landscape, ancient and indigenous knowledge will be discussed, and new tools for their conservation, planning and management will be offered.

The symposium seeks new contributions from landscape ecology to the theme of biocultural landscape, especially from Native Americans, Latin America Indios, Africans, Siberians, Australian Aboriginals and Maori.

## **Landscape Services in a Changing Environment**

**Principal organizer:** Felix KIENAST

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The analysis of ecosystem services has become very popular in numerous research and planning projects all over the world due to its integrative character. Recently, the concept has been successfully extended to include the landscape scale. Landscapes consist of ecosystem complexes that can be delineated on different hierarchical levels, and they can be described and assessed or characterized as an entity. Most importantly landscapes have the capacity to supply manifold services. Consequently landscape services are the flows of benefits of landscapes to society and depend upon both the *capacity* of the landscape to supply these services, and the *demand* from society for the benefits they provide. An implicit principle of sustainability is that flows in the form of ecosystem goods and services cannot exceed the long-term capacity of landscapes to provide them. Thus assessing capacities is a difficult but necessary step to ensure the sustainability of landscape benefits for society.

Landscape service research is based on successful concepts such as e.g. the concept of ecosystem services or the concept of multifunctionality of landscapes. Below we identify several new and novel trends and research avenues in landscape service research. The Symposium goal is to provide a forum to discuss these trends with selected contributions from all continents, and from local to continent-wide scales. The circumpolar nature of the concept will be highlighted and participants will profit from the variety of culturally-based approaches.

- The landscape service paradigm is gaining momentum in many parts of the world, and an increasing number of Environmental Agencies are adopting them as planning principles (see e.g. The Ecosystem Services Partnership; <http://www.fsd.nl/esp>, 30. May 2010)
- We argue that the landscape services concept better covers spatial aspects (spatial patterns, interactions and fluxes as well as planning purposes than ecosystem services.
- The recent literature covering both ecosystem and landscape services has a strong bias towards production and regulation functions. This is primarily due to the availability of (spatial) data and appropriate economic valuation methods. In particular there is a lack of appropriate methods and data to assess information functions.



- There is an increasing number of studies linking service assessments with climate change, and separating land use impacts from climate change impacts.
- An increasing number of studies provide methods to improve the participatory character of landscape functions assessments, e.g. the *Natural Capital Project* ([www.naturalcapitalproject.org](http://www.naturalcapitalproject.org), 30 May 2010). This is an important step towards increased environmental stewardship.
- An increasing number of papers are now mapping landscape functions and their trade-offs over large areas. However, we feel that more emphasis should be given to projects that focus on concrete spatial reference units on different scales as well as including non-monetary assessment methodologies.
- There is an urgent need for novel techniques to assess trade-offs among landscape services, and to generate broad-scale multi-functionality assessments
- Landscape functions and function changes must be assessed dynamically, i.e., historical and future land-use and land-cover change but also changing human preferences, values and demands have to be considered.

## **Linking Landscape Structure and Biodiversity**

**Principal Organizer:** Ulrich WALZ

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**Co-organizer:** Ralf-Uwe SYRBE

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The decline of biodiversity, as a major environmental problem, currently attracts worldwide interest (e.g. the Nagoya-Conference 2010). An important key for the solution of the biodiversity problem is the consideration of changes of land uses and land use structure. Biological diversity is determined by landscape structure as an expression of variety of natural assets and the use by human. Landscape structure can be described by landscape metrics regarding size, shape and distribution of single patches, land use classes and landscape patterns.

Within the last years achievements were made in considering the landscape as a gradient and the calculation of its three-dimensional characteristics. The workshop exceeds the view at the classical landscape structure approach by:

- going beyond simple species considerations
- extending conventional landscape metrics
- integration of third spatial dimension (relief, real areas and distances)
- regarding of temporal and scale effects
- complex consideration of landscapes
- improved diversity metrics

Concerning the linkages between landscape structure and landscape function an increasing amount of literature shows the value of landscape metrics to evaluate the state of biodiversity

at a higher spatial level (ecosystems or landscapes). The indices are used as integrative indicators for biodiversity at landscape level, for monitoring of landscape change and for evaluation of impact on biodiversity, but they are also used in habitat modeling. In order to preserve a high level of biodiversity, the conservation of a diverse spatial heterogeneity (geomorphology, soils etc., commonly known as geodiversity) is important also. Sophisticated indices are able to yield specific information about underlying processes.

## **New Frontiers in Landscape Economy - Assessment and Up-scaling of the Impacts of Land-use Practices on Ecosystem Services**

**Principal Organizers:** Dr. Christine FÜRST, Carsten LORZ

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Land-use changes are most important for the sustainability and extend to which socially desirable ecosystem services are provided. The assessment of the impact of land-use changes is facing three major challenges.

First, the impact of land-management practices is difficult to assess and classify in a way that allows for generalization. Therefore, land-use changes are often interpreted synonymously to land-cover changes. In consequence, valuable information is lost or not considered. Thus, the potential of land-management practices to contribute to a healthy and well functioning environment might be substantially underestimated.

Second, so far no standardized reference for evaluating the impact of land-use changes exists. In some cases, “land-use functions” are used which address the three pillars of sustainability. These approaches are often not easy to transfer from one region to another due to their high level of complexity and high demand for information and data. Recent approaches focus on ecosystem services. Though this concept acknowledges humans and their environment are tightly linked, a lack of explicit inclusion of human dimension and especially of socio-economic aspects can be observed.

Third, sectoral evaluation approaches, e.g. from forestry or agriculture are up-scaled to landscape scale without considering the impact of mutual interactions between differing land-uses and their local context. Landscape metrics, which might be supportive in solving this problem, are mainly used in landscape ecology. In contrast, economic aspects, such as costs for different technological solutions in land-management depending on size, form and spatial distribution of a land-use are so far rarely considered.

The symposium intends to (a) to look at new approaches for the assessment and evaluation of land-use changes with a focus on integrating both - land-management practices and landscape structure aspects and (b) to discuss development needs for addressing equally human and nature aspects in a holistic and transferable landscape economy.

## **Processes and Patterns in Hydrosapes: Fragmentation, Domestication, and Consequences**

**Principal Organizer:** Quan DONG

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Hydroscape refers to a type of landscape, where water covers a large numbers of patches or large areas for long time periods. In hydrosapes, water plays a defining role in the formation of spatial patterns and the configuration of spatial processes, and water flow seems to be the determinant physical process that influence and determine other physical, chemical and biological processes. Globally, humans have fundamentally altered the hydrological processes of freshwater and thereafter many aquatic ecosystems. Water control efforts have led to hydroscape fragmentation and hydroscape domestication. Many hydrosapes have become human dominated landscapes.

Historically in landscape ecology, a predominate majority of studies have been conducted in terrestrial systems. Recently, aquatic studies started to draw attentions. We believe that ecological studies of hydrosapes can offer great insights about the mechanistic links between processes and patterns, because the dominate roles that water flow plays. Note that the understanding of links between processes and patterns has come very slowly in the studies of terrestrial landscapes. Hydroscape ecology will be an emergent frontier in landscape ecology. In addition, hydroscape domestication will be an important issue in landscape ecology, land management, natural resource management, and ecosystem restoration.

This symposium will bring together leading ecologists from universities and research institutions to present their studies of major types of hydrosapes: riverscape, lakescape, wetland landscape and coastscape, at multiple spatial scales. Speakers will address two main questions: 1. What critical hydrologic features interact with other physical and biogeochemical processes to impact ecosystem processes and patterns, and how? and 2. How human activities influence these hydrologic features, the interplays, and consequent ecosystem processes and patterns. The objective of this symposium is to culminate in a discussion and synthesis across studies of seemingly diverse hydrosapes. The discussion and synthesis will provide insight into how local human activities and natural process interplay with human influences and landscape patterns at hydroscape scales.

I believe this symposium will attract a large audience of both management practitioners and ecologists because the impacts of hydrologic engineering projects have been hotly debated in many parts of the world. We'll bring ecologists from both different countries, most of them well-established, nevertheless some may be considered as new faces.

## Remote Sensing and Spatial Indicators for Detecting Urban Trajectories

**Principal organizer:** Maik NETZBAND

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**Co-organizers:** Jefferey SELLERS<sup>1</sup>, T.V. RAMACHANDRA<sup>2</sup>

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Large-scale urban development is likely to be one of the primary sources of environmental change over the next decades, and more of this development will take place in India and China than in any other two countries. Rapid urban growth can have severe consequences for environmental sustainability creating an urgent need for alternative pathways to development. To better understand the global variation in urban land-cover patterns and trajectories the variation in urban landscape structure for a subset of cities distributed throughout the world assessed at circa 1990 and 2000. This symposium presents findings from systematic comparative analyses of development on the urban fringe and its environmental consequences in various countries. The presentations analyze local and regional variations in developmental trajectories and sustainability among a number of urban regions within each country. The focus of each is on land use, ecosystems and environmental.

## Sustainability of Protected Area Landscapes in Asian Tropical Regions

**Principle organizer:** Saiful A. ABDULLAH

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**Co-organizer:** Nobukazu Nakagoshi,

*Graduate School for International Development and Cooperation, Hiroshima University,  
Japan*

Tropical deforestation is a global environmental issue which impact biodiversity, human well-being and climate. Over the past decades tropical deforestation particularly in the Asian region occurred at unprecedented rate. It is expanding and intruding inside protected areas. Deforestation is caused by population growth, agricultural expansion, weak institutions, trade liberalization and developmental policies. However, the main factors may differ between regions. The differences need to be identified and addressed to ensure these protected areas sustainability. Collectively, the factors affect protected areas capacity, effectiveness, sustainability and the livelihood of people, especially indigenous people within the surrounding area, who depend on protected areas for their daily subsistence. Therefore, restricted land use development must be imposed to prevent encroachment into protected areas. Nevertheless, to ensure protected areas as *in-situ* conservation area, a systematic conservation planning and management are needed. In this context, suitable and effective conservation tools and approaches which consider all factors which contribute to the sustainability of protected area must be developed. With this rational, this symposium is

organized to discuss the current status of protected areas and factors that contribute to their effectiveness and sustainability in Asian tropical region. In addition, discussion on tools and approaches needed for systematic conservation planning and management will also be conducted. The objectives of this symposium are i. to understand issues affecting sustainability of protected areas, ii. to identify future studies needed for sustainability of protected areas and iii. to improve conservation planning and management of protected areas network system, in the Asian tropical region.

## **Sustainable Forest Management for Biodiversity Conservation and Ecosystem Services in Asian Countries.**

**Principal Organizer:** Ken SUGIMURA

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**Co-organizer:** Tengchiu LIN

*National Taiwan Normal University*

Due to a long history of human exploitation of natural resources, there are only small areas of pristine forest ecosystems that have not been exploited for a long period of time in the East and Southeast Asian countries. On the other hand, fairly rich fauna and flora has been maintained in landscapes dominated by forests that local people have utilized in their daily lives for a long period of time in various ways in terms of biodiversity-related ecosystem services, such as harvesting non-timber forest products for food or medicinal uses. Besides, in so many local communities they have determined their management through participatory processes. In contrast, government or non-government agencies attempt to preserve as large area of forests as possible in pristine conditions without allowing most of human activities legally or by paper. If they were very successful, however, local people would lose a large portion of the ecosystem services. These exclusive approaches certainly will not be accepted and supported by local people who should play a crucial role in sustainable use and conservation of forests. Therefore, it appears practical to allow forest use by local people to a certain extent.

The overall goal of the symposium is to answer a question as to how forest management or uses would affect the state of biodiversity and ecosystem services. We aim at providing innovative approaches to effective measures for biodiversity conservation as well as sustainable ecosystem services.

Topics the proposed session addresses are:

- (a) Is it reasonable to evaluate biodiversity-related ecosystem services (ES) as one of crucial criteria in decision making for forest management? This kind of ES includes non-timber forest products (NTFP), pollination, recreation activities, existence values associated with endemic species, etc.
- (b) Under what kind of conditions biodiversity conservation and human activities are compatible?

- (c) In some cases participatory process and local traditional use of forests support protecting diversity of fauna and flora are more practical, compared with centralized top-down legal enforcement?
- (d) Finally we will discuss about landscape management strategies in such contexts as, biodiversity conservation and human activities being compatible, sustainable ecosystem services, while considering various social conditions and ecosystems in which human use and disturbances are allowed to a limited extent.

## **Systems and Tools for Integrated Ecosystem Services Modeling and Decision Support**

**Principal Organizer:** Shuguang LIU

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**Co-organizer:** Bruce Jones

*U.S. Geological Survey*

Ecosystems provide a wide range of goods and services to the society. Maintaining sustainable ecosystem services to ensure provisioning of resources for future generations has become an explicitly stated goal for many land management entities and agencies and, in some cases, has been legislatively mandated. Because of the complexity and connectedness in ecosystem functions and services, any changes in land use, disturbances, and climate would invoke simultaneous changes in myriad ecosystem services at a range of spatial and temporal scales. However, past practices have been on quantifying one or a few ecosystem services at a time, potentially producing unintended consequences since a management scenario that is optimal for one service can be disastrous for other services. Hence, there is a strong need to develop modeling systems and tools to simultaneously quantify the impacts of land use and climate change on diverse ecosystem services for decision makers. In this symposium, we include presentations on current practices for developing and applying this kind of modeling systems and tools. Talks will cover theoretical considerations of integration, technical aspects of modeling development and integration, trade-off or optimization schemes, and applications to scientific research and decision support.

## **The Status of etlands in forest mosaic landscapes**

(Sym. 14 - Guy Lempérière)

**Principal organizer:** J. Piriou

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**Co-organizers:** Y. PETIT-BERGHEM<sup>1</sup>, G. LEMPÉRIÈRE<sup>2</sup>

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The concepts and methods of historical biogeography and landscape ecology allow investigating the evolution of forest landscapes. Overexploited during the 18<sup>th</sup> and 19<sup>th</sup> centuries for the huge needs of local industries, forests have been planted with coniferous trees since the middle of the 19<sup>th</sup> century. The species used for the reforestations were first indigenous, like the Scots Pine and then exotic, like the Douglas-Fir, the Japanese Larch and the Sitka Spruce. The great plantations of coniferous trees had harmful consequences on the structure and functions of intraforest wetlands which punctuate the landscape mosaic. Today the attempt is to restore these environments using conservation ecology tools. The effectiveness of those works is questionable and raises the question of the natural dynamics of the vegetation within forestry. This study investigates sites and their status along a transect between the southeastern part of the Massif Central (France) including the Limousin, Brittany and Normandy (France) and sites in Northern Ireland (UK).

## **Topographic Effects on Landscape Complexity and Sustainability**

**Principal Organizers:** Miska LUOTO<sup>1</sup>, George P. MALANSON<sup>2</sup>, Zehao SHEN<sup>3</sup>

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To enhance the sustainability of our environment, as the chief goal of environmental sciences in 21<sup>st</sup> century, it is crucial to understand the underlying mechanisms that regulate the interaction of environmental and cultural processes at landscape and related scales. As a silent and ubiquitous factor, topography, while not adequately appreciated, has been found to affect ecological, environmental and cultural pattern and processes in many related sub-disciplines, and to play an important role in regulating the diversity, complexity and sustainability of landscapes. However, a comprehensive framework is still in need to summarize its contribution to mainstream ecology. The key issue, and the goal of this symposium, might be to understand the underlying mechanisms and the correct scales of interaction of ecological and cultural process and pattern with regard to topography and geomorphic processes. Specifically, this symposium will contribute perspectives from both the environmental and cultural aspects, and focus on the topographic effects on ecological complexity and sustainability at landscape and related scales.

For this symposium, we plan two 3-hour sessions, invite 12~15 presentations, and a one-hour discussion. The following issue will be addressed, while might not be limited to:

- 1) Topographic effects on biodiversity;
- 2) Environmental process and topographic regulation
- 3) Topographic effect on cultural process;
- 4) Biological response to topography and geomorphologic process
- 5) Topographic complexity and scale
- 6) Landscape sustainability induced by topographic complexity

By this symposium, we hope to outline the framework of ecological effects of topography, from a “pattern-process-scale” perspective, which should be a cornerstone of landscape ecology as a science of complexity. This framework also has broad implications for the practice of ecological conservation and landscape sustainability.

## **Urban Ecology for Sustainable Urban Environment**

**Principal Organizer:** Jürgen BREUSTE

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The proposed symposium fits in the IALE 2011 Beijing World Conference’s main topic of sustainable environment and culture approaches within landscape ecology. Urban landscapes are supposed to be actually and in the future focal points of landscape transformation. More than 50% of the world population lives in cities and this number will increase.

Urban landscapes undergo dramatic changes from which the majority of the world’s population will be affected. The following 10 challenges are seen as the most important:

1. To develop models for sustainable cities,
2. Management of urban growth and urban structural changes,
3. Climate change,
4. Increasing risks by natural processes,
5. Planning for urban sustainable environment,
6. To secure and improve urban biodiversity and urban nature,
7. To stabilize and develop urban ecosystem services,
8. Demographic and social changes,
9. Weakening of administrative influences and drastic shortages in public finances,
10. Interactions of urban environment and urban culture (experiences, conflicts and management).

For each of these challenges valuable contribution from urban ecology can be expected to present the state of the art, case studies and methodological approaches in the respective field. Empirical evidence, research but also practice experiences with these subjects of different countries worldwide are will be presented , are welcome and will be discussed. The discussion should be targeted to identify the ecosystem-related impacts of these challenges, to discuss how to define targets for future sustainable development/improvement of urban ecosystems’ functionality and quality of life as well as to evaluate the methods, steering instruments and best practice examples how to deal with these challenges.

The following subjects are identified as sub-topics of the symposium in research, planning and management aspects:



1. Climate change and sustainable urban environment
2. Modeling of sustainable urban environment
3. Urban ecosystem services – processes, pattern and planning
4. Urban Biodiversity and urban nature
5. Sustainable urban environment in different urban cultures

## **Urban Green Spaces, Human Health and Eco-environment Quality**

### **Principal Organizer: Nobukazu NAKAGOSHI**

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### **Co-organizer: Fanhua KONG**

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As a result of urbanization, the world's population is being increasingly concentrated in cities. The byproducts of rapid urban development were manifest in the reduction of natural resources, worsening conditions of the urban environment, and increasing urban climatological and ecological problems. Urban green spaces viewed as the last remnant of nature in urban areas perform important functions. They can contain rich flora that contribute significantly to biodiversity and the connectivity provided by urban green spaces offers habitats and corridors that help conserve biodiversity. Urban green spaces can provide considerable socioeconomic benefits, such as providing amenity-recreation venues, reducing work-related stress and increasing property values. Urban forests can reduce atmospheric CO<sub>2</sub> and other greenhouse gas directly and indirectly. Urban green spaces will play a major role in our ability to cope with future climate change. Urban green spaces also play a role in preventing soil erosion, absorbing rainwater and pollutants. Green space is becoming an important measure in judging the urban resilience. Rapid urbanization and increased leisure time can make people more aware of urban green space within cities especially as it there is now a realization that it is difficult to live without some contact with nature.

The Symposium will highlight the benefits of green spaces and accordingly provide the solutions to some of the health and eco- environmental issues we are facing today. The Symposium program will focus on the following five key areas:

1. Urban green spaces and climate change: the way that the urban green spaces help the city to adapt to the climate changes.
2. Urban green spaces and urban morphology
3. Urban green spaces and people health: What are the key health benefits that the urban green spaces add to individuals and the wider community?
4. Urban green space and the biodiversity conservation:
5. Economic benefits of urban green spaces

## Urbanization and Its Impacts on Terrestrial Ecosystem

**Principal Organizers:** Chunyang HE, Zhifeng LIU

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The world is undergoing rapid urbanization which is hugely transforming regional natural landscapes. More than half of the world's population now live in urban areas. Urbanization is expected to continue well into the 21<sup>st</sup> century, especially in the developing countries, where urban sustainability has become one of the most pressing issues that human face today. Urbanization is usually associated with significant changes of land use and land cover, in specific, the creation of non-evaporating and non-transpiring impervious surfaces and the loss of precious vegetation covered land. It thus brings impacts on the terrestrial ecosystem, including increasing carbon emissions, lowering photosynthetic activity, reducing both species richness and evenness for most biotic communities and consequently affecting ecosystem processes and functioning. It is well known that such impacts will bring ecological risk to the sustainability of urban development. With aim at improving the understanding on urbanization process and its particular effects on terrestrial ecosystem at different scales and finding the strategies to govern the ecological risk of urbanization, the symposium will bring participants from all over the world to discuss the relative research progresses. The topics of the symposium will focus on (but not limited to):

- (1) Mechanism, pattern and progress of urbanization at different scales;
- (2) The impacts of urbanization on the structure of terrestrial ecosystem;
- (3) The impacts of urbanization on the function of terrestrial ecosystem;
- (4) The impacts of urbanization on the process of terrestrial ecosystem;
- (5) The impacts of urbanization on the value of terrestrial ecosystem
- (6) The strategy to govern the ecological risk due to urbanization.

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