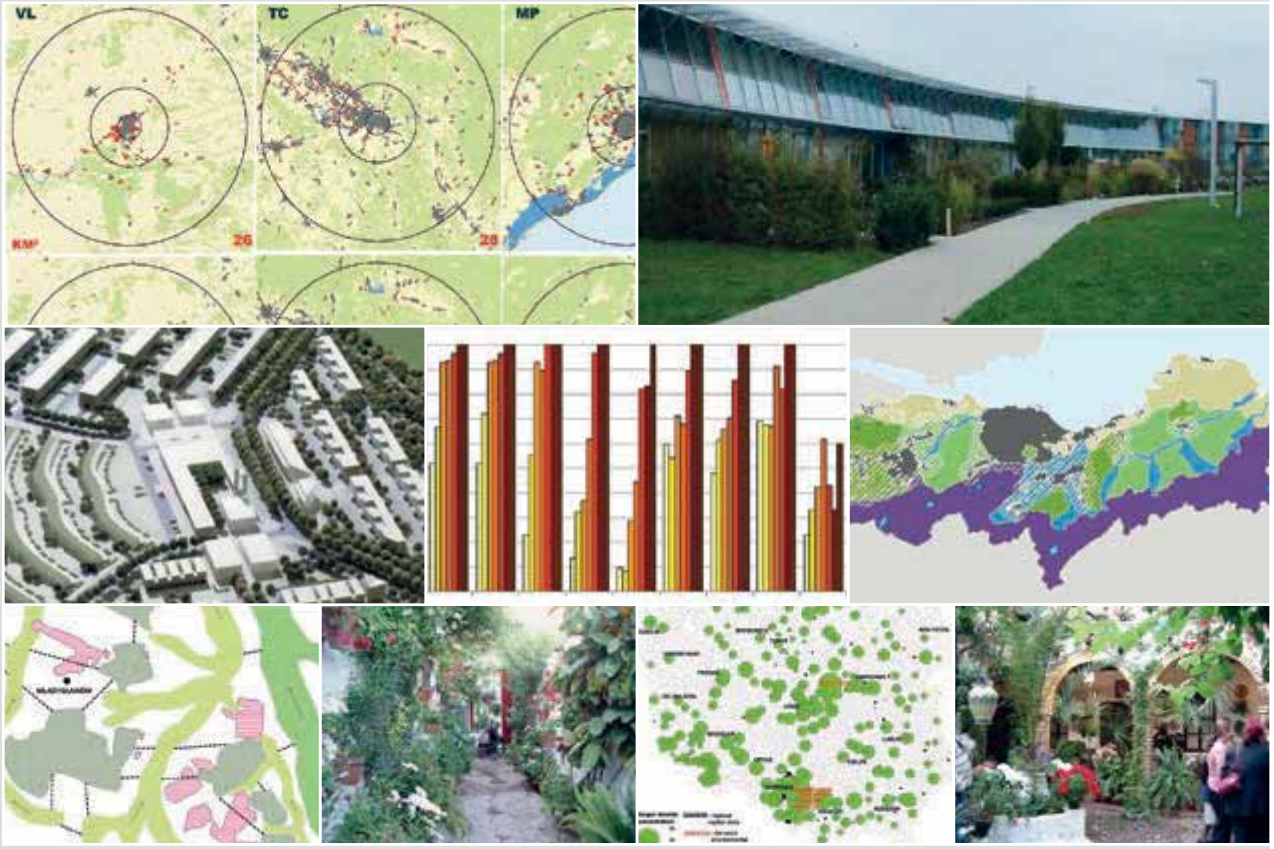
Bayerische Akademie für
Naturschutz und Landschaftspflege

Implementation of Landscape Ecological Knowledge in European Urban Practice



Laufener Spezialbeiträge 2012

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Zum Titelbild

Von links oben nach rechts unten:

Spatial temporal layer. Artificial uses: Changes 1990-2000 and 2000-2006 of the cities Valladolild, Montpellier, Florence and Den Haag; figure from the contribution by Marian Simon ROJO on the pages 27-31 (Fig.: Marian Simon Rojo).

SolarCity residential estate; figure from the contribution by Jürgen BREUSTE on the pages 19-25 (Fig.: Jürgen Breuste).

The ecocity solarCity Linz, model photo of the first settlement area with integrated green spaces; figure from the contribution by Jürgen BREUSTE on the pages 19-25 (Fig.: Treberspurg & Stadt Linz 2008).

Percentage of Polish cities which included data on environmental quality depending on the number of population; figure from the contribution by Mariusz KISTOWSKI on the pages 79-84 (Fig.: Mariusz Kistowski).

Spatial Framework identifying landscape character zones with regard to new woodland planting opportunities in Scotland; figure from the contribution by Ian WHITEHEAD on the pages 39-46 (Fig.: Landuse Consultants 2011).

Analysis of the ecological structure of the mining area Adamow; figure from the contribution by Katarzyna FAGIEWICZ on the pages 73-77 (Fig.: Katarzyna Fagiewicz).

Courtyard like corridor of multi-family dwelling in Cordoba, Spain; figure from the contribution by Carlos PRIEGO GONZÁLES de CANALES, Luis Rodríguez-Morcillo BAENA & Jürgen H. BREUSTE on the pages 67-72 (Fig.: Carlos Priego).

Average concentration of the air pollution ($\mu g*m^{-3}$) in the selected Polish cities in the years 2000-09; figure from the contribution by Mariusz KISTOWSKI on the pages 79-84 (Fig.: Mariusz Kistowski).

Courtyard of a single-family dwelling in Cordoba, Spain; figure from the contribution by Carlos PRIEGO GONZÁLES de CANALES, Luis Rodríguez-Morcillo BAENA & Jürgen H. BREUSTE on the pages 67-72 (Fig.: Carlos Priego).

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Implementation of landscape ecological knowledge in European urban practice

Vorwort

In Erinnerung an Prof. Dr. Zev Naveh

Am 31. März 2011 verstarb unser verehrter Nestor der Landschaftsökologie Prof. Dr. Zev Naveh in Haifa, Israel. Für viele wird er ein Vorbild an Engagement und Ideenreichtum für eine komplexe, holistische Landschaftsökologie, die Anwendung und Praxis ganz selbstverständlich einschließt, bleiben. Er hat eine Generation von Landschaftsökologen nachhaltig beeinflusst und wird nicht nur als Vorbild, sondern auch als Mensch immer in unserem Gedächtnis sein. Der Zufall wollte es, dass die enge Zusammenarbeit von Prof. Zev Naveh und Prof. Jürgen Breuste ihn 2009 nach Salzburg führte, wo Prof. Jürgen Breuste die Europäische Konferenz der Landschaftsökologen (IALE) organisierte. Zev Naveh war der Ehrenpräsident der Veranstaltung. Es war seine letzte große Konferenz, an der er aktiv teilnahm.

Abb.: Prof. Naveh (rechts) mit Prof. Breuste 2009 in Salzburg

Geblieben ist uns neben den Erinnerungen auch sein wahrscheinlich letztes Manuskript ‚Systems Concepts for a Transdisciplinary Landscape Science' (gemeinsam mit Prof. Ervin Laszlo), das aus technischen Gründen nicht mehr in die Tagungspublikation 2009 integriert werden konnte. Zusammen mit Ervin Laszlo widmet er sich darin den von ihm begründeten systemtheoretischen Grundlagen der Landschaftsökologie. Es führt damit auch an den Anfang seiner Arbeiten in den 70er Jahren des vergangenen Jahrhunderts zurück und schließt damit den Bogen von seinem grundlegenden Werk ‚Landscape Ecology: Theory and Application' (NAVEH & LIEBERMANN 1984). Wir empfinden es als eine Ehre, den Aufsatz von Laszlo und Naveh an den Anfang unserer Publikation stellen zu können und damit posthum zu veröffentlichen. Dank sei auch Herrn Prof. Ervin Laszlo, dem Erstautor, für die Zustimmung zur Publikation. Es freut uns, dass diese Publikation gerade in Laufen, im Salzburger Raum erscheint, da diese in Salzburg mit einem großartigen Vortrag 2009 ihren Ursprung hatte.

Zum Tagungsband

Das zweite Symposium der *European Association of Landscape Ecology* (IALE Europe) hat eine Vorgeschichte. 2009 hat Prof. Breuste zur Europäischen Konferenz der Landschaftsökologen (IALE) nach Salzburg eingeladen. Dort wurde die Europa-Sektion der Landschaftsökologie (IALE Europe) gegründet. Prof. Breuste übernahm die Leitung der Arbeitsgruppe „Landscape Ecology in Practice". Nach einem ersten, sehr erfolgreichen Symposium 2010 in Poznan, Polen, organisiert von Prof. Mizgajski von der Adam-Mickiewicz Universität Poznan, Polen, konnte IALE Europe nunmehr in Laufen ihr zweites Symposium durchführen. Mehr als 50 Wissenschaftler und Praktiker gehören diesem aktiven Netzwerk ‚Landscape Ecology in Practice' in ganz Europa inzwischen an. Sie wollen die Entwicklung landschaftsökologischen Wissens für die Praxis und die Anwendung von Forschungsergebnissen in der Praxis fördern, dokumentieren und zur Diskussion stellen. Gute Beispiele in Europa sollen zeigen, wie man Planung und Gestaltung von Landschaften weiter verbessern kann, um Europäische Landschaften in ihrer Naturausstattung, ihren Funktionen und als Lebensraum der Menschen zu erhalten und zu entwickeln.

Organisiert wurde das 2. Symposium *Landscape Ecology in Practice* von Jürgen Breuste, Annette Voigt und Daniel Wurster (Arbeitsgruppe Stadt- und Landschaftsökologie der Universität Salzburg) in Kooperation mit Christoph Goppel, Ursula Schuster und Johannes Pain (ANL Laufen). Damit wurde die erst seit 2010 bestehende Kooperation zwischen der Bayerischen Akademie für Naturschutz und Landschaftspflege in Laufen, Deutschland, und der Arbeitsgruppe Stadt- und Landschaftsökologie der Universität Salzburg, Österreich, weiter mit Leben erfüllt. Sie basiert auf dem gemeinsamen Wunsch die Stadtlandschaften viel stärker als bisher aus der Perspektive der Ökologie, der Gestaltung als Lebensraum und des Landschaftsschutzes in den Mittelpunkt zu rücken, eine

Position, die ihnen als wichtigster Lebensraum der Menschen in Europa auch zukommt.

Folgerichtig stand nach einer ersten Bestandsaufnahme 2010 in Poznan beim 2. Symposium der europäischen Landschaftsökologie 2011 in Laufen und Salzburg die Stadtlandschaft im Mittelpunkt. Die Anwendung von landschaftsökologischem Wissen in der urbanen Praxis in Städten und ihrem Umland war Thema des Symposiums. Neueste Erkenntnisse aus der landschaftsökologischen Forschung und Praxis in urbanen Räumen waren vom 20. bis zum 22. September 2011 das Tagungsthema. Wissenschaftler, Planer und Berater aus verschiedenen Ländern Europas haben sich dort getroffen. Urbane Landschaften sind für die große Mehrheit der europäischen Bevölkerung (meist deutlich mehr als 70%) der wichtigste Lebensraum. Städte und ihr Umland sollen attraktive Lebensräume in nachhaltiger Nutzung mit einer Naturausstattung, deren Leistungen (Ökosystem-Dienstleistungen) den Menschen zugutekommen, sein. Dies ist bei weitem noch nicht überall in Europa der Fall, obwohl es gerade hier bereits überzeugende Beispiele gibt, denen anderswo nachgeeifert werden kann. Salzburg und sein österreichisches und bayerisches Umland gehören dazu. Die manchmal noch bestehende Kluft zwischen Forschung und praktischer Anwendung des Wissens muss dabei gezielt von Forschung und Praxis überwunden werden.

17 Vorträge und 18 Poster wurden in den drei Themenbereichen:

(1) Ecosystem Services,

(2) Urban Green und

(3) Planning Tools

von 40 Teilnehmerinnen und Teilnehmern aus 10 Ländern Europas und Japan an drei Arbeitstagen in Laufen vorgestellt.

Die Beiträge behandelten vielfältige Aspekte der Stadt- und Landschaftsökologie wie Ökosystem-Funktionen von Gründächern, die Anwendung des Konzept Ökostadt, die Umsetzung des Konzepts der Ökosystem-Dienstleistungen in Städten, die Wahrnehmung und Bewertung von Stadtgrün durch die Stadtbewohner, die Habitatvernetzung zur Verbesserung der urbanen Biodiversität, die Planung von Grünnetzwerken und gute Beispiele zur Entwicklung einer urbanen Grün-Infrastruktur. Das Beispiel der japanischen Stadt-Agglomeration Nagoya erlaubte interessante Vergleiche zur Ausdehnung von Städten in einen Stadt-Land-Übergangsraum („Zwischenstadt").

Auf einer Exkursion in den grünen Süden der Stadt Salzburg, der ein Mosaik von unterschiedlichsten städtischen Grünflächen aufweist, konnten die behandelten Themen dann am Beispiel Salzburg unter Leitung von Prof. Breuste „ergangen" werden.

Die Tagung war inhaltlich und organisatorisch, nicht zuletzt durch die hervorragende Unterstützung der Bayerischen Akademie für Naturschutz und Landschaftspflege im Meinungsbild aller Teilnehmer ein voller Erfolg. Diese Publikation fasst die Ergebnisse zusammen uns stellt sie einer breiten Öffentlichkeit zur Diskussion. Wir freuen uns, wenn damit zur Diskussion um die Verbesserung und Entwicklung der europäischen Stadtlandschaften beigetragen werden kann.

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Implementation of landscape ecological knowledge in European urban practice

Preface

In memoriam Prof. Dr. Zev Naveh

On March 31, 2011 our honored Nestor of landscape ecology, Prof. Dr. Zev Naveh, passed away in Haifa, Israel. For many he will stay a role model for commitment to and inventiveness in a complex and holistic landscape ecology, which naturally imbeds implementation and praxis. He strongly influenced a generation of landscape ecologists and he will always remain in our memories not only as role model but also as a friend. As luck would have it, the close collaboration between Prof. Dr. Zev Naveh and Prof. Dr. Jürgen Breuste brought him to Salzburg in 2009, to the European Conference of Landscape Ecologists organized by Prof. Jürgen Breuste. Zev Naveh was honorary president of the event and it was the last big conference at which he actively participated.

Fig.: Prof. Dr. Naveh (right) and Prof. Breuste in Salzburg

What remains, apart from our memories, is his probably last manuscript, 'Systems Concepts for a Transdisciplinary Landscape Science' (co-author: Prof. Ervin Laszlo). Due to technical reasons it was not possible to include it in the conference proceedings of the European Conference of Landscape Ecologists 2009. In the manuscript he, together with Ervin Laszlo, discusses the systems-theoretical fundamentals of landscape ecology, which he developed himself. The manuscript looks back to the beginning of Naveh's works in the 1970s and connects thereby to his fundamental work 'Landscape Ecology: Theory and Application' (NAVEH & LIEBERMANN 1984). We are deeply honored that we have the opportunity to publish this paper by Laszlo and Naveh posthumously by placing it at the beginning of our publication. We also would like to express our thanks to the first author Prof. Ervin Laszlo for his approval of the publication.

As the manuscript had its origin in Salzburg in 2009 with a great lecture, we are pleased that the place of publication now can be in the greater region of Salzburg, in Laufen.

The conference proceedings

The 2nd symposium of the *European Association of Landscape Ecology* (IALE Europe) had a previous history: In 2009 Prof. Breuste organized the European Conference of Landscape Ecology (IALE) in Salzburg, where the European chapter of landscape ecologists (IALE Europe) was founded. Prof. Breuste took the chair of the working group 'Landscape Ecology in Practice'. A first, very successful, symposium had been organized by Prof. Mizgajski (Adam-Mickiewicz University Poznan) in Poznan, Poland, in 2010, and could now be followed by the 2nd symposium of IALE Europe in Laufen.

More than 50 scientists and practitioners from all over Europe have become members of the active working group 'Landscape Ecology in Practice' by now. Their aim is to promote, document, and discuss the development of landscape ecological knowledge for the praxis as well as the implementation of research results in practice. Best-practice examples show how planning and design of landscapes can be improved in order to preserve and develop European landscapes with their nature provisions, functions, and as living space of men.

The 2nd symposium 'Landscape Ecology in Practice' was organized by Jürgen Breuste, Annette Voigt, and Daniel Wurster (Research group 'Urban and Landscape Ecology', University of Salzburg) in cooperation with Christoph Goppel, Ursula Schuster, and Johannes Pain (ANL Laufen). This further activated the cooperation between the Bavarian Academy for Nature Conservation and Landscape Management (ANL) in Laufen, Germany, and the research group Urban and Landscape Ecology of the University of Salzburg, Austria. The cooperation has only been in existence since 2010 and is based on the common desire to strengthen the focus on urban landscapes from the perspective of ecology, of design as living space, and of landscape conservation. This is a position urban landscapes

deserve as they are the most important living space of men in Europe.

Consequently, after a first ascertainment in Poznan in 2010, urban landscapes took center stage in the 2nd symposium of the European landscape ecologists in Laufen and Salzburg in 2011. The implementation of landscape ecological knowledge in urban practice in cities and their surroundings as well as latest findings from landscape ecological research and praxis in urban areas were the topics of the symposium in Laufen from the 20th to the 22nd September, 2011, where scientists, planners, and consultants from various European countries came together. For the majority of the European population (mostly significantly more than 70%), urban landscapes are the most important living space. Cities and their surroundings should be attractive and sustainably used living spaces with nature provisions that make (ecosystem) services available to men. This is largely not yet the case in all parts of Europe, although there are already convincing examples here, which can be followed elsewhere. Salzburg and its Austrian and Bavarian surroundings are one of these positive examples.

The gap between research and the implementation of the knowledge in practice, which sometimes still exists, has to be systematically bridged by research and praxis.

17 lectures and 18 poster presentations on the three topics

(1) Ecosystem Services,

(2) Urban Green, and

(3) Planning Tools

were presented by 40 participants from 10 European countries and from Japan on three days. The contributions dealt with various aspects of urban and landscape ecology, e.g. ecosystem functions of green roofs, the implementation of the eco-city concept and of the ecosystem-services concept in cities, the perception and valuation of urban green by city dwellers, the connections between the interconnectedness of habitats and urban biodiversity, the planning of green networks, and best practice examples to develop an urban green infrastructure. The example of the Japanese urban agglomeration Nagoya permitted interesting comparisons regarding the extension of cities into the surrounding area ('Zwischenstadt'). The treated topics could be experienced first-hand on a field trip lead by Prof. Breuste to the green South of Salzburg, which shows a mosaic of urban green.

Concerning content and organization, the symposium was, not only due to the excellent support by the Bavarian Academy for Nature Conservation and Landscape Management (ANL), according to all participants a great success. This publication summarizes the results and makes them available for discussion for a broad public. We look forward to this publication adding to the discourse on the improvement and development of the European urban landscapes.

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In memoriam Prof. Dr. Zev Naveh (1919 - 2011)

Systems concepts for a transdisciplinary landscape science

Ervin LASZLO & Zev NAVEH

Zusammenfassung

Die Europäische Konferenz der International Association of Landscape Ecology (IALE), die im Juli 2009 in Salzburg stattgefunden hat, hat sich den Herausforderungen des Landschaftswandels gewidmet und beschlossen, ein neues Kapitel der europäischen IALE aufzuschlagen. Nach 70 Jahren, in denen der Biogeograph TROLL den Begriff der "Landschaftsökologie" prägte, konnte in dieser Konferenz eine deutliche Verschiebung hin zu einer transdisziplinären Landschaftsforschung beobachtet werden. TROLL konzipierte die Landschaftsökologie als eine ganzheitliche "Öko-Wissenschaft", ein Studium der Landschaften in ihrer Gesamtheit als voll integrierte Einheit oder ganzheitliches System, in dem das Ganze mehr als seine Teile darstellt. Dies ebnete nach dem Zweiten Weltkrieg den Weg der Entstehung der Landschaftsökologie in Mitteleuropa als eine ganzheitliche, interdisziplinäre Wissenschaft der Landschaftsplanung und -gestaltung, des Landschaftsmanagements, der Landschaftspflege und –wiederherstellung. 1984 lieferten NAVEH und LIEBERMAN die Systemkonzepte der Landschaftsökologie als theoretische Grundlagen für eine transdisziplinäre Human- und Ökosystemwissenschaft. Neben der Verschiebung zur transdisziplinären Landschaftsforschung befinden sich aber auch die menschliche Gesellschaft und ihre offenen und bebauten Landschaften in einem tiefgreifenden Wandel von einem Industrie- hin zu einem globalen Informationszeitalter. Diese "Makroverschiebung" wird durch eine tiefe ökologische, sozioökonomische und kulturelle Krise begleitet.

Introduction

The European conference of the International Association of Landscape Ecology (IALE) in July 2009 at Salzburg has been devoted to the challenges of landscape transformation and decided to form a special European IALE chapter. In this conference a significant shift towards a transdisciplinary landscape science has taken place, seventy years after the German bio-geographer TROLL coined the term "landscape ecology" (TROLL 1939). He conceived landscape ecology as a holistic "eco-science" for the study of landscapes in their totality, as a fully integrated entity or system, in which the whole is more than the parts (TROLL 1971).

This paved the way for the emergence of landscape ecology in Central Europe after World War II as a holistic, interdisciplinary science of landscape planning and design, management, conservation and restoration. Two years after the foundation of IALE, NAVEH & LIEBERMAN (1984) provided the systems concepts for landscape ecology as the theoretical basis of a transdisciplinary human ecosystem science.

Since its foundation IALE has become a well-recognized global scientific organization, and as discussed recently (NAVEH 2007) it has made great strides towards transdisciplinary research and action. However at the same time, human society and its open and built-up landscapes are undergoing a crucial transformation from the industrial to the global information age. This "Macroshift" (LASZLO 2008) is accompanied by a deep ecological, socio-economic and cultural crisis.

The need for a systems approach

In view of these developments, we have to re-examine the system concepts for the emerging transdisciplinary landscape science, in the light of new insights that became available regarding the dynamics of complex systems and the coherence of the world as a whole. These 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, and in the new field of consciousness research, have been summarized and integrated into a unified view of the world as the "in-formed universe," where all organisms and environments are coherently connected (LASZLO 2004). These are fields to which many of us pay scant attention, yet they offer an all-embracing systems conception that sheds new light on the place of humans in nature. And thus it offers fresh insights into the place and role of human beings and societies in regard to rural, urban, industrial, and traditional landscapes.

The broadening of the scope of our worldview has far-reaching implications for a correct comprehension of the relations between human beings and human culture and society. Understanding these relations is a cornerstone of a transdisciplinary science of landscape planning and management, conservation, and restoration.

We need to become conscious of the fact that we have arrived at a watershed in history. The world we have created is no longer sustainable: it will either change, or break down. The question is no longer whether change will happen, only when it will happen and at what price.

Given current trends in demography, resource consumption, militarization, life-style and wealth-disparities, and the degeneration of the environment, our future is no longer assured. While on the one hand we could pave the way toward a system of social, economic, and political organization that is peaceful and capable of ensuring an adequate level of sustainability of the human life-supporting environment and its landscapes, on the other we could find ourselves on a descending path toward spreading terrorism, crime, and war, with growing cultural clashes, political conflicts, ecological degeneration, and more and more natural and man-made catastrophes. The choice at this point in time is still open. It merits deeper reflection.

The unsustainability of the world means that change must happen, and that it cannot be piecemeal and superficial. The future can no longer be a simple continuation of the past; it will have to be fundamentally different. Many people have difficulty comprehending this basic fact.

A more sophisticated variant of the currently dominant view perceives the possibility of change, but does not see it as fundamental. It describes the future in terms of the unfolding of "trends". Trends, whether local or global, micro or mega, introduce a measure of difference: as they unfold, there are more of some things and less of others. The world is still the same, only some people are better off and others worse. This view is also shared by forecasters and by trend analysis and has been applied often to characterize landscape transformations.

Trend-based forecasting ignores the fact that trends not only unfold in time, but can also break down and give rise to new trends, new processes, and different conditions. This possibility needs to be considered, since no trend operates in an infinitely adapted environment; its present sway and future unfolding have limits. These may be natural limits due to finite resources and supplies, or human and social limits due to changing structures, values, and expectations. When a major trend encounters such limits, the world is changing and a new dynamic enters into play. Extrapolating existing trends does not help in defining the emerging world. We need a systems approach to change and transformation.

The developmental dynamics of complex systems

To know what happens when a trend breaks down calls for going beyond the observation of current trends and following their historic path. It calls for knowing the developmental dynamics of the system in which the observed trends appear – and may disappear. Such knowledge is provided by the theory of complex systems, especially its branch popularly known as "chaos theory." Because of the unsustainability of many processes in today's world, the dynamic of development that will apply to our future is not the linear dynamic of classical extrapolation but the nonlinear chaos dynamic of complex-system evolution.

The crisis we are currently experiencing will not be overcome by tried and tested measures, carried out step by step. The way beyond today's crisis lies in profound and radical transformation. We can no longer ignore that current trends build toward critical thresholds – toward some of the famous (or infamous) "planetary limits" that in the 1970s and 1980s were said to be the limits to growth. Whether they are limits to growth altogether is questionable, but they are clearly limits to the kind of growth that is occurring today. As we move toward these limits, we are approaching – and have now definitively entered – a period of instability. It brings with it the deflection or disappearance of some trends and the appearance of others. This is not unusual: systems and chaos theory tell us that the evolution of complex systems always involves alternating periods of stability and instability, continuity and discontinuity, order and chaos. We are living in the opening phases of a period of social and ecological instability – at the bifurcation point.

The evolutionary process

A bifurcation is the critical decision-point of a vaster and more general process: the process of complex-system evolution. Whether it occurs in nature or in the human world, evolution is characterized by basic features that recur independently of the nature of the things that evolve, and also of their particular their time and place. Wherever it occurs, the process is continuous and unrelenting, but it is not smooth and even. Aside from occasional temporary reversals, the evolution of complex systems is largely irreversible, and the way it unfolds is highly nonlinear. A seemingly enduring process of change suddenly forks off in a new direction. This process comes to the fore whenever and wherever the systems undergo irreversible change.

The processes of evolution are continuous and unrelenting, but not smooth and even. Aside from occasional temporary reversals, evolution is largely *irreversible*, and the way it unfolds is highly *nonlinear*. A seemingly enduring process of change suddenly forks off in a new direction. The systems become chaotic, more exactly, the kind of butterfly-shaped attractors that were discovered by meteorologist EDWARD LORENZ appear in the dynamic "portrait" of their evolution. As a result their trajectory forks off: it *bifurcates*. This process comes to the fore whenever and wherever complex systems undergo irreversible change.

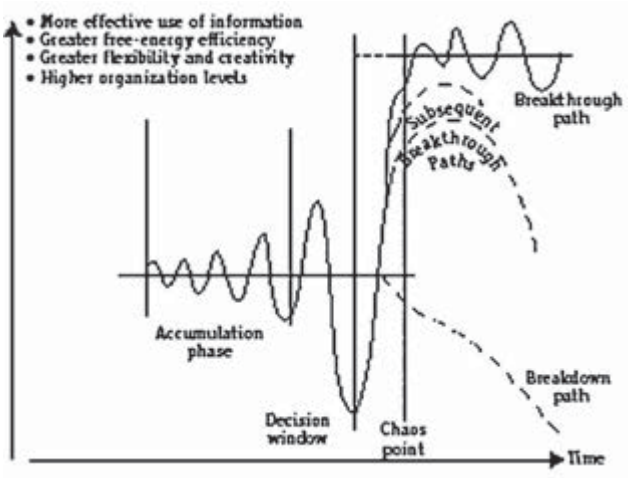

Fig. 1: The basic bifurcation diagram
At the threshold of a critical instability, fluctuations that were previously corrected by self-stabilizing negative feedbacks within the system run out of control – they break open the system's structure. The system enters a period of chaos. Its outcome is either the disintegration of the system into its individually stable components *(breakdown)*, or rapid evolution toward a kind of system that is resistant to the fluctuations that destabilized the prior system *(breakthrough)*.

Evolution in the biosphere is an integral process; it encompasses unicellular organisms on the one end of the scale of organization and complexity, and entire biospheres populated by multicellular organisms on the other. The process is driven by the flow of free energy from the Sun. Free energy is transformed by plants into biomass; the biomass is consumed by herbivores that in turn are food for carnivores, creating a continuous cycle that constitutes an open thermodynamic system. This energy-mill drives the biological and biochemical processes in the biosphere.
The evolutionary process is integral, but its unfolding is strongly nonlinear. Periodic bifurcations in the evolutionary history of biological and ecological systems mark the course of evolution on Earth, with its early phases occurring throughout the universe.

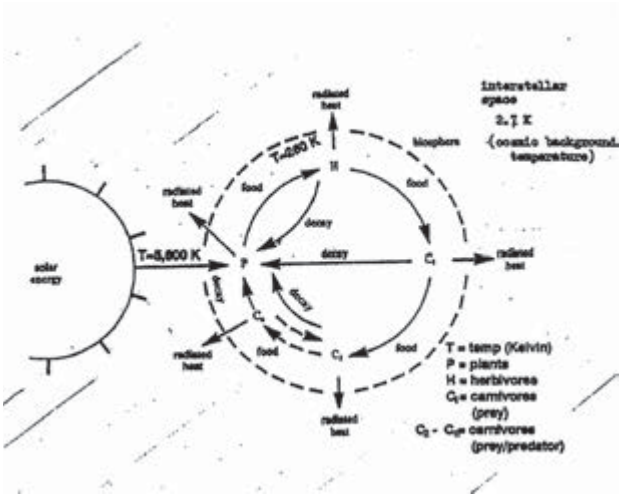

Fig. 2: The energy-mill that powers life in the biosphere
The thermal energy gradient between the energy streaming from the Sun to the surface of the Earth and the temperature of space around the planet (the cosmic background temperature) constitutes an energy-mill where the heat energy of solar radiation is transformed into systems of increasing complexity, and the waste energy – degraded to lower temperatures – is radiated off into space.

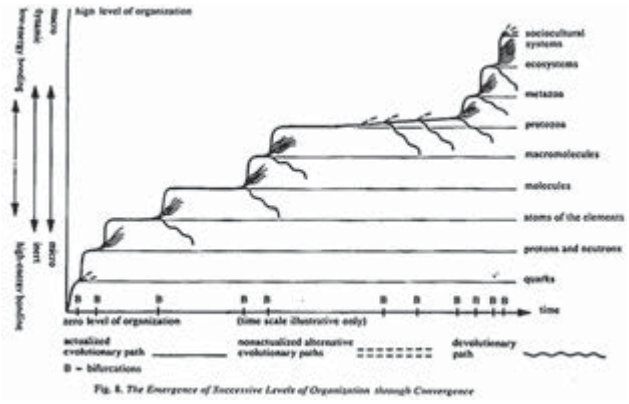

Fig. 3: Evolution through bifurcations in nature
Evolution in the universe took off from physical systems and – through the chemical evolution of stars and related interstellar processes – moved progressively from the substratum of quarks and elementary particles to the atoms of the elements and the molecules and crystals formed by atoms. On the Earth's energy-irradiated surface, evolution progressed further. Solar radiation combined with submarine hot springs stirred the rich "molecular soup" in the shallow primeval seas of the young Earth and created progressively more complex structures: prokaryotic and then eukaryotic cells, and subsequently colonies of cells and ultimately genuine multicellular organisms.

The evolutionary process of alternating dynamic stability and critical instability leads to the progressive build-up of complexity in nature, from the physical substratum of quarks and elementary particles, through the atoms of the elements, the molecules formed by some of the atoms and, in suitable planetary environment, to the macromolecules and cells formed by some of the molecules. On Earth it has further led to protozoa and metazoa based on macromolecular and cellular components, to the ecosystems formed by these sequentially integrating natural systems, and to the socio-cultural and technological systems formed by human groups and their integration with their environment as the Total Human Ecosystem. Evolution through periodic bifurcations gave birth to the lineage of hominids. The family of primates split off from the then existing species of mammals around 40 million years ago. The first primates were the old world monkeys that populated wide areas of Asia and Africa. Then, about 9.2 million years ago the primate family split into two groups. One, the pongids, stayed with arboreal life and, while several branches became subsequently extinct (such as *gigantopithecus* and *sivapithecus*), the survivors evolved into the modern apes: the chimpanzees, gorillas, orangutans, and gibbons. The other group became terrestrially based bipedalists: the family of hominids.
Although the details of hominid evolution are not definitively established, it appears that modern human beings, *H. sapiens sapiens*, evolved from *H. erectus* in Africa and moved at the Lower Pleistocene, about a million years ago, via the Rift Valley and the Jordan Valley to Asia and from there, also to Europe. Some forty thousand years ago sapients appeared in Europe, probably co-inhabiting the continent with *H. neanderthalis*. The latter disappeared around thirty thousand years ago, making *sapiens sapiens* the sole survivor of the hominid branch.
With *sapiens sapiens* evolution shifted from the biological to the sociocultural dimensions. Here it is not the genetic structure that mutates, but the dominant civilization: how people are organized, what ideas and values they entertain, and how they see themselves and the world around them. Mutations in society are all-encompassing, involving every segment and every aspect. They are shifts in civilization: shifts that are "macro." Across numerous hills and valleys, and occasional abrupt leaps, these Macroshifts drive toward the progressive integration of different peoples, enterprises, economies, societies, and cultures in systems of larger and larger dimensions.

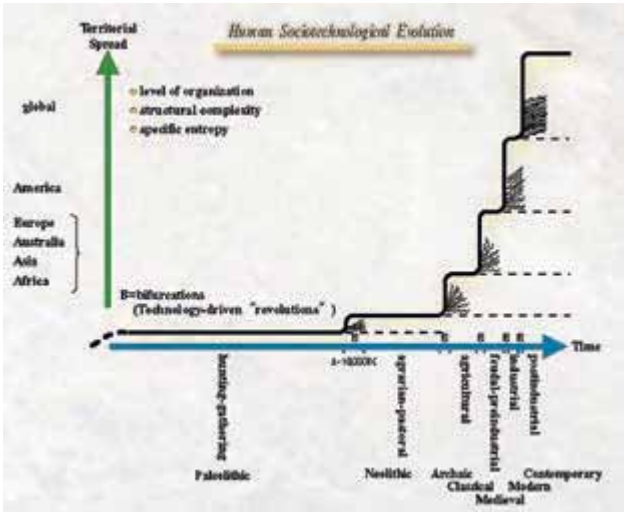

Fig. 4: The path of human socio-cultural and socio-technological evolution

The evolution of human groups in intercommunicating kinship or social structure-based communities is described in the chronicles of history. This is a complex process, for human beings are not simply the passive subjects of evolution, but are active (even if usually not voluntary and conscious) agents that influence its unfolding.

Nevertheless, even if they do not will it, or even know it, the societies formed by human beings undergo an evolutionary process that is analogous to that which occurs in biological nature. In history, too, bifurcations intersperse comparatively stable periods and lead to systems that are more and more complex, and are further and further from inert states of entropy and thermodynamic equilibrium. The evolution of human societies has been driven by the innovations that periodically destabilize the existing systems. Major innovations have been rendered possible by *sapiens'* capacious cranium, harboring a brain of some 1,350 cm^3. This enabled our forebears to develop an expressive and then a symbolic language, conceptual thinking, advanced tool use, and group behavior based on the cooperative use of progressively more sophisticated technologies. At first, societal evolution was slow: Paleolithic Stone Age societies were highly enduring, with a low level of innovation and great stability. However, the first major innovation that proceeded the major bifurcation of the Neolithic revolution in the Levant was by the intentional use of fire as the first extrasomatic energy source of *Homo erectus* in the Lower Pleistocene, about 800 000 years ago. This triggered the first, long lasting bifurcation, intensified by the Neanderthals and the first groups of *H. sapiens*. The bifurcation gradually transformed the pristine forest landscape into a sub- and semi-natural, relatively open landscape in Middle Pleistocene about 100 000 years ago. This was followed in the last Pleistocene stages, about 14 to 10 000 years before our time by a second bifurcation, induced by more advanced hunting and food collecting technologies. In the Levant, these were applied on Mt. Carmel by *H. sapiens* sapiens Natufians. Presumably, their intensive fire-induced vegetation management created more open, proto-agricultural "cultural" landscapes, richer in grasses with edible seeds, including the progenitors of wheat and barley. This led to the domestication of cereals and thereby trigged the principal Neolithic bifurcation of the advent of agriculture.

To support these contentions, NAVEH & CARMEL (2004) referred to the striking ethno-ecological equivalence between the Mt. Carmel Natufians and Californian Coastal Indian tribes, such as the Esselen, the Salinan and the Chumash before their contact with the Spanish missionaries. In comparable climate and vegetation conditions they used controlled burning as a major management tool to increase forage for people and for game, and especially for ungulates.

The first major innovation that rocked these societies was the domestication of plants and animals around ten thousand years before our time: the "Neolithic Revolution." Together with the continued use of fire as a major pastoral management tool it transformed these hunter-gatherers into settled pastoralists, and then into agriculturists. Then, and thenceforth, bifurcations were triggered by advances in the technologies devised by human groups. Technological innovations included the invention of the wheel, the design of progressively more sophisticated tools, and the invention of more and more powerful devices for extending the power of human muscle and the human brain. Such innovations enabled humans to live in larger and larger communities, with progressively greater social differentiation and divisions of labor.

Following the early discovery of how to ignite, conserve, and transport fire, the paramount innovation was pastoralism and the early forms of agriculture. Subsequent innovations – including the invention of the alphabet and the number system, the means of communication over vaster distances, and the stratification of societies from the tribal circle of elders to the hierarchically organized state – transformed groups of Neolithic pastoral-agrarian communities into the vast archaic empires of Babylonia, Egypt, India, and China. Less than four thousand years ago at the rim of the Mediterranean there was another major bifurcation: in classical Greece nature philosophers pioneered a societal mutation that replaced mythical concepts with theories based on observation and elaborated by reasoning. Greco-Roman civilization entered the scene of history. The pre-Socratic philosophers evolved the "heroic mind," present in Homer and the early epics, into the visionary and the theoretical mind, and then the rational mind epitomized by Plato and Aristotle. Logos became the central concept: it was at the heart of philosophy as well as of religion. Together with metron, the concept of quantitative measurement it provided Western civilization with the rational foundation upon which it was to build for nearly two and a half thousand years.

After the fall of the Western Empire of Rome and the founding of the Byzantine Empire in 476 C.E., a further shift occurred in the development of European societies. The rise of Christianity modified the classical culture of Greece. The medieval belief system added to the classical concepts a divine source: the world's creator and prime mover, as well as ultimate judge. Reason came to be embodied in the Holy Trinity and incarnated in man, God's creation. This belief system, whose principal elements were elaborated by St. Augustine and Thomas Aquinas, was dominant in European civilization until the advent of the modern age.

The rationality of the Greeks, borrowed and elaborated by the Romans, was conserved in medieval fiefdoms and princedoms, notwithstanding the addition of Christian elements. It found expression in the creation and use of mechanical devices such as clocks, windmills, watermills, animal-drawn agricultural implements, and horse-drawn carriages.

A further shift occurred in the sixteenth and seventeenth centuries. Although medieval Europe's culture was otherworldly and Christian, in everyday practice it was mechanically colored; it embraced the concept elaborated by Giordano Bruno and Galileo Galilei: the world as a giant machine. This concept, underpinned by new scientific discoveries and wedded with traditional handicrafts, led to an entire series of technological innovations. These included the harnessing of the power of steam and later oil, and the invention of mass production for mass markets. Europe, followed shortly by America, entered the industrial age.

Thanks to an accelerating series of ever more powerful technological innovations *sapiens* became the dominant species on the planet. But this reign is not assured. In its present form, industrial civilization is not sustainable. In the opening years of the twenty-first century the industrial age is shifting into a post-industrial age, impelled by the "second industrial revolution" – a revolution hallmarked by the advent of the technologies of information and communication. These technologies are more powerful than the steam and fossil fuel-based technologies of the first industrial revolution, and the "revolutions" they catalyze are unfolding much faster than the first industrial revolution: in a matter of years instead of decades or centuries. Ultimately the evolutionary dynamic of society builds toward a point of bifurcation, the critical phase at which society's evolutionary path is rapidly decided. As in nature, bifurcations in society are triggered by instabilities that are beyond the ability of the system to overcome: this is the true meaning of "unsustainability." The status quo becomes untenable, and the system either comes up with new ways of maintaining itself, or it goes under.

Breakdown or breakthrough

In the past the evolutionary build-up of structure and complexity was local, national, or regional. Today it is global. Humanity's socio-cultural evolution has reached the dimensions of the planet. Today we are approaching the limits of sustainability in our globalized system – the status quo is no longer tenable. One or another of the available alternative paths of systems development must be entered upon. The alternatives are wide-ranging. There is a distinct possibility that the next phase will be a phase of breakdown, involving growing stress, conflict, and chaos. But there is also a realistic possibility that society will enter a path leading toward sustainability and peace. The scenario of breakdown involves a series of increasing stresses, leading ultimately to global chaos. By the year 2020 wars fought with conventional and non-conventional weapons escalate to the global level; the international economic and financial system is in chaos; political relations among states break down; anarchy and destruction become generalized.

The alternative scenario of breakthrough calls for a major transformation in all aspects and dimensions of society. This would not be unprecedented in the annals of history. Systemic transformation is part of a process of socio-cultural evolution that began with the mythic civilizations of the Stone Age, continued with the theocratic civilizations of the archaic empires, and shifted to the civilizations based on human reasoning innovated by the ancient Greeks. This "Logos-civilization" survives to this day, albeit with the mixture of spiritual and theocratic elements. At present its reign is drawing to a close: the short-term rationality underlying its dominant form of produces more negative social, economic, and ecological side-effects than positive achievements. The time has come for a further civilizational shift: from the civilization of Logos to a civilization that perceives and embraces all aspects and dimensions of society in the context of its life-sustaining environment: the civilization of Holos.

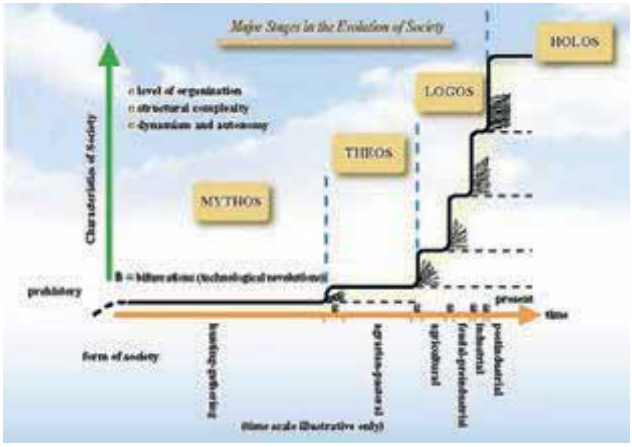

Fig. 5: The major civilizational-shifts in history, leading from the mythology-based civilizations of antiquity through the theocratic civilizations of the classical empires, to the Logos-inspired rationality-based civilization initiated by the Greeks – and then to the current shift toward an integral planetary civilization based on a holistic concept of the human being and the biosphere.

The shift to Holos-civilization has become necessary because in its present form the human/nature system on this planet, and including its landscapes, has become critically unsustainable. Concern with just some of its elements to the exclusion or neglect of others would lead to growing instability, and ultimately to breakdown. The holism required for a sustainable civilization is not a mysterious metaphysical quality. It is the adoption of the systemic approach without which no complex system can be safely and enduringly managed.

The cultural factor on the path to Holos-civilization

The safest and most effective path toward a planetary Holos-civilization is a cultural path: the path of adopting adapted values and behaviors. These need to emerge in a critical mass within civil society; for in the absence of such a cultural shift political and business leaders remain powerless to effect the necessary changes – the former for lack of popular support, and the latter for lack of corresponding demand in the marketplace.

The requirement for a cultural movement that would be capable of producing motivation for heading toward Holos-civilization is not utopian. In many parts of the world a variety of culture is surfacing that could be the harbinger of a civilizational transformation. In this culture people are re-thinking their preferences, priorities, values, and behaviors, shifting from consumption based on quantity toward selectivity in view of quality defined by environmental friendliness, sustainability, and the ethics of production and use. Lifestyles hallmarked by matter and energy wasteful ostentation are shifting toward modes of living marked by voluntary simplicity and the search for a new morality and harmony with nature.

The people who join the new cultural movements are united by the aspiration to live a more simple, healthy, natural, and responsible life. They are appalled by what they see as the heartless impersonality and mindless destructiveness of mainline society. The rise of inner-city deprivation and violence, the drift toward anarchy and ethnic intolerance, the impotence of police and military measures to cope with it, the dissolution of the social contract between society and worker, and the rise of unemployment and homelessness prompt them to alter their thinking and their acting.

These changes in values and behaviors, although they are generally dismissed or underestimated, are rapid and revolutionary. For the present they are occurring at the margins of civil society, where a number of grassroots movements are opting out of the mainstream and are reforming themselves. Their members try to rethink the beliefs, values, and life ways that dominate their society, and adopt alternative patterns of personal and social behavior. A hopeful culture is growing rapidly also in the United States, at the heart of the industrialized world. This is the finding of a series of opinion surveys carried out recently by organizations and individuals keen on tracing the evolution of the thinking and acting of Americans. The factor that identifies the culture that researcher PAUL RAY called "cultural creatives" is less what their members preach than what they practice, for they seldom attempt to convert others, preferring to be concerned with their own personal growth. Their behavior, especially their lifestyle choices, differentiates them from the mainstream.

The common denominator of values and lifestyles among the cultural creatives is holism. This comes to the fore in their preference for natural whole foods, holistic health care, holistic inner experience, whole system information, and holistic balance between work and play and consumption and inner growth. They view themselves as synthesizers and healers, not just on the personal level but also on the community and the national levels, even on the planetary level.

Although the new culture at the margins of society is growing, its members are not well organized and the culture as a whole lacks cohesion. The cultural creatives do not yet possess the political, social, and economic weight to make them into a significant agent of societal transformation. If transformation of the required kind were to get under way, mainstream society would have to enter the scene, with more adapted values and priorities. But for the present, most people in the mainstream are disoriented and disheartened. They find themselves in a rat-race for economic survival in a world where jobs become ever scarcer and finding employment beyond middle age is nearly impossible. Those who pose deeper questions find that they are surrounded by a spiritual, moral, and intellectual vacuum. There are no meaningful answers to questions such as "Who am I?" and "What am I living for?" The consequences include a continuing rise in the popularity of mystical teachings, and an explosion of religious fundamentalism.

Orientation from the new sciences

There are elements of hope illuminating the seeming darkness. The search for meaning and wisdom has gone beyond the confines of the established world. As former Czech President VACLAV HAVEL said, "The authority of a world democratic order simply cannot be built on anything else but the revitalized authority of the universe." A new civilization, capable of orienting people and providing the foundations for peace and cooperation can only be built when the "authority of the universe" informs the authority of the institutions by which people govern themselves in democratic societies. That more and more people are actively seeking a higher authority to conduct their affairs, looking beyond the dominant rationality of their society, means that a window may be opening for the motivation to enter on the path to a planetary Holos-civilization.

Science is the best source we possess for discovering the authority of the universe. It is not only the fountainhead of the new technologies that are shaping our lives and everything around us, but also the basis for a trustworthy view of the world. Science could help people adopt timely values and attitudes and even a suitable morality. However, science does not yet fulfill its transformation-facilitating potentials in society. People fail to look to science for guidance because of the separation of science from society, and an outdated views of what science truly is. The mainstream tends to believe that science is limited to observation, and their measurement and computation. In fact, science is far more: it is part of the perennial human quest for making sense of the world. It is a search for meaning along with religion, art, and literature. The difference between these branches of culture and human endeavor is not in the end they seek, but in the method they adopt for reaching that end. Science uses rational thinking in analyzing and interpreting what experience and experiment discloses, while religion combines such thinking with an element of unquestioning faith, and art and literature combine it with aesthetic elements.

The current belief about science is a carry-over from the kind of science that had dominated most of the Modern Age. "Classical" science derived its view of the world from the theories of Galileo, Kepler, Newton, and Descartes – the world as a mindless, soulless domain of inert matter, blindly obeying the universal laws of motion and interaction. At the cutting edge of the new sciences the world is not seen as a machine that can be manipulated at will. It turns out to be very different from a simple world where things behave as solid material objects should behave and are either here or there and not in many places at once. Nor is the effect of one thing necessarily limited to just one or a few other things. True, such conditions hold in our immediate surroundings, but they turn out to be limited to certain orders of size and magnitude, and certain dimensions of speed and distance. Beyond these dimensions things become more and more strange.

It is with good reason that a widely discussed film asked, "What the bleep do we know?" and suggested that it is our consciousness that creates reality. However, even if the world is surprising in light of science's new concepts, it is nonetheless comprehensible. The universe turns out to be meaningful; indeed, more meaningful than the mechanistic world where inert matter moves impersonally against a background of passive space. The whole world proves to be harmonious systems where all things interact together create a

THE NEW WORLD VIEW

	The Modern View	The Emerging World-View
Physical World	Atomisitc, fragmented Objects are independentand free-standing People are individual and discrete	Holisitc; interconnected Objects and people are interwoven into a community
Physical processes	Materialistic; deterministic, mechanisitc	Organic; interactive, holistic
Organic function	Discret and separable; parts are exchangeable	Interwoven and interdependent; parts are not interchangeable or exchangeable
Social ethos	Technology oriented; goods based	Communication oriented; service based
Social progress	Consumptiom dependent; conversion of resources	Adaption oriented, service based
Economics	Competetion and profit driven; exploitative, interventionist	Cooperative and information driven; complementray, intergrationist
Humankind	Mastery over nature; Anthropocentric	Integrated into nature; Gaiacentric
Culture	Eurocentric; colonial	Pluralistic

Tab. 1: Some contrasting features of the typical "modern" view – inspired by Newtonian mechanistic-reductionist science – and the emerging "systemic" view based on the holistic concepts derived from the latest developments in the sciences.

coherent whole. This is not a mechanical aggregate, for it is not readily decomposable to its parts. It is a system: an integral whole. The findings that ground the new worldview of science come from almost all of the empirical disciplines – from physics, cosmology, the life sciences, and even consciousness research. Although the specifics of the phenomena on which they focus differ in detail, they have a common thrust. They speak of interaction that creates interconnection and produces multifaceted coherence. The hallmark of a system of such coherence is that its parts are correlated in such a way that what happens to one part also happens to the other parts – hence it happens to the system as a whole. The system responds to the rest of the world as a whole, maintains itself as a whole, and changes and evolves as a whole.

Wholeness and coherence can also function as basic criteria of a more adapted morality. Given the overall trend toward wholeness and coherence in nature, we have sound reasons to consider actions that promote coherence and wholeness as good, and actions that hinder them as evil. Wholeness in us signifies the integral functioning of our organism: it means health. And wholeness around us means a healthy social community, living in a healthy landscape; an integral ecological milieu.

The new sciences tell us that nature is a whole, and so is the biosphere; only human beings are a major factor of fragmentation and incoherence. This was not always the case: traditional societies respected the integrity of nature and, in times past, even the cosmic laws they believed govern the universe. The fragmentation and incoherence we have wrought in the modern world is a relatively recent unintended evil. When we realize it for what it is, we shall overcome it: the current discovery that we are connected to one another and to nature furnishes motivation for it.

The new sciences could be effective sources of wisdom in society. They could inspire greater solidarity in the human world, and greater concern with and care for nature. They confirm that our fleeting impressions and intuitions of oneness are not figments of the imagination but have roots in the reality of the universe. We are indeed one with each other, with the living world, and with the universe at large. Our individual actions, and even our thoughts and intentions, affect other people around us, and are affected in turn by other people. This makes us part of a network of connection and wholeness. With this realization we could become part of the solution rather than remaining part of the problem. We could become moral agents seeking wholeness in ourselves as well as in our environment.

Conclusions

The realization that we can become part of a biospheric network of connection and wholeness through our landscapes, viewed as the concrete space-time defined ordered wholes of our Total Human Ecosystem, is of greatest relevance for everyone concerned with landscapes in the broadest sense: scientists, professionals and entrepreneurs. They could become conscious architects of a sustainable planetary civilization, ensuring that the "hard" instrumental and "soft" non-instrumental life supporting and enhancing functions of the landscapes of our total Human Ecosystem are coherent. For this reason we need to promote the establishment of new, better-balanced complementary relations between healthier, more livable and attractive urban-industrial techno-sphere landscapes and their "hinterland" of viable and diverse natural and semi-natural biosphere landscapes, as well as their productive agricultural forms. This requires the restoration of degraded uplands, the revitalization of wetlands, rivers, lakes and their embankments, the holistic and dynamic conservation management of nature reserves and parks, and the creation of living corridors and biosphere islands as parks in urban landscapes.

These tasks cannot be achieved merely by piecemeal, ecological, technological, political, and economical means. Success requires a far-reaching mind-shift from a civilization based on the rationality of Logos to the holistic mindset of Holos. This means adopting transdisciplinary systems thinking, transcending and crossing disciplines and professions, including the spheres of scientific, cultural, spiritual and ethical values, and joining them together to bring about a planet-wide sustainability revolution.

Because of the chaotic dynamics of bifurcating complex systems we must realize that we cannot predict the future simply by extrapolating past "trends" into the future, whether of our economy, our society, or our landscapes. But we can take part in creating the future by translating our visions and research data into actions, realizing that what we do today shapes the world of tomorrow. This should be accepted as one of the major challenges for the teaching, research, and public activities of the European IALE landscape association. The IALE needs to work together with all moral citizens of this planet, people who are concerned with, and dedicated to, the sustainability of all life on Earth.

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Topic 1

Ecosystem Services

The concept of ecocities and solarCity Linz, Austria, as example for urban ecological development

Jürgen BREUSTE

Fig. 1: The ecocity solarCity Linz, model photo of the first settlement area with integrated green spaces (TREBERSPURG & STADT LINZ 2008)

Zusammenfassung

Das Konzept der Ökostadt wird momentan auf verschiedenen Ebenen getestet und neu entwickelt. Es wird ganz oder teilweise in vielen in der Planung oder im Bau befindlichen Ökostädten weltweit umgesetzt. Diese Städte oder Stadtteile können Beispiele für eine neue nachhaltige Stadtgestaltung werden.

Eine Ökostadt ist eine ökologisch gesunde Stadt. Eine Ökostadt ist eine Stadt, die Umweltbelastungen verringert, Lebensbedingungen verbessert und die Verwirklichung einer nachhaltigen Entwicklung unterstützt, indem eine umfassende Planung sowie ein effizientes Flächen- und Ressourcenmanagement das städtische System nachhaltig verbessern und Umweltverbesserungsmaßnahmen umsetzt (GORDON 1990).

Die Entwicklung neuer Siedlungen ermöglicht, stets den neuesten Stand der Technik, Architektur, Planung und Design zu integrieren. Ehrgeizige moderne Planungen werden immer versuchen, ökologische Kriterien in der Planungen zu berücksichtigen. Solche neuen Städte oder Stadtteile werden "ökologische Städte" oder "Ökostädte" genannt. Am Beispiel der Öko-Stadt solarCity Linz wird untersucht, welche ökologischen Kriterien bezüglich Bau und Design beachtet wurden. Zudem wird eine Bewertung auf Basis allgemeiner ökologischen Kriterien durchgeführt, um die tatsächliche ökologische Zielerreichung der Ökostadt zu evaluieren.

Schlüsselwörter: Ökostadt, nachhaltige Stadtgestaltung, nachhaltige Stadtentwicklung, solarCity Linz

Abstract

The ecocity concept is actually in proofed and developed new on different scales. It is implemented completely or partially in many ecocities worldwide which are in planning and in built. They can be examples for a new sustainable urban design.

An ecocity is an ecologically healthy city. An ecocity is a city that decreases environmental stress, improves living conditions and helps in achieving sustainable development through a comprehensive urban improvement system involving planning and management of land and its resources and implementation of environmental improvement measures (GORDON 1990).

The development of new settlements always allows the integration of the state of the art in architecture, planning and design. Ambitious modern planning will always try to use ecological planning criteria. Such new cities or districts are often called "Ecological Cities" or "ecocities". On the example of the eco-city solarCity Linz it will be showed which ecological principles had been used in building and design and an evaluation of the general ecological criteria and its implementation allows clearly estimating the ecological content of the ecocity.

Keywords: ecocity, sustainable urban design, sustainable urban development, solarCity Linz

1. The ecocity concept

1.1 What is an ecocity?

An ecocity is an ecologically healthy human settlement modelled on the self-sustaining resilient structure and function of natural ecosystems and living organisms. It is an entity that includes its inhabitants and their ecological impacts. An ecocity is a subsystem of the ecosystems of which it is part – of its watershed, and bioregion (ECOCITYBUILDERS 2011).

An ecocity is a city that decreases environmental stress, improves living conditions and helps in achieving sustainable development through a comprehensive urban improvement system involving planning and management of land and its resources and implementation of environmental improvement measures (GORDON 1990, 15ff.).

An ecocity must enable people to live in balance with nature and achieve sustainable development. People oriented ecocity development requires the comprehensive understanding of complex interactions between environmental, economic, political and sociocultural factors based on ecological principles (RAVETZ 2000, 3ff.; ECOCITYBUILDERS 2011).

Ecocity development integrates administration, ecologically efficient industry, people's needs and aspirations, harmonious culture, and landscapes where nature, agriculture and the built environment are functionally integrated (BARTON 2000, 10ff.).

The ecocity concept also starts on the neighbourhood-scale, the city-district level (Ecodistrict). Ecodistricts allow learning about district-scale sustainability best practices in finance, governance and policy, district energy and water utilities, net-zero buildings, smart grid, networked transportation, urban ecosystem services, zero waste, and human behaviour.

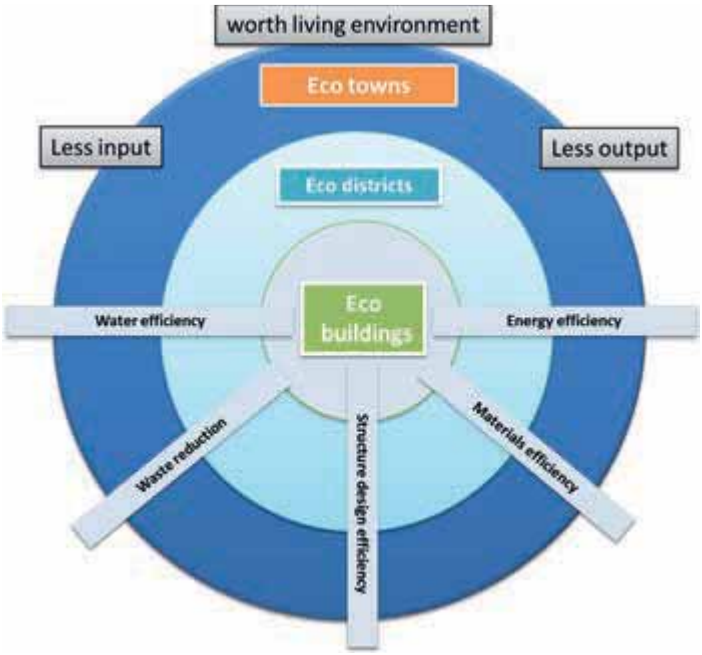

Fig. 2: Scales of the ecocity concept (BREUSTE, unpublished)

1.2 What does ecocity development require?

Ecocities can be characterized by some essential elements:

• Ecological security – clean air, and safe, reliable water supplies, food, healthy housing and workplaces, municipal services and protection against disasters for all people.

• Ecological sanitation – efficient, cost-effective eco-engineering for treating and recycling human excreta, grey water, and all wastes.

• Ecological industrial metabolism – resource conservation and environmental protection through industrial transition, emphasizing materials re-use, life-cycle production, renewable energy, efficient transportation, and meeting human needs.

• Ecological-landscape integrity – arrange built structures, open spaces such as parks and plazas, connectors such as streets and bridges, and natural features such as waterways and ridgelines, to maximize accessibility of the city for all citizens while conserving energy and resources and alleviating such problems as automobile accidents, air pollution, hydrological deterioration, heat island effects and global warming.

• Ecological awareness – help people understand their place in nature, cultural identity, responsibility for the environment, and help them change their consumption behaviour and enhance their ability to contribute to maintaining high quality urban ecosystems (GORDON 1990, 38ff., BREUSTE & RIEPEL 2008).

1.3 What actions for ecocities are needed?

To target on an ecocity a set of actions can be inluded:

• Provide safe shelter, water, sanitation, security of tenure and food security for all citizens.

• Minimize the loss of rural land by all effective measures, including regional urban and peri-urban ecological planning.

• Identify ecologically sensitive areas and identify areas where nature, agriculture and the built environment should be restored.

• Design cities for energy conservation, renewable energy uses and the reduction, re-use and recycling of materials.

• Build cities for safe pedestrian and non-motorized transport use with efficient public transportation.

• Provide strong economic incentives to businesses for ecocity building and rebuilding.

• Provide adequate, accessible education and training programs to increase community participation and awareness of ecocity design and management.

• Create a government agency at each level – city, regional and national – to craft and execute policy to build the ecocity. The agency could coordinate and monitor functions such as transportation, energy; water and land use in holistic planning and management, and facilitate projects and plans.

• Encourage and initiate international, intercity and community-to-community cooperation to share experiences, lessons and resources in ecocity development and promote ecocity practice in developing and developed countries (TJALLINGII 1995, 10ff.; RAVETZ 2000, 263ff.; BREUSTE & RIEPEL 2008).

Selected Eco-City Projects in China

Projekt:	Foreign Partner	Status
Beijing Mentougou Eco-City	Finnland	Signing of Sino-Finland Ecological Valley in May 2010. currently in the planning phase
Beijing Changxing International Eco-City	England (Arup)	Planning phase
Tangshan Caofeidian International Eco-City	Schweden (Sweco)	Start of the construction in September 2008; Start in March 2010 with 10 big projects (Total investment: 11,6 Billion RMB)
Shanghai Chongming Dongtan Eco-City	England (Arup)	MoU-Signing in January 2008; Start in the second part of the year 2008; currently not in progress
Suzhou Western Eco-City	-	Construction began in February 2010
Langfang Wanzhuang Eco-City	-	Construction began in Jun 2008
Wuxi National Low-Carbon Eco City Demonstration Zone, Wuxi Sino Swedish Low-Carbon Eco-city	Schweden (Tengbom)	Construction began in July 2010
Tianjin Sino-Singapone International Eco-City	Singapur (Keppel)	Construction began in 2008. Until the end 2009: realised investment 8,0 Billion . RMB, The total planned investment by the end of 2010: 17,0 Billion RMB
Zhangjiagang Sino-Danmark Ecological Science & Technology Park	Dänemark	Planning phase
Hubei Xianning Eco-City	Deutschland (Siemens)	Signing the „Strategic Partnership Fremework Agreement" in October 2009; currently in the planning phase

Tab. 1: Selected ecocity projects in China (2011)

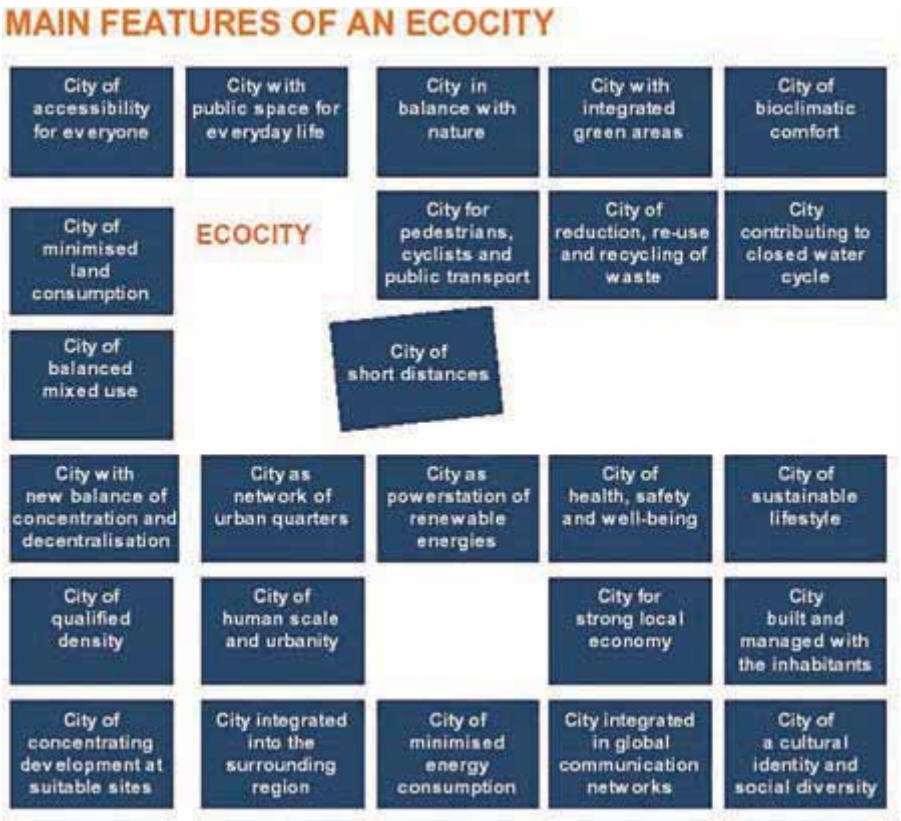

Fig. 3: Main features of an ecocity (ARKITEKTUR 2005, quotet by BREUSTE & RIEPEL 2008)

Actually several ecocities are in planning or in built. Only 170 Chinese cities aim to become sustainable or ecocities. 40 ecocities are in China actually in planning or in process (see tab. 1).

2. The ecocity solarCity Linz, Austria

2.1 The planning

The project initiative for an ecocity in the scale of an ecodistrict began in 1990, when Linz, the capital of Upper Austria, introduced a policy of low-energy social housing. At that time 12,000 people were looking for homes in the Linz area. Simultaneously awareness was increasing that high consumption of fossil energy was a significant contributor to the greenhouse effect. Both facts provided decisive arguments for an ecological and sustainable housing scheme. It was decided to construct a major development on low energy lines with a minimised consumption of fossil fuels. So the idea for building a "solarCity" was born. Many planning issues were raised by this objective. One was the supply of energy to houses; another was the design of the settlement in a manner that minimised transport requirements.

The selected development area in the south of Linz next to the village Pichling is characterised by small lakes and by the Traun-Danube floodplains, one of the largest, continuous, natural biotope landscapes in Upper Austria (MAGISTRAT LINZ 2004). This required careful planning, to provide a sensitive integration of a future housing estate into the existing landscape surroundings.

The master plan for the Linz-Pichling residential district (ecocity solarCity) was finished in 1992. This master plan makes provision for between 5,000 and 6,000 homes together with the entire infrastructure servicing the area. This concentrates development in nodes along a tram route that links in to a local railway station and the city centre.

In 1993, the Linz City Council took the proposal further by commissioning a study to demonstrate how the homes in Pichling could serve as an example of low energy living. The following year the City of Linz, together with four of the most important non-profit-making housing associations in Linz, agreed to finance the planning and development of 630 low energy homes in Pichling. Eight non-profit-making building organisations joined the development in 1995. Therefore current plans propose 1,317 on a site of around 32 hectares forming one of the nodes proposed in the Master Plan. The City of Linz commissioned world-class architects Norman Foster, and Richard Rogers from England and Thomas Herzog from Germany to plan the first 630 homes.

The EU General Directorate XII for Research and Development subsidised the planning work with a contribution of EURO 600,000 (EIBLMAYR 2004, 44). The planned school, kindergarten and community commercial centre are models of resource-saving solar architecture, with special provision for bio-climatic design to reduce expensive air conditioning.

The project has been led by an interdisciplinary group working according to "systemic" principles working with a project advisory board drawn from the public sector, business and the community. Considerable effort has been allocated developing a project identity and project marketing. Awards from the European Union and the 100 Best Practices Programme have been prominently publicised as part of the development of a marketable image.

The construction was finished in 2005 in its first part on 35 ha ground with 2,942 residents live in 1,293 apartments. Each of the 12 housing associations involved in this project have finished their buildings by 2006 (BREUSTE & RIEPEL 2007).

2.2 The actual status and key principles of sustainable framework

The leading architect TREBERSPURG wrote 2008

"The solarcity is a model for a sustainable future. To be more precise, it is a complex, conscientiously planned, constructed, used an inhabited urban model which at all levels and in all aspects represents the latest state of development" (TREBERSPURG & STADT LINZ 2008, 9f.).

This had been proved by BREUSTE & RIEPEL 2007. Beside the several very positive results this statement could only be partly confirmed (see 2.3).

The name solarCity implies an extensive utilization of solar energy according to the European Solar Charta in architecture and town planning, installed in 1996. The term "solar" is to be understood in a wider sense and includes functions as follows:

• designing residential areas and individual buildings according to the principles of solar architecture,

• utilization of active and passive solar energy,

• direct use of the sun to increase welfare of people inside as well as outside of buildings,

• general utilization of renewable energies,

• emphasizing the aspects nature and leisure,

• social integration, social warmth, social energy and

• new approaches in general for a lasting development of residential areas (MAGISTRAT LINZ 2004).

The city of Linz set up criteria for preserving the basic ideas of the solarCity. Low-energy construction (with an energy factor not exceeding the maximum of 40 kW/m²a) was compulsory, as well as the use of solar panels for creating hot water. Furthermore, the city of Linz invested approx. EUR 73 million into the exemplary and complete infrastructure.

Due to its costs, solar electricity generation was only applied in individual projects of the solar city's infrastructural buildings. Solar hot water production, on the other hand, took place ubiquitously and reached an average of 47-48% of WW demand. The buildings normally run at a level much lower than recommended. Some require a thermal heat value of only 28 kWh/m²a, others do not even exceed 21 kWh/m²a (WAECHTER-BÖHM 2004, 33).

A tramway line of about 2.3 km connects the city center of Linz since September 2004 with the solarCity. However, the distant to Linz and who to bridge it is the weakest point of the ecocity.

Most part of the "Traun-Donau wetlands" is legally protected. This unique nature reserve remains protected and at the same time it is meant to constitute a nature experience for the solarCity's residents. Wooden footbridges for walks are installed in the alluvial forests. Info-checkpoints make the offer complete. The connection of nature protection and urban development is a very important and actual challenge for urban development. SolarCity is an example for a project in which this was not only included in the design of the city and its surroundings, but in which, beyond that, nature protection and recreation were excellently integrated so that both complement each other.

The solarCity Pichling is not only regarded a positive example for a well-organized town planning project because of its architecture, but it also sets a benchmark by simultaneously completing the overall project and the infrastructure necessary for the residents. It is the perfect example for a "smooth" town expansion in the open countryside, too. That is because way back in the beginning of the project ecological aspects and social demands were connected with each other (WAECHTER-BÖHM 2004, 33).

Yet one must not forget that a project in this dimension involves a high degree of complexity. The development of the project turned out to be a learning process for all participants. New technologies, knowledge transfer and setting up an extensive communication network were new and unfamiliar to them. When building the solar City, the emphasis clearly lay on the energy supply concept. Besides thermal solar panels and photovoltaic, also wind and biomass were taken into account in the energy concept.

All in all, the "solarCity project" was awarded several prizes. In 1998, for instance, the United Nations granted them the "Best Practice" award in the course of a competition for the enhancement of the environment. In 1999, the solarCity received the "Environmental Award 2001" from the "Earth Society Foundation", an NGO group (non-governmental organization) located in New York. In 2000, the project stood among the top five "innovative building concepts" in the competition "Haus der Zukunft" ("House of the Future"), and in 2001 it also found itself on the same position in the second international conference "business and municipality – new partnerships" in Bremen (MAGISTRAT LINZ 2004).

Fig. 4: SolarCity residential estate (Photo J. Breuste)

The designers and planners of the ecoCity list up the following in aspects of ecological development they have included for solarCity:

- Energy efficiency and sustainable energy usage,
- Recreational infrastructure and pedestrian routes,
- Open spaces and landscape as planning focus,
- Nature protection and people's contact with nature,
- Innovative building concepts,
- Management of resources,
- Social stability (ownership and rental, age groups etc.),
- Urban district management,
- Mobility management,
- Optimization and adaptation of both constructional and social standards to changing conditions,
- Sustainability - Monitoring – focusing particularly on urban development, architecture, energy management, climate protection, material management and user satisfaction and
- Adaptability of the concept to other places

2.3 Ecological evaluation of the project

It goes without saying that not all guidelines can be met in this ecocity project. Preconditions and circumstances differ enormously between evaluation subjects and project areas. However, it is striking that most criteria and guidelines that had been detected were regarded in the development concept and during the construction of the solarCity. Moreover, the guidelines are just there to give some clues for an ecological housing development project. Still, the more criteria and guidelines a project fulfils, the more ecological a residential area gets, in a sustainable sense. A large number of criteria were met in this project, the emphasis lying definitely on the energy concept and open space planning. Other criteria, such as soil, were neglected, not fulfilled or even not target at all. But the ecocity project "solarCity", with its lasting effects and organization, is undoubtedly a positive step towards a sustainability-oriented future, as far as guidelines in ecological settlement projects are concerned. On the basis of the results an arithmetic mean could be calculated. With this, an overall evaluation of the single criteria, implemented in the solarCity Linz project, can be deduced. The arithmetic mean is that point in the scale which is at a time below and above of the half of the values (ZÖFEL 1988, 43).

The grade 5 (insufficient) corresponds with the former category 1 (not implemented): 1 = excellent, 2 = good, 3 = satisfactory, 4 = sufficient, 5 = insufficient. The used (BREUSTE & RIEPEL 2007) assessment scale consists of five categories with a different hierarchy (ZÖFEL 1988: 267ff): 1 = not implemented, 2 = partly implemented, 3 = implemented, 4 = well implemented, 5 = very well implemented.

To achieve a final grading of the ecocity project solarCity Linz, the five hierarchical categories are going to be transformed into grades from 1 to 5 (VAN DER VEN 1980, 34). The arithmetic mean from all criteria was calculated to achieve this final grading and resulted in the value 3.24. This value stands for the cumulative grade "satisfactory". A comparison and assessment is more effective with the evaluation of the assessment categories and the single criteria instead of summarizing them to single number.

The ecocity solarCity was evaluated by BREUSTE & RIEPEL 2007 on its ecological criteria. This analysis is based on the evaluation of all available relevant documents, observations, inquiries and conversations with the stakeholders. It is as possible objective and proves all relevant ecological criteria.

The following criteria had been included, following KENNEDY 1984a, b and KENNEDY & KENNEDY 1998: siting and land use, open space, soil, material, indoor environmental quality, energy, traffic, waters and waste.

Assessed criteria	Assessment results
Open Space	
Use existing vegetation and landforms to moderate climate conditions and provide protection for native habitats	3
Plant native or well-adapted species	3
Use greenbelts and protected wetlands to create a continuous web of native habitats	4
Restore the native landscape	4
Open space for recreation and child's play	5
Roof gardens can be established on the flat roofs of buildings using potted trees, shrubs and plants	2
Energy	
Energy-Conscious Urban Planning	5
Energy Conservation	4
Use renewable energy sources	5
Passive Heating and Cooling	5
Insulation	3
Alternate Sources of Energy	4
Daylighting	4
Energy Efficient Equipment and Appliances	1
Traffic	
Settlements should be located around or close to public transport nodes and frequently used routes	3

Settlements should be planned around a network of pedestrian routes which encourage walking and cycling	4
Limit on-site parking	3
Use porous alternatives to traditional paving for roads and walkways and reduce street width	3
Carpooling strategies should be encouraged in addition to mass-transit use	1
Use existing vehicular transportation networks to minimize the need for new Infrastructure	2
Minimize noise disturbance	1
Water	
Use permeable surfaces	3
Collect and use harvested water	4
Collect and use rainwater	4
Design an appropriate harvesting and storage system	5
Reduce overall water use	4
Utilize greywater for nonpotable purposes	4
Use constructed wetlands	4
Treat brownwater from toilet-flushing with on-site systems	4
Use reclaimed water for purposes such as toilet-flushing	3
Waste	
Minimize use of resources - Reuse Existing Buildings	1
Minimize waste generated from construction, renovation and demolition of buildings	3
Minimize waste generated during building occupancy	4
Material	
Design for future reuse and adaptability	3
Use durable products and materials	3
Choose low-maintenance building materials	3
Buy locally produced building materials	4
Use salvaged building materials when possible	1
Minimize packaging waste	5
Indoor Environmental Quality	
Design for human comfort	5
Improve indoor air quality	4
Siting and Land Use	
Renovate older buildings	1
Create community	4
Encourage in-fill and mixed-use development	4
Minimize automobile dependence	4
Value site resources	5
Existing planted vegetation that has to remain on site needs to be protected during construction	4
Situate buildings to benefit from existing vegetation	1
Building smaller is better	3
Design for durability	3
Soil	
Minimize pavement area	1
Emphasize preservation of mature vegetated soils	1
Minimize earthwork and clearing	1
Minimize use of landscape irrigation, herbicides, pesticides, and fertilizers	1
Consider use of permeable paving materials	1
Build pedestrian surfaces with loose aggregate, wooden decks, or well-spaced paving stones	2

Tab. 2: Structuring of evaluation criteria and assessment for solarCity (BREUSTE & RIEPEL 2007)

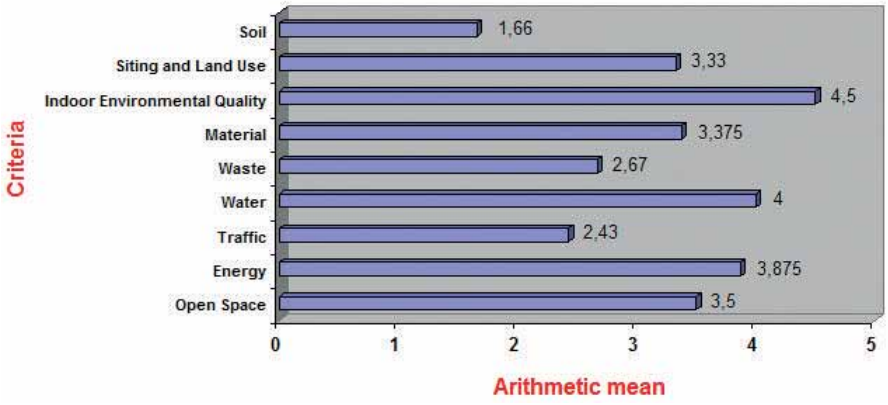

Figure 5: Validation of the single criteria (BREUSTE & RIEPEL 2007)

3. Summary

The location, gross density and form of an ecocity should be determined in conjunction with programs for energy supply and conservation technologies. Lots of studies demonstrate that the pattern of growth is more important than the amount of growth in determining the level and efficiency of resource use and traffic congestion.

On the basis of the case study solarCity the development as well as the current methods for the ecological settlement planning had been mentioned. Solarcity Linz is a good example for an ecocity. The standardisation of ecological criteria, which were already implemented in smaller ecological settelment projects, are often not sufficiently applied yet in

bigger projects, for instance in the solarCity Linz. One of the reasons for this is that there is not enough experience with such huge projects. The general conditions for the various projects are too different and the willingness to change planning to a more ecological attitude has not happened yet. It is predominantly the duty of public authorities and private planning entities, which are responsible for projects like the solarCity Linz, to consider the ecological standards in town and settlement planning in order to not keep on destroying nature.

The existing ecological standards according to a list of criteria had been implemented to the solarCity example. This list does not define the technical instruments for ecological settlement planning but set the holistic standards with simultaneous consideration of ecological aspects. Considering this list of criteria it would be possible, before starting an ecological settlement project, to develop scenarios, which, depending on different existing general conditions could show various ecological approaches and thus could lead to the ideal solution. Most important is not the technical measure, like the supplies of energy through for example wind power or biogas, but that renewable energy is used at all.

Developing such scenarios a collaboration of various scientific areas would be useful in order to develop the concept of ecocity further (BREUSTE & RIEPEL 2007, 2008).

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Integrating periurban agrarian ecosystem services into spatial planning to cope with urban pressure

Marian Simon ROJO

Zusammenfassung

Nach Corine Land Cover-Datenbanken wurden in Europa zwischen 1990 und 2000 77% der neuen bebauten Oberflächen auf früheren landwirtschaftlichen Flächen erbaut. Die Zersiedelung der Landschaft ist bei weitem noch nicht unter Kontrolle, so ist zwischen 2000 und 2006 der Anteil an bebauten Flächen stärker gewachsen als in den zehn Jahren zuvor. In Spanien, wie in den meisten Ländern, sind die Auswirkungen der Zersiedelung in den letzten Jahren besonders in den stadtnahen Gebieten und Agrarflächen zu spüren: zwischen 2000 und 2006 wurden 73% der neuen Überbauungen auf früheren landwirtschaftlichen Flächen errichtet. Dieser Beitrag untersucht durch einen Vergleich der vier Fallstudienstädte Valladolild, Montpellier, Florenz und Den Haag, ob Stadt- und Raumplanung dazu beitragen können, den städtischen Druck auf das Hinterland zu reduzieren. Der systematische Vergleich und die Analyse von erfolgreichen Ansätzen liefern einige Hinweise, wie Stadtplanung zu überdenken ist, um landwirtschaftliche Flächen zu erhalten.

Abstract

According to Corine Land Cover databases, in Europe between 1990 and 2000, 77% of new artificial surfaces were built on previous agrarian areas. Urban sprawl is far from being under control, between 2000 and 2006 new artificial land has grown in larger proportion than the decade before. In Spain, like in most countries, the impact of urban sprawl during the last decades has been especially significant in periurban agrarian spaces: between 2000 and 2006, 73% of new artificial surfaces were built on previous agrarian areas. The indirect impact of this trend has been even more relevant, as the expectations of appreciation in the value of land after new urban developments reinforce the ongoing trend of abandonment of agricultural land. In Madrid between 1980 and 2000 the loss of agricultural land due to abandonment of exploitation was 2-fold that due to transformation into urban areas.

By comparing four case studies: Valladolild, Montpellier, Florence and Den Haag, this paper explores if urban and territorial planning may contribute to reduce urban pressure on the hinterland. In spite of their diversity, these regions have in common a relative prosperity arising from their territorial endowments, though their landscapes are still under pressure. The three last ones have been working for years on mainstream concepts like multifunctional agriculture. The systematic comparison and the analysis of successful approaches provide some clues on how to reconsider urban planning in order to preserve agricultural land. The final remarks highlight the context in which public commitment, legal protection instruments and financial strategies may contribute to the goals of urban, peri-urban or regional planning about fostering agrarian ecosystem services.

1. Urban planning in a context of urban pressure and agricultural abandonment

The impact of urban sprawl that has taken place in Spain during the last decades has been especially significant on periurban agrarian spaces. According to Corine Land Cover databases, between 2000 and 2006, 73% of new artificial surfaces were built on previous agrarian areas. The indirect impact of this trend has been even more relevant, as the expectations of appreciation in the value of land after new urban developments reinforce the ongoing trend of abandonment of agricultural land. In Madrid between 1980 and 2000 the loss of agricultural land due to abandonment of exploitation was 2-fold that due to transformation into urban areas.

This paper explores the potential of integrating agrarian ecosystem services in urban planning to contribute to halt the loss of periurban agrarian land. The systematic comparison of four European cities provides some clues on how to reconsider urban planning to integrate agrarian landscapes surrounding metropolitan areas. The “ecosystem services approach” is not explicitly mentioned in the different plans analyzed. Indeed much of what happened is the result of more general cultural or institutional attitudes towards periurban agrarian land. They are part of an ever-important mainstream policy that aim to reconsider the way in which periurban agrarian areas are dealt with in urban and territorial plans, seeking out opportunities for synergies between the different ecosystem services provided by those areas.

2. Methodology of research

2.1 Selection of cases

The research focuses on Valladolid, the main city of an agrarian and relatively prosperous area, the middle stretch of River Duero in Spain. Regional’s economy is partially based on its local production, on the exploitation of endogenous resources, mainly viticulture. It is therefore an example of the sort of strategies that are being promoted in Europe in its quest to combine territorial cohesion and competitiveness in a globalized world. In this paper we review four case studies to understand how urban and territorial planning initiatives are coping with periurban areas development.

The evolution of the metropolitan area of Valladolid is compared to other European regions with historically strong agrarian linkages: Toscana, Montpellier and Zuid-Holland. In spite of their diversity, these regions have in common a relative prosperity arising from their territorial endowments, though their landscapes are still under pressure.

The selection of cases was based on a research developed by the GIAUS[1)] about "Agricultural space between the city and the countryside" (VAZQUEZ & VERDAGUER 2010). Montpellier, Tuscany and Zuid-Holland were considered "good" practices that deserved closer inspection. All three have been part of European research projects: PLUREL and GreenLink, therefore it was expected to have detailed information available online.

2.2 Context analysis

To understand the evolution of periurban agrarian ecosystems, first their spatial configuration together with the demographic evolution is analyzed. The spatial analysis is confined in each region to the hinterland within 30 km of the city (Valladolid, Firenze, Montpellier and Den Hag) and is based on the CORINE land cover database (1990, 2000 and 2006) at level 3 that provides rough but comparable information on the distribution of ecosystems. Beyond this spatial evolution, each case has been studied, applying the Context Analysis approach (de JONG 2004).

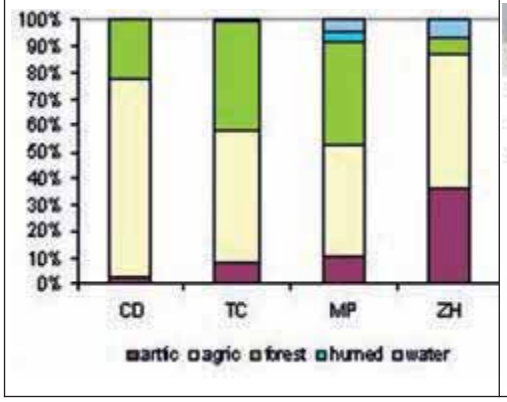
Most of the urban and territorial plans aimed to preserve periurban agriculture were implemented after the period analyzed or at its very late stages. The evolution of urban pressure on agricultural land has to be understood by considering the different cultural, economic and social conditions. The analysis of economic and cultural evolution has taken into account urban-rural relationships, local markets, short-chain production and consumption, interest groups and networks as well as value of agrarian land, social recognition, local identity and protection plans.

• **MP Montpellier Agglomération. Montpellier´s hinterland.** The city of Montpellier, within the Mediterranean region Languedoc-Rousillon, is since the 60s a pole of demographic attraction. The constant demographic growth is accompanied by a strong urban sprawl that affects municipalities at a greater distance from the city. Urban sprawl occupies territories traditionally linked to agriculture, mainly to wine production and transform landscapes and socioeconomic dynamics.

• **ZH Zuid-Holland. The Hague´s hinterland.** The area is one of the most densely urbanized areas of Europe, close to the Green Heart, a protected National Landscape since 1998. The region is still under urban pressure from artificial uses expansion and from the increasing urban demand for recreation spaces. In general this demand for leisure and recreation in the landscape is seen as an opportunity to guarantee the future viability of the agrarian landscape and there is a strategy to develop the economic assessment of rural goods and services.

3.2 The importance of agrarian and artificial land

Tab. 1: Distribution of land surfaces (%) 2000



Tab. 2: Ecological layer. Population and ecosystems distribution

Case		CD	TC	MP	ZH
Ecological layer					
Population	1.000	360	200	400	1000
Artif area/capita	m^2 /inhab	200	462	605	618
Ecosystems (2000)	km^2				
Arable land		1915	479	60	379
Vineyards		45	150	608	0
Pastures		0	16	1	430
Mixed with natural areas		138	431	245	52
Broad-leaved forests		104	766	98	32
Coniferous forests		299	70	27	2
Mixed forests		15	284	49	5
Seminatural areas		220	60	899	59

Exploitation of CLC data from European Environmental Agency
http://www.eea.europa.eu/data-and-maps, last visited June 2011

3. Case studies

3.1 Four European metropolitan areas

• **CD. Douro Valley. Valladolid and its hinterland.** The area analyzed faces the challenge of an acute polarization process. Although there is a relative prosperity, the population in the countryside is declining and increases its dependency from the main cities that concentrate growth, power and functions.

• **TC Toscana. Firenze´s hinterland.** Firenze concentrates the more dense populated areas in the region Toscana. Its hinterland is subject to the highest urban pressure. Until some decades ago, the plain, la Piana, was a rural area devoted to agriculture. Nevertheless the residential boom in the 60s, the construction of huge infrastructures like the airport or the highways and the sprawl of industry and malls have broken the traditional structure of settlements and transformed completely the landscape and their functions.

In general, the number of agricultural plots has decreased in a larger proportion than the surface; therefore there has been a process of enlargement of the average size of exploitations. The area of cultivated land has decreased in all cases but Tuscany. It is noticeable that in the Plain more than 90% of agrarian land remains cultivated (REGIONE TOSCANA 2007). There is also general trend to foster quality production and ecological agriculture.

3.3 Cultural and institutional context

It has to be highlighted that in all cases there is an increasing demand for recreation and open space activities. Connected with this demand, which is understood as an opportunity to reactivate the agrarian sector, sometimes farmers try to reorientate to multifunctional agriculture. Production of quality and – to a lesser extent – ecological agriculture are also predominant in these regions. There is altogether a general concern about shifting urban-periurban-rural Beyond these similarities, each case has its own peculiarities that are summarized below. What follows is a very brief summary of the

[1)] GIAUS: Grupo de Investigación Arquitectura, Urbanismo y Sostenibilidad. Research Group in Architecture, Urbanism and Sustainability

reports about Montpellier, Tuscany and Zuid-Holland, written for the "Agricultural space between the city and the countryside" in (VAZQUEZ & VERDAGUER 2010).

A social movement of young neo-rurals that moved from towns to the countryside seeking for a more sustainable way of living started in Tuscany some decades ago. With them new connections between urban and rural inhabitants were established, based in mutual confidence, short-chain production-consumption relationships and Solidarity Purchasing Groups. Since then, these networks have consolidated and the institutions have finally incorporated them to their strategies. By 2007 the regional government started the Filiera Corta (short-chain) project to promote local agriculture. Nowadays urban municipalities provide spaces for farmers and promote cultural activities connected to farmers' ecological products.[2)]

In Montpellier this process started later, nowadays there are some institutional projects to support local production[3)] and to promote short-chain commercialization of production. In this case, the ability of farmers unions to bring the periurban agriculture into the political agenda already for decades has to be highlighted. Different laws related to rural development have been passed and by 2005 a specific law for the development of rural areas (Loi développement des territoires ruraux) became an instrument to preserve periurban agrarian spaces and treat them favourably. SAFER, a public institution, facilitates access to land property for those collectivities that propose a project of public interest to manage an agrarian area.

In Zuid-Holland´s policies regarding agriculture, there has been a progressive shift from production to recreational activities and nature preservation. The Social and Economic Council of the Netherlands (Sociaal-Economische Raad) concluded that green (environmental) and blue (water management) services will play a decisive role for the future feasibility of farming (SER 2008). Emphasis is therefore put on Rural Good and Services approach. In fact public natural areas aimed for recreation are very expensive to upkeep and authorities are looking for more affordable alternatives, like promoting new management practices of agrarian areas to provide these recreational services (AALBERS 2009 et al.). Authorities try to foster this approach not only with regulations, but also by promoting it with subsidies for farmers providing green or blue services.

3.4 Integrating periurban agrarian ecosystems services

Cultural services of periurban agrarian ecosystems. In Tuscany, as well as in Montpellier and Zuid-Holland there is a wide recognition that farmers play an essential role in preserving the landscape. In South-Holland there is increasing interest in farming as providing social services, for education, nursery, therapy, healthcare and rehabilitation.

Provisioning services of periurban agrarian ecosystems. Tuscany and Montpellier have enhanced agricultural production of quality; wine with Denomination of Origin play an important economic role (linked to landscape preservation and tourism) also in the Douro Valley, close to Valladolid. Both in Montpellier and in Tuscany local associations (third sector) as well as authorities and universities aim to consolidate local production and short-chain relationships.

Supporting services of periurban agrarian ecosystems. In those cases where there is a commitment towards ecological agriculture, this has also positive consequences on supporting services provided by periurban agrarian systems. Some Universities, like the University of Florence are exploring possibilities to facilitate transition towards ecological agriculture.

4. Evolution 1990-2006

4.1 Urban sprawl or urban containment

In Figure 1 the same legend has been applied to represent the four cities and their hinterland within 30 km. Red areas show where new artificial areas have been developed. The graphics under the maps show the distribution of these new artificial areas in relation to the distance to the city core.

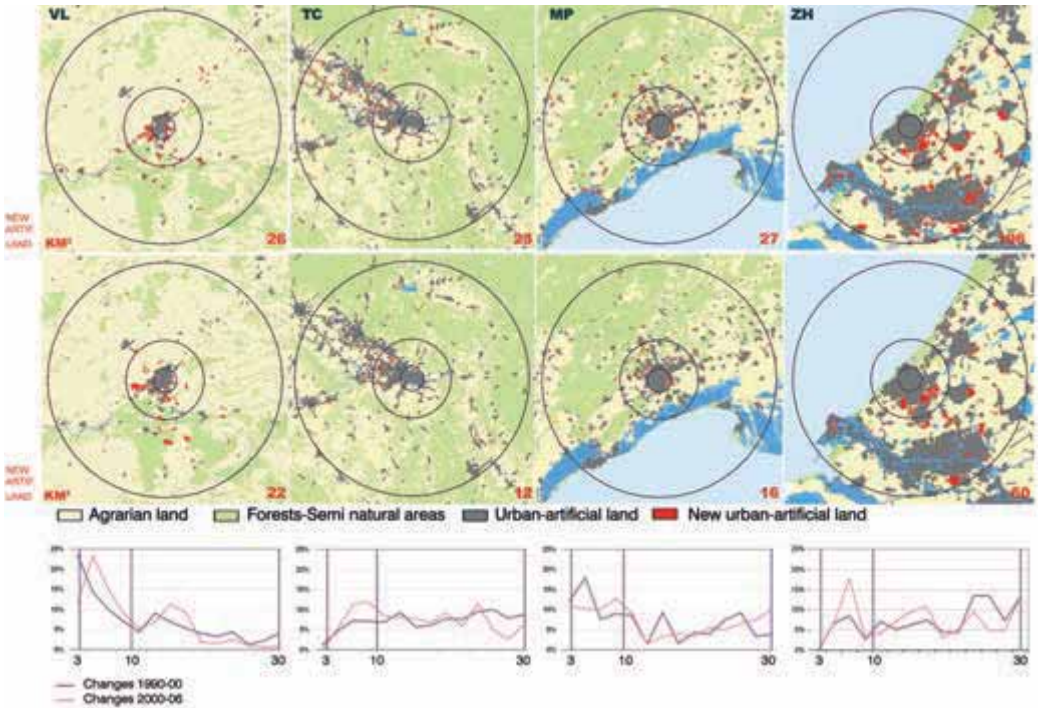


Fig. 1: Spatial temporal layer. Artificial uses: Changes 1990-2000 and 2000-2006

[2)] The project ARTE E CIBO allocates specifc spaces within museums to gastronomic cultural activities and commercialization. The project Patti di Filiera promotes agreements between producers and other sectors like restaurants, commerce or tourism.

[3)] Projects like CROC *(Compétences, Réseaux, Observatoire, Communication)* or platforms like Qualité Hérault or Bienvenué à la Ferme.

The expansion of artificial land has been especially relevant in the surroundings of The Hague, or more specifically, in the conurbation The Hague Rotterdam. Both cities exert great pressure on agricultural land. Artificial land accounted already for more than 30% of total surface by 1990, with the highest rate of m^2 of artificial land per capita (approximately 618, compared to 200 in Valladolid). The official discourse of preservation of the open space has not been translated in effective containment of urban expansion.

In Valladolid, between 1990 and 2000 artificial land increased by 37%. Its historical urban contention has disappeared, following the path of other western countries. In this case the gradient of distribution of new artificial lands is very clear from the city core to the countryside. Between 1990 and 2000 new developments concentrated mainly within a radius of 5 km and there was a minor peak at 12 km distance, where some of the secondary cities are located. This urban expansion is by no means, under control, between 2000 and 2006 it has increased by 30% and the curves of distribution are slightly displaced 2-3 km further to the centre.

In Tuscany urban expansion has been much moderated, with 27 new km^2 between 1990 and 2000 and only 12 between 2000 and 2006. Practically all new developments are located along the eastern axis: Firenze-Prato-Pistoia, in the Parco della Piana. This process was a matter of concern for different authorities that have approved different kinds of plans to preserve open space, agrarian land and traditional structures.

4.2 Shifting agricultural land

In Figure 2, changes in agricultural land between 1990 and 2000 and between 2000 and 2006 are drawn proportionally. The projection of expected changes in a business-as-usual scenario are also drawn in faded colors.

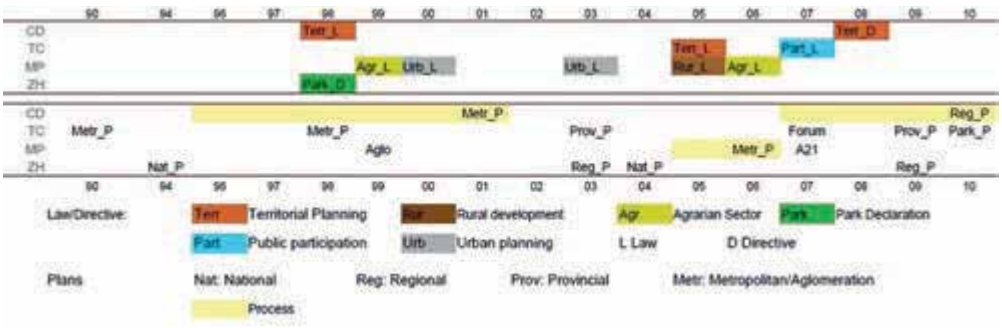
Whereas in Montpellier and Tuscany basically loss of agricultural land was the result of urbanization, in Valladolid main changes in agrarian land were due to shifting from one category of agriculture use to another (according always to CLC) and this sometimes is derived from changes in the way that mixed patterns are categorized.

Only in Montpellier and Tuscany urban pressure seems to be under control. Especially in the latter the containment of urban expansion has resulted in reducing almost by half the loss of agricultural land. On the contrary in Valladolid urban sprawl was by 2006 far from being controlled. Probably only the structural crisis, bursting by 2007, has reverted this expansive trend.

Fig. 2: Changes in agricultural land. 1990-2000 and 2000-2006 (Source of data: CLC)

4.3 Different planning approaches

Figure 3 shows the different plans and legal instruments regarding periurban spatial planning in each area.



Laws and plans. Milestones:	
CD	1998: Regional Law on Territorial Planning (Ley de Ordenación del Territorio Cas tilla y León) 2001: Metropolitan Plan. Directrices de Orde nación Territorial de Valladolid y su Entorno, DOTVa ENT 2008: Terrritorial Directive. Directrices Esenciales de Ordenación del Territorio CyL 2010: Regional Plan. Plan Regional del Valle del Duero
TC	1990: Metropolitan plan Piano strutturale area metropolitana Firenze-Prato-Pistoia 2003: Provincial plan. Piano territoriale di Coordina mento provincia de Prato. 2007: Forum. Local stakeholders create a forum for the agrarian park in Prato 2009: Regional plan. Piano Territoriale di Coordina mento Provinciale 2010: Park Plan. Master Plan Parco della Piana.
MP	1999: Agricultural Law. Loi d'Orientation Agricole with protection for agrarian areas *(Zone Agricole Protégé)* 2000: Urban planning law. Loi Solidarité et Renouvellement Urbain 2001: It is created the Aglomeration de Montpellier 2003: Loi Urbanisme et Habitat 2005: Rural development law. *Loi développement des territoires ruraux*w with protection for peri urban agrarian areas *(Périmètre de Protection et de Mise en Valeur des Espaces Agricoles et Naturels Périurbains)* 2006: Metropolitan Plan. SCoT Montepellier 2007: Local Agenda 21 starts
ZH	1998: Nationale Landschap Groene Hart 2003: Regional Plan. Streekplan Zuid-Holland. 2004: National Plan. Nota Ruimte 2004: Provincial (structural vision) plan. Provinciale Ruimtelijke Structuurvisie 2020 2005: Territorial Agreement. VeenweidePact Krim penerwaard 2006: Nota Ruimte officially into act 2009: Regional plan (nature protection/management) Natuurbeheerplan Zuid-Holland

Fig. 3: Regulations, territorial and urban plans. 1990-2010

According to the results of urban containment, Tuscany had the most successful approach. The different provinces involved had their own plans and they discussed and agreed on the structural plan for the regional area. There is also a pro-active law regarding public participation, although it was passed after the period of land changes' analyzed. Noticeably, part of Tuscany´s success has to be derived from the social movement that linked urban and rural inhabitants.

Montpellier has partially reduced its urban pressure on agrarian periurban land. In this case, the spatial plan is also later to the period analyzed. Therefore, the key factor has to be found in a wide legislative pro-agrarian sector and pro-rural development.

The Dutch system of spatial planning is widely recognized, and it is certainly impressive its ability to agree and coordinate spatial plans at different scales. Nevertheless, the practical implications of these hierarchical plans have been weakened. In areas of high urban pressure, these plans have not been able to thwart the expansion of artificial land over agricultural land. In fact agrarian land has neither the wide social support of Tuscany Plain, nor the legal protection of French framework.

4.4 Lessons learned

Comparing different metropolitan areas allows us to understand the process by which rural urban relationships are shifting and to identify how spatial planning may contribute to optimize multifuncionallity of periurban agrarian ecosystems. In short, to understand the role that spatial planning may play to control urban expansion, and to preserve and reconnect periurban agrarian spaces with urban inhabitants, in a quest for a more cohesive and resilient territory.

The most successful case analyzed, Tuscany, based its success in the ability of its inhabitants to build over a wide period of time, strong networks between rural and urban spheres, between producers and consumers. Local agriculture of high quality was part of a social movement to reconnect urban citizens to their surroundings. Here the highest rates of cultivated agrarian land are to be found together with participatory process of urban and territorial planning. Traditional landscapes depend on farmers and are recognized as highly valuable by the population. Agriculture focus on provisioning services was complemented with cultural services and – as agroecological agriculture is increasing – supporting and regulating services.

In the case of South Holland, it appears that, when dealing with agricultural land protection, policies in favour of recreational and nature conservation goals connect well with people expectations. Nevertheless relegating production to a very secondary position reduces the possibilities to encourage public-citizen support for the conservation of periurban agrarian systems.

The analysis of Montpellier provided information to conclude that strong institutions with competences and laws that enable them to facilitate social projects of sustainable land management are effective to cope with urban pressure. They only work if there is a social recognition of the value of local agriculture, together with farmers or collectives committed to work in this sector.

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Topic 2

Urban Green

The effectiveness of seed sowing *in situ* to create low maintenance ornamental meadows for hostile urban environments

Zoë DUNSIGER & James HITCHMOUGH

Zusammenfassung

Die Forschung an der Universität in Sheffield ist sehr erfolgreich in der Entwicklung von Methoden der *in-situ*-Samen Aussaat, um Wiesen und Weiden in urbanen Landschaften zu schaffen. Diese sollen sich zuverlässig etablieren und sich in der Pflege durch einen minimalen Arbeitsaufwand und mit wenig gärtnerischer Ausbildung auszeichnen. Solche Erfahrungen wurden in einer aktuellen Studie gesammelt, in der eine Reihe von Mischungen aus Staudenarten hinsichtlich ihrer spezifischen Anforderungen an eine städtische Umgebung und bezüglich der Möglichkeiten, neue Vegetation auf degradierten, semi-durchlässigen oder undurchlässigen Oberflächen zu etablieren, getestet wurden. Es ist anzunehmen, dass Begrünung durch Saatgut dort widerstandfähiger und erfolgreicher ist als durch Jungpflanzen, wo lediglich kleine Mengen an Kultursubstrate vorzufinden sind.

Schlüsselwörter: Pflanzenartenreichtum, Ressourcenmanagement, Stadterneuerung

Abstract

Research at the University of Sheffield has been highly successful in developing the method of in situ seed sowing for the creation of grassland and meadows in the urban landscape. It has permitted greater confidence that they will establish reliably and can be maintained with a minimum of labour with little horticultural training. This experience was built upon in the current study to test a range of mixtures of herbaceous perennial species, with specific requirements within urban environments, where there is a possibility of establishing new vegetation over degraded, semi-permeable or impermeable surfaces. Establishment from seed is likely to be more durable and successful than from plug plants in these environments, where there is minimal volume of growing media.

Keywords: plant species richness, resource management, urban regeneration

1. Introduction

This paper represents a discussion of the role of a seed established planting scheme within the context of an environmentally poor urban environment, its diversity of plant species, contribution to restoration or recreation of habitats and land usage. It is a departure from both the more traditional views of urban bedding schemes and from conserving areas of urban land, with minimal human intervention or interaction, for spontaneous appearance of valued wildlife species. The current work recognises the need to make use of urban land most efficiently, particularly where there is changing land use, creating an environment for both human and wildlife species. Rather than seeing the preservation of a specific habitat or species as central to maintaining urban biodiversity, this method presents an opportunity to make positive changes in an urban system to increase diversity of selected species, particularly flowering species. There is the possibility also promote the ingress of other valued local or native species.

Summary methodology and results are given to present the study in the context of urban landscape research. More detailed methodology and results will be published and made available in the scientific literature. It is the aim to continue to spread the use of this technique and the consideration of appropriate species usage to practitioners and land managers, and to promote further discussion of species selection and inclusion within the urban environment.

We consider in this study the identification of site appropriate plant communities, which are successful in establishment and continuity. How are species assessed and selected in the urban environment? Should urban areas be used to conserve rare species, or is it more effective to create or enhance communities which are regionally or locally appropriate rather than traditional habitat restoration?

2. Background

Previous work from Anhalt University since 1998 to produce attractive, low maintenance planting schemes for urban areas, named Perennemix, forms a base for this study. It is further developed by applying the same principle of a defined combination of herbaceous perennial species to produce a mixed community of known characteristics, but creating them from seed to minimise establishment costs and permit their use over larger areas. A closer interaction between species can be generated by controlling the sowing density of the species. The mixes may be for specific environmental situations or to satisfy a requirement for native or exotic species, in a similar manner to the Perennemixes.

The method of seed sowing mixes has been used to dramatic effect in U.K., in Sheffield Botanical Gardens, and in RHS Garden Wisley, established in 2008 to 2009, where a diverse vegetation community of mixed origin was achieved over a large area at minimal cost. The future Olympic Park in 2012 in London will demonstrate the method on its largest scale; all these schemes have been created from seed.

A further development of the method is the use of manmade and waste materials as growing media. With increasing regulation in the control and reuse of construction materials in urban and peri-urban environments and with the high value of naturally derived soils, there is a niche for serious consideration of the use that is made of readily available materials of manmade origin as a vegetation growing me-

dium. This leads to a specific application, growing in an artificially created system within a high environmental stress urban environment. The groundwork of selected perennial species growth in construction materials was carried out in monoculture pot studies (HITCHMOUGH et al. 2001, 2003) and in field studies with mixed species (GRAHAM 2008).

3. Overview of method

A field experiment was set up to establish a range of mixtures of perennial species mixtures which would have the characteristics of a defined height, a diverse vertical structure and a long flowering period. Species were selected from steppe or prairie habitats in both central Europe and North America, based on their habitat of origin and their height. The objectives were trialling of North American and European perennial species grown in predefined mixtures. The origin of the species could be defined as generally native or regional or as exotic when considered from a western European perspective.

Eight different seed mixtures were created, which were intended as either low growing, up to 30 cm maximum height, or high growing, up to 100 cm in height.

The species were selected by their tolerance of xeric habitats or xeric–mesic habitats on both continents, giving a wide range of species tolerant of diverse environmental conditions. The plant community groups used for selection were those described as short-grass prairie or goat prairie in North America, or continental steppe or dry grassland in central Europe. The groups of plant species created are not necessarily seen growing together naturally as communities. However they are selected to have a distinctive character, recognisable in the larger region, although not necessarily the local area.

A multilayered vertical structure was achieved by selecting species of varying growth habit and maximum vertical height, particularly in the mixes with 100 cm total vegetation maximum.

The two selected heights of the vegetation mixes would produce neat, low profile schemes, from the shorter plants, and taller beds with greater impact and range in height. Additionally the mixes were intended to flower throughout the summer season, providing both colour and a nectar food source for invertebrates.

The growing conditions imposed were those of restricted environmental resources, limited root volume and organic matter and therefore low water and nutrient availability. The mineral component in addition was nutritionally inert and very freely draining. Due to its origin as quarried material, it was free of weed propagules, a significant advantage in new vegetation establishment. The depth of growing medium was limited to ten centimetres, to test the response of the selected species to drought stress imposed by limited substrate water availability. Access to ground water or the lower soil profile was strictly limited with plastic sheeting, while allowing free drainage of water away from the plant root system, in order to simulate the conditions of growing over hard landscape surfaces. Irrigation and weed species removal was limited to the first season of growth, and not continued in subsequent years.

Assessment of the vegetation was made after establishment during the first growing season and after three years of growth, with the aim of quantifying species survival, their increase or decrease in frequency, and therefore an indication of a growing or declining population. The maximum height of the vegetation in total and the presence or survival of each species, are presented here. The total standing vegetation was also collected, dried and its weight determined to give a value of biomass or carbon accumulation after three years growth.

4. Summary results

Initial results showed a wide range in the rate of germination of seeds from different geographical regions, the rate of establishment and ground coverage. It was speculated that this would have implications for the eventual establishment of the mixed community. Population surveys after one year of growth showed distinct trends in establishment of particular species. After three years, it could be seen that while there was a loss of almost 50% of species from some mixes, others were stable in species frequency.

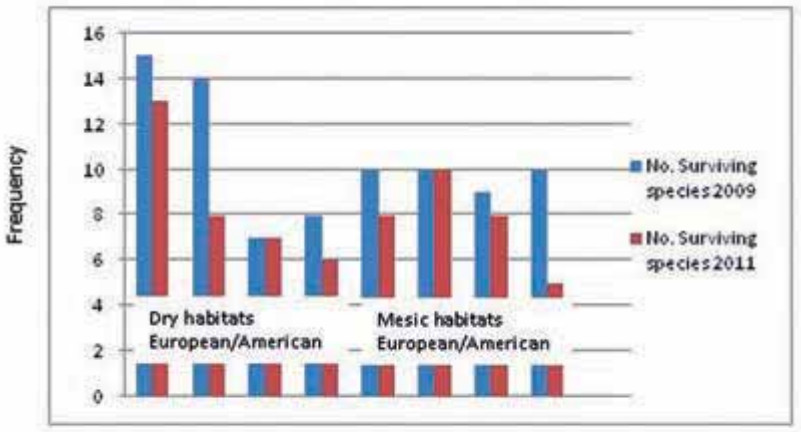

Fig. 1: Change in the number of surviving species of 8 species mixtures over 3 years' growth

Those species with rapid germination were not necessarily successful in dominating the community, but frequently succeeded in establishing large individual plants, which could later become a distinctive feature of the population, even in low numbers. It was noted those which could be useful as alternative ground cover plants for ornamental schemes, to create greater diversity in urban vegetation, with consequent benefits in faunal biodiversity.

With low inputs of water and fertiliser, only a limited number of species reached their full height potential after one year but this was achieved by the third year, with consequences for the overall visual impact of the mixture. Low-growing species were found to be more successful in colonisation in general. It appeared that there was miniaturisation of some species, however with survival of high frequencies of individuals and distinctive vegetative growth form in clumps.

Productivity of the systems as a whole were in general low, no more than 350 g per m^2, expected in a low resource environment. A notable result of a vegetation system suited to very low maintenance was the absence of significant invasive grass colonisation or dominance of the scheme, particularly where there was complete ground coverage by sown species.

The significant findings of the study were

• Consistent establishment of a limited range of mixed species

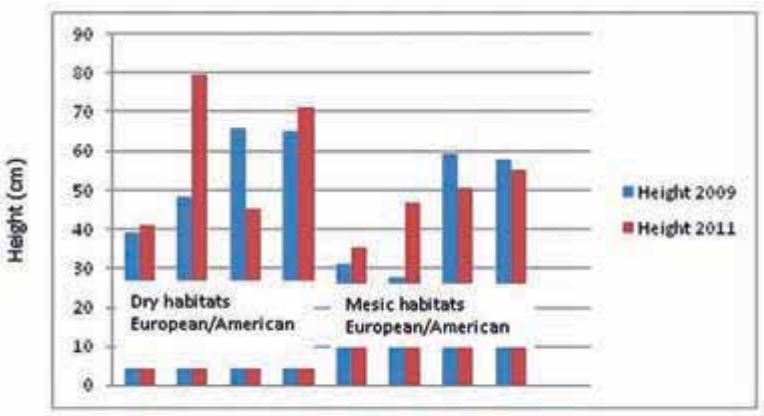

Fig. 2: Increase in height of 8 species mixtures over 3 years' growth

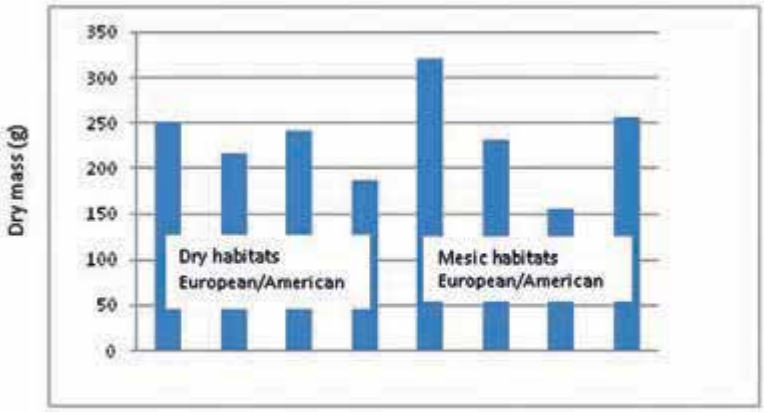

Fig. 3: Maximum biomass achieved in 8 species mixtures after 3 years' growth

• Reliability in horizontal (i.e. ground coverage) and vertical vegetation structure

• Weed control and effects of limited water on competitive species ingress

5. Discussion and application

This study and the background method described may be considered as a departure from more traditional ecological or plant community ideas of habitat recreation or enhancement of diversity. When the application of ecological methods is the focus of modern work particularly in urban areas, we need greater subtlety and complexity in vegetation establishment and management.

The areas of interest within urban areas where this research can be applied include;

• Poor sites – economically, socially and environmentally

• Restricted growing medium

• Restricted drainage and potential for surface water flow

• Novel substrates and reclamation of material

• Economical and large scale ground coverage

• Long term visual improvement and increase in diversity, native or non-native.

This study represents an examination at the small scale of plant individual and community response, which provides the opportunity for larger scale visual changes and provision of feeding and sheltering sites for invertebrates and vertebrates. It examines development in two time scales – vegetation establishment, and so the development of ground cover, which leads to potential for and awareness of, land management. The enhancement of aesthetic value and species diversity results then in long-term improvement of the area.

Cessation of mowing or grazing has steadily lead to a loss of species in meadows and xerophilic grassland and an increase in competitive or alien species, particularly in urban adjacent areas. The current study most closely lends itself to reconsidering meadow or grassland vegetation types within these areas. Management of establishment is used here as a method for directing development of the vegetation. Greater emphasis should be given to low-growing mixtures, focusing on reliability of establishment and visual impact of the mixture as a whole.

Further developments from this trial allow the refinement of perennial mixtures with defined vegetation structure and ground coverage. It will potentially provide empirical evidence of the generation of meadow-like habitats in degraded landscapes. Follow-on benefits from this approach are the provision of habitat sites for local invertebrates. It was not within the remit of the study to quantify this, but invertebrate feeding was observed, in an area of poor provision of flowering plants. With limited evidence of a widely spread requirement for specific host species in invertebrate feeding, this represents an additional food source for the existing and incoming population. Visiting by invertebrates could now be quantified in further studies. Some requirement for specific vegetation structures has been seen, for example among spiders. The experimental work sits most comfortably within this area of research.

Issues of native and alien or invasive species are addressed here by careful consideration of the species included in the mixes, and in developing geographically distinct mixes. Historically invasive species are frequently the result of human activity. A sensitive approach to use of vegetation may improve the quality and so value of land in urban areas. Use of American species in urban landscape has been developed to augment native European species mixes (HITCHMOUGH et al. 2004). In the context of the current study, North American species were found to have more specific uses in potentially controlling growth of weed grass species, and achieving consistent ground cover. There is currently a need to restrict the ingress of alien species by careful selection in new species, and prevention of access to niches or unutilised resources, particularly where they are garden escapes or appear at higher frequencies in populated areas.

There is continuing post industrial structural change in landscape and habitats. With interest in management of water resources comes the development of xerophilic greenspace. Consequently there is an opportunity to make use of the land area to develop appropriate vegetation. Species richness and composition within an urban environment are influenced by their land use and human interaction and management.This study examines areas of minimal management, of low intensity land use or low value. An immediate use of the method is in the development of brownfield sites in derelict areas or those undergoing land use change. Some of these sites are already valued for spontaneous ingress of some species, particularly ruderal plant species or invertebrates. Management of self established vegetation may enhance urban wilderness (MARQUES

2008). Is it more highly valued if it is spontaneous rather than sown? Direction of the development of vegetation, especially in flowering species may increase the rate of re-inclusion of the sites in the urban land use system, or in reassigning them as areas or green space. Use of brownfield sites represents an enhancement in biologically transitional or marginal land within the urban area, in a structured way, rather than a loss or competition for use of more highly valued greenspace. Sites of low ecological and social value; undesirable, abandoned or problem areas, in that they are not readily adapted to traditional restoration, may be brought into use for with limited establishment and management costs. It combines the potential for community involvement and for improvement in plant species diversity.

6. Conclusions

It can be demonstrated that the seed sown method can be used to establish a plant community group of selected species, with benefits for developing more biodiverse systems. While this technique has been used to great effect in more conventional plant growth and ground preparation, this current work supports development of research into particularly urban environments, of low resource input and restricted rooting and water availability. It is proposed that in turn there is a contribution to improved greenspace connectivity and urban habitat heterogeneity. It provides an alternative method for the increase in known or controlled species richness, within the urban area.

A second outcome of the study is the quantification of survival of these species in manmade mixed communities. Although low numbers were recorded, they represented at least a 50 % establishment of the sown species, with minimal maintenance after the first season. In addition, these numbers appeared to develop into a stable population. Their long-term persistence is not however, known. It was observed that the biomass of these plant communities was low. Low productivity was reflected in the low maximum height of vegetation achieved in the first season. However by the end of three years' growth, this had increased to fulfil the typical maximum height expected for the chosen species. It is significant, both in achieving deliberate visual impact and in a distinct vertical vegetation structure.

A benefit of the system created in this study, was seen in the control of weed species ingress on the experimental plots. By establishing a sown sward over the ground surface, and due to limited water availability, there was little opportunity for other vegetation growth, particularly of weed grass species. These can be detrimental to survival of desirable species in a resource competitive environment. Where there was significant weed species ingress, it was observed on plots where ground coverage at establishment was low. Further work on the measurement of invertebrate diversity in similar systems would contribute to evaluation of the plant community established. It would be of interest to further refine the communities and assess a greater number of possible species. If highly valued or rare species can also be successfully introduced in this way, it would be of use in the fulfilment of local Biodiversity Action Plans. Further consideration could be made of the extent to which this could achieve or approach pre-classified vegetation types. The current work focuses on highly robust, persistent species mixes, with their defined visual and structural character.

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Implementing the Central Scotland Green Network: Developing best practice within the Edinburgh City Region

Ian WHITEHEAD

Zusammenfassung

Dieser Aufsatz untersucht die frühe Umsetzung des Central Scotland Green Networks (CSGN) in der Edinburgh City Region und stützt sich weitgehend auf die Arbeiten der Lothians und Fife Green Network Partnership (LFGNP), eine regionale Dachorganisation von fünf lokalen Behörden im Osten des CSGN Bereichs. Der Schwerpunkt des Artikels liegt auf der Edinburgh City Region. Zudem werden aber auch in einem weiteren Kontext grüne Netzwerke innerhalb Europas betrachtet. Ziel ist, breit anwendbare Prinzipien grüner Netzwerke zu identifizieren, die auf schottischen bewährten Praktiken basieren und von der strategischen und politischen Ebene bis hin zur erfolgreichen Etablierung von Netzwerken vor Ort reichen.

Abstract

This paper evaluates the early implementation of the Central Scotland Green Network (CSGN) within the Edinburgh City Region and draws extensively on the work of the Lothians and Fife Green Network Partnership (LFGNP), a regional umbrella body representing five local authorities in the East of the CSGN area. Whilst the primarily focus of the paper is on the Edinburgh City Region, it will also consider the wider context of green networks within Europe. It will aim to identify broadly applicable principles for delivery of green networks based on Scottish best practice, from strategic and policy level through to successful establishment of networks on the ground.

The significance of partnership structures and framework development, with regard to their composition, function and relationship to wider strategic and policy structures will be considered. These structures include the CSGN itself, development planning policies and specific planning guidance including regional Indicative Forestry Strategies. The role of toolkits and habitat data will be considered, particularly Integrated Habitat Network (IHN) modeling using Forest Research's BEETLE mode (WATTS et al. 2005).

The paper will evaluate how projects have been identified and prioritised using strategic processes and toolkits. Specific examples of green network projects in the LFGNP area will then be highlighted including

i) River corridor management plans
ii) Integration of protected landscapes within wider networks
iii) Habitat creation within urban greenspaces
iv) Green infrastructure within Core Development areas
v) Greening of vacant and derelict land

Through these examples, the necessary steps and processes will be teased out from survey, evaluation, resource acquisition, stakeholder consultation, management planning and finally moving through to implementation. Conclusions will stress the requirement for a single partnership led vision and the need for top down strategy to be balanced with bottom up action. This action needs to be backed up with quality data and robust tool kits. To secure quick wins, the importance of a "hands on" incentive driven approach will be emphasized.

1. Introduction and context to Green Networks

1.1 Definition of Green Network

The term "green network" is a broad one which is extensively used within Scotland to define "a set of connected areas of green space and habitats such as parks, paths and woodlands within an urban or suburban region which provide a range of social, ecological and economic benefits such as increasing the quality of life within an area, and creating sustainable communities." (SCOTTISH NATURAL HERITAGE 2011). For practical purposes here, the terms "green network" and "green infrastructure" are considered interchangeable; however, the term "green network" is considered to be more easily understandable to non specialists as it emphasises the significance of connections between adjoining greenspaces within a wider continuum.

Scottish Natural Heritage also clarify differences between green networks and habitat (ecological networks) noting that, "Habitat and green networks have some features and objectives in common, but they have different primary aims. A green network has multiple objectives, often with a primary aim of improving the environment for people, and usually to help to improve the economic status of an area, by making it a more attractive place to live and work. However, a habitat network or an integrated habitat network may be a key component of a green network." (SCOTTISH NATURAL HERITAGE 2011).

Natural England observes that 'Green Infrastructure is a strategically planned and delivered network comprising the broadest range of high quality green spaces and other environmental features. It should be designed and managed as a multifunctional resource capable of delivering those ecological services and quality of life benefits required by the communities it serves and needed to underpin sustainability." (NATURAL ENGLAND 2009)

1.2 European examples and comparisons

Initial scoping work carried out to evaluate potential for developing the Central Scotland Green Network considered a range of existing European examples of green networks at varying spatial scale. A report entitled "Central Scotland Green Network;

Defining the Concept" (LAND USE CONSULTANTS 2008) proposed three broad models for green network development. These were:

i) "Scandinavian" model: This draws upon an intrinsic attachment to natural heritage in Scandinavian (and Dutch culture) based around using green corridors and spaces to shape patterns of development. Examples included the Copenhagen "Finger" Plan, The Stockholm Green Structure Plan and the Netherlands Randstat Urban Area.

ii) Post industrial model: This model utilises the creation of "green structure" as a framework for large-scale regeneration through mixed use development, leisure, culture and recreation provisions and comprehensive environmental improvement. The best known, and arguably most successful, example of this type is the Emscher Park in the Ruhr area of Germany.

iii) Environmentally led model: The final model emphasises protection of green structure through the establishment of a robust regulatory framework. This advocates protection of greenspace and habitats with compensatory provision where damage is likely to occur and utilizes developer contributions to assemble land for environmental improvement. Munich's "Grünplanung' (Green Structure Planning) is a good example of this type of model.

Although the approaches taken were different in each incidence, all succeeded in achieving a high level of integration of greenspace creation and management within the wider context of spatial planning. Key lessons for the CSGN learned from the European examples included (LAND USE CONSULTANTS 2008);

• The importance of local context for developing green networks which build upon existing structures and assets.

• The benefit of a strong overall concept which can be easily communicated and understood by a disparate range of audiences.

• The potential for policy instruments particularly with regard to the spatial planning system to embed green networks at their core and to secure additional benefits through maximising developer contribution.

• The importance of incorporating locally led projects within the network to promote stakeholder buy-in and tailored solutions.

• The potential of green networks to address multiple benefits which may evolve through time.

Another key aspect of green infrastructure is that it can be applied at all spatial scales. The European Commission held a workshop in March 2009 entitled "Towards a Green Infrastructure for Europe" which evaluated the priorities for building a green infrastructure at European level. This considered the various initiatives being taken forward by member states, the integration of these with spatial planning and existing networks of core habitat such as the Natura 2000 Network (SUNDSETH & SYLWESTER 2009). In addition many individual states have produced their own green infrastructure guidelines and have been taking forward action on the ground. The need to link policy and initiatives at the various spatial scales is seen as paramount for successful green network delivery, both locally and across the European Union.

2. Background to CSGN within Edinburgh City Region

2.1 The Central Scotland Green Network (CSGN)

The Central Scotland Green Network (CSGN) was launched in 2010 with the aim of changing the face of Central Scotland, through restoring and transforming the landscape. The CSGN covers nearly 10,000 km² (CSGN PARTNERSHIP BOARD 2011), and includes 19 local authorities, stretching from Ayrshire in the West to Lothians and Fife in the East (fig. 1). The area is home to 3.5 million people and includes the City Regions of Glasgow and Edinburgh, Scotland's two major urban areas. The CSGN was one of 14 National developments in the Scottish National Planning Framework 2 (SCOTTISH Government 2009).

The environment of the CSGN area shares many common characteristics. Landscape character has been determined largely by the underlying geology of the Midland Valley of Scotland. The Midland Valley provided extensive coal measures and oil shale deposits, the extraction of which fuelled Scotland's industrial revolution in the 19th Century. The subsequent decline of these heavy industries, including mining, iron and steel production has left a rich heritage within the area. However, significant negative impacts, including the scarring of the landscape and widespread industrial dereliction, have resulted.

The socio-economic profile of the area reflects this. There are high concentrations of multiple deprivation, particularly in West Central Scotland and associated with communities where traditional heavy industries have declined. Effected communities are characterised by high unemployment rates, low levels of educational attainment and poor access to public services. This also includes access to quality built and green environments.

Conversely within the CSGN area, there are significant growth areas including the major urban centres of Edinburgh and Glasgow and their associated satellite communities. These centres provide much of the region's employment, educational and economic potential. Growth targets within these areas have been revised significantly downward in the light of recent global economic recession.

The CSGN aspiration is to change the face of Central Scotland by restoring and improving the rural and urban landscape of the area. The Vision for Central Scotland is that:

"By 2050, Central Scotland has been transformed into a place where the environment adds value to the economy and where people's lives are enriched by it's quality" (CSGN PARTNERSHIP BOARD 2011).

With this in mind the CSGN aims to incorporate a varied range of habitats, green spaces, urban environments and natural capital assets. These include;

• Networks of natural and semi natural habitats, such as woodlands, hedgerows and peatland.

• Blue spaces including rivers, streams, ponds, wetlands, canals and sustainable urban drainage schemes (SUDs).

• Coastal habitats including rocky shores, cliffs, beaches and salt marshes.

• Greenspaces such as parks, public spaces, gardens and street trees.

• Path and cycle networks and green transport corridors.

• Green roofs and green walls in urban areas.

There is a strong presumption within CSGN that these elements need to be better integrated within grey infrastructure development through the creation of holistic approaches to planning at regional, local and master-planning stages. In this respect the aspirations of the CSGN are closely aligned with the Scottish Government's sustainable economic growth agenda; the aim being to better guide and integrate infrastructure development within wider environmental and sustainability parameters.

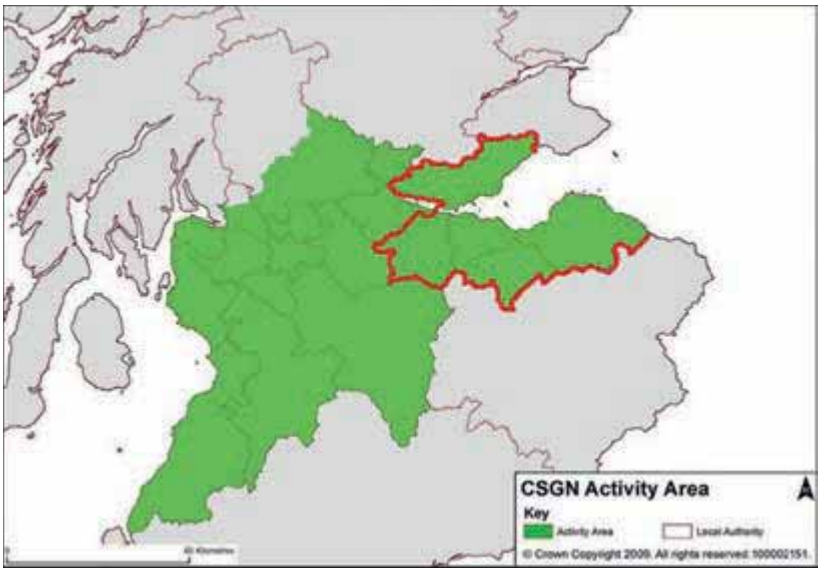

Fig. 1: The CSGN Area (green) indicating the extent of the Lothians and Fife Regional Partnership (red)

2.2 CSGN Partnership structures within the Edinburgh City Region

The Lothians and Fife Green Network partnership (LFGNP) is a regional body covering 5 Local authorities within the East of the CSGN area (fig. 1). LFGNP is one of a number of developing regional structures within the CSGN. The Partnership is a recent evolution of the Edinburgh and Lothians Forest Habitat Partnership (ELFHNP) which was launched in 2008. LFGNP acts as a mentor and facilitator for green network projects within Lothians and Fife. The Partnership works across 15 lead partner organisations with the following aims (WHITEHEAD 2010);

- To create an attractive environment across Lothians and Fife.
- To provide biodiversity and green infrastructure benefits, particularly with relation to new developments.
- To improve health, active travel and well-being benefits.
- To promote empowered communities.
- To assist education and lifelong learning using the outdoor environment.

Partners within LFGNP include representatives of the five local authorities, local implementation bodies (NGOs) and key government agencies; particularly Forestry Commission Scotland (FCS) and Scottish Natural Heritage (SNH) who collectively lead and finance core functions of LFGNP. For practical purposes the Partnership is housed within the offices of the Edinburgh and Lothians Greenspace Trust (ELGT), an environmental NGO. However, the Partnership must be perceived as non partisan to receive the full backing of the range of stakeholders.

A partnership ethos is very much at the heart of LFGNP with co-ordinated action by communities, agencies and business being seen as the key to success. LFGNP functions aim to add value rather than duplicate the work of existing stakeholders through providing enhanced co-ordination of green network activity, particularly in the three areas of strategy, partnership and project delivery. In this respect LFGNP provides a bridge between the strategic policy context and delivery on the ground through facilitating and canvassing a "broad church" of partnership "buy in". This reduces conflicts and emphasises synergy and action on the ground.

The focus of LFGNP activity is very much on end point of delivery through translating policy into action on the ground. This aims to create quality greenspace close to where people live and work and also to develop green and blue networks in the wider countryside.

3. Strategic partnership roles within Edinburgh City Region

LFGNP is developing its co-ordinated vision through promoting policy and translating this into action on the ground. The development of robust planning guidelines which stress synergy and integration at all levels are seen as imperative to guide the green network agenda. The Partnership in particular is contributing to the following policies at a strategic level;

3.1 Development of forest and woodland strategies (FWS)

Forest and Woodland Strategies (FWS) provide the spatial context for new woodland creation. Current Scottish Government targets aim for 25% woodland cover nationally by 2050 against a present coverage of 17.1% (FORESTRY COMMISSION SCOTLAND 2006). Currently in the Lothians woodland cover is only 13.5%, far below the national target.

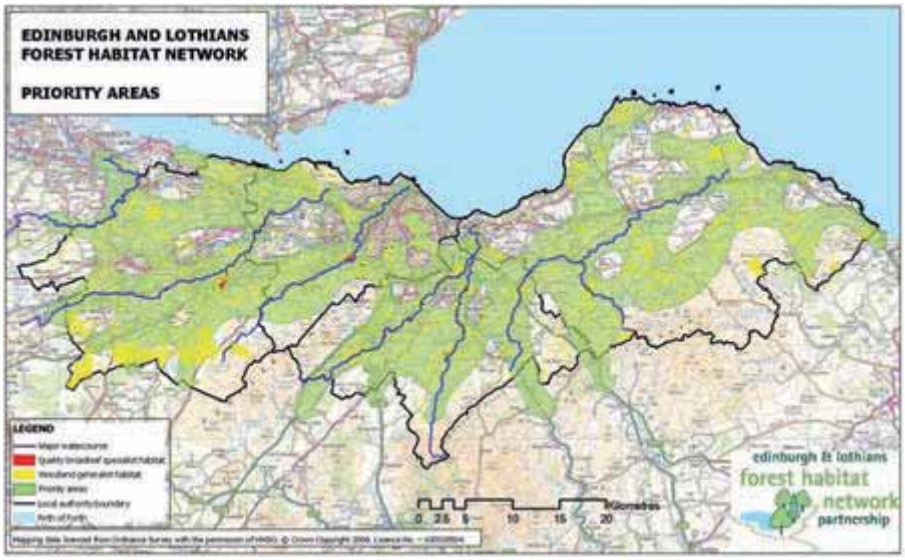

Fig. 2: Opportunities (Priority Areas) for enhancing woodland habitat connectivity within the Lothians (WHITEHEAD 2008)

Separate Forest and Woodland Strategies (FWS) are being developed for both the Lothians and for Fife, reflecting regional variations, political administration and local priorities in each area. Work in the Lothians builds on the earlier "Forestry Framework for Edinburgh and the Lothians" (WHITEHEAD 2008) which incorporates a strong landscape ecology component; aiming to consolidate functional connectivity of woodland habitats with proposed grey infrastructure creation, particularly within Core Development Areas (fig. 2).

The draft Forest and Woodland Strategy for Edinburgh and the Lothians (LANDUSE CONSULTANTS 2011) builds on the connectivity concepts developed in the Forestry Framework. The emerging FWS also now incorporates a spatial framework based on detailed constraint mapping and analysis of new woodland creation opportunities according to identified landscape character zones (fig. 3).

Notional woodland creation targets are proposed for each zone based on a number of potential scenarios and targets (fig. 4). This has been complicated by the fact that existing targets at national, regional and CSGN levels do not synergise fully, requiring additional analysis to be undertaken.

These now take into account a variety of parameters including local landscape character analysis, competing land use functions, economic value of forest products, ecosystem services and potential social benefits of forestry to communities, particularly within urban areas. Benefits for local people include heath, recreation, community cohesion and education. Social and ecological benefits of forestry are accorded high priority as are the economic returns from commercial timber production.

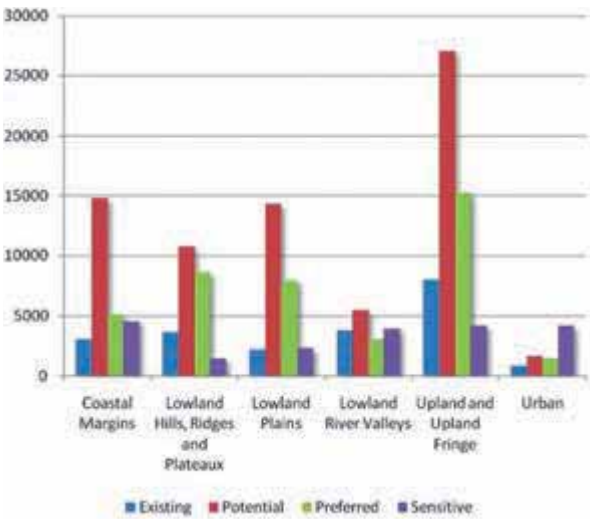

Fig. 4: Potential woodland expansion opportunities (ha) according to identified landscape character areas (LANDUSE CONSULTANTS 2011)

3.2 Development of strategic planning guidance

The full integration of green networks within planning policy is seen as one of the key drivers for guiding and facilitating future green infrastructure programmes. This needs to be done all levels within the planning system hierarchy; at national, regional, local and masterplan levels.

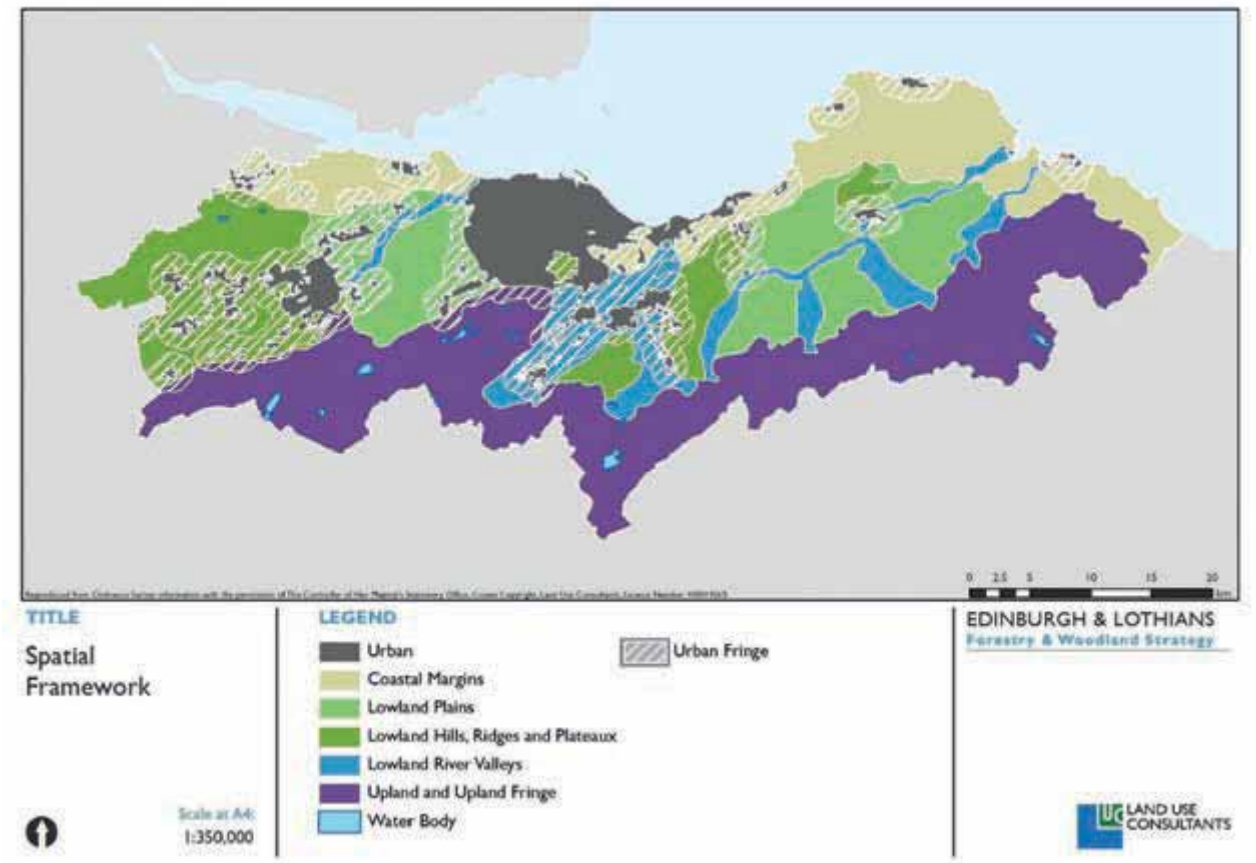

Fig. 3: Spatial Framework identifying landscape character zones with regard to new woodland planting opportunities (LANDUSE CONSULTANTS 2011)

Green networks form a component within SESPlan, the Strategic Development Plan for Edinburgh and South East Scotland. The SESPlan Main Issues Report (SESPLAN 2010) references recommendations for the incorporation of Green networks into Development Planning; in particular with regard to proposed Core Development Areas (CDAs). Individual Local Authorities are also charged with producing Local Development Plans (LDPs).

Local Development Plans in particular are seen as a key vehicle to drive the creation of the green network. A major role of LFGNP has been to integrate the concept of green networks within the development planning process. At a practical level this involves consensus building with local authority planning departments and elected members. SESPlan Policy 11 "Delivering the Green network" provides a context for this;

"The Strategic Development Plan supports the creation of a strategic Green Network including the Central Scotland Green Network and the Scottish Borders Green Network. Local Development Plans will identify opportunities to contribute to the development and extension of the Green Network and mechanisms through which they can be delivered." (SESPLAN 2010).

An important role of LFGNP is to undertake advocacy work with local authorities to raise awareness of the role of green networks, methodologies and practical tools which are available including Integrated Habitat Network (IHN) modelling. The aim is to build capacity within each local authority through providing hands-on support and mentoring. With this in mind, a number of workshops and events have been organised targeting the planners from the various authorities.

3.3 Integrated habitat network (IHN) dissemination

LFGNP has been working closely with the UK Forest Research Agency and the CSGN Support Unit to provide Integrated Habitat Network (IHN) modeling to local authorities, agencies, NGOs and commercial consultancies across Lothians and Fife. The IHN datasets are based on the BEETLE methodology (WATTS et al. 2005) and provide high resolution GIS mapping of habitats and associated dispersal networks.

The IHN methodology has developed significantly since inception. Initially modeling within the Lothians area focused on forest habitats with the production of "A Forest Habitat Network for Edinburgh and the Lothians" (RAY & MOSELEY 2006). However an integrated approach incorporating a range of indicator habitats is now favoured with species rich grasslands, wetlands and heathlands now all being added. Updates to Phase 1 habitat survey data have also taken place in conjunction with the production of new datasets.

A challenge has been the inconsistency of IHN datasets across the CSGN area with gaps in the data coverage or different evolutions of the model operating within the various local authority areas. An early priority has been to homogenise the IHN datasets across the whole CSGN area to provide overall consistency of approach. This is particularly important with regard to cross boundary projects.

An important role for LFGNP and the CSGN Support Unit has been to undertake mentoring work with the various local authorities, private consultants, land managers and developers to illustrate how IHN data can best be used effectively. Particular applications include the development master-planning process and land management operations such as forestry. Simple web based versions are also currently in the process of development for easy access by non specialist GIS users.

4. Developing best practice pilot projects on the ground

Delivery on the ground is the imperative with the CSGN to build the reputation of the initiative and to secure future project funding. In this respect the securing of quick wins has proved vital to win political support and to prove the effectiveness of the developing structures. Best practice projects have been identified and prioritised through the strategic planning processes and toolkits including IHN modeling.

Many of these projects have been taken forward by LFGNP and local partners working collaboratively. Work to date has focused on feasibility studies, consultation and developing detailed specifications to take through to successive implementation phases.

Whilst there is widespread political support, the launch of the CSGN has co-incided with a period of intense economic instability and recession. Certain projects, particularly those which were due to financed through private sector developer contributions, have not taken place or have been postponed. This is particularly true of projects relating to Core Development Areas such as the proposed Shawfair (South East Wedge) development in South East Edinburgh where proposals have been effectively put on hold following the withdrawal of developer finance. However, stalled developments have also created opportunities for new greenspaces, notably the chance for temporary greening of vacant and derelict land; an approach which has formerly been resisted by developers and land use planners.

To secure quick wins, seed-corn funding in the form of the Central Scotland Green Network Development fund has been made available by government agencies, Forestry Commission Scotland and Scottish Natural Heritage. This has equated to £2.4 million during the first two years and has allowed a diverse range of work to take place across the CSGN area through a competitive bidding process. The aim is that seed-corn funding should compliment existing funding streams including the Scottish Rural Development Programme (SRDP). This should further encourage uptake of these grant schemes. There has previously been a low uptake for SRDP funding, particularly for woodland creation within East Central Scotland.

Specific examples of green network projects in the LFGNP area include;

4.1 River corridor management planning – North Esk Valley

IHN mapping has been used to identify a section of the North Esk River Corridor as a high priority for action. The emphasis is on improving condition of existing core habitats comprising of ash/oak gorge woodland and mosaic riparian habitats. In particular the biodiversity value of remnant ancient woodlands is under threat from regenerating beech and sycamore, despite the fact that core areas are officially designated as Sites of Special Scientific Interest (SSSIs). Regeneration of native woodland and under-storey species are currently being affected.

A detailed management plan has been developed across 191 ha and involving 11 different land ownerships. The aim is to bring about a co-ordinated approach to management across the whole area whilst recognising the aspirations of the individual landowners. The project also aims to provide social outcomes in the form of improved access to woodlands from surrounding communities and local participation in woodland management. Implementation work is being taken forward with the respective owners through a series of targeted funding bids.

4.2 Connectivity in protected landscapes – Pentland Hills Regional Park

A strategic approach has been adopted within the Pentland Hills protected landscape area through the development of a Woodland Action Plan. This indentifies five core areas where new native woodland creation can help to restore habitat connectivity lost through fragmentation.

The areas selected include key river catchments such as the headwaters of the Water of Lieth and the River North Esk. Within these catchments riparian woodlands have been lost through grazing pressure and through an emphasis on land management for sporting purposes. The North Eastern slopes of the Pentland Hills have also been selected as providing habitat connectivity close to the route of the Edinburgh City Bypass.

The project has adopted an enabling approach which has aimed to respond to the aspirations of land managers whilst attempting to identify opportunities and potential sources of funding. Detailed management planning work has been undertaken with a view to taking forward a number of projects to implementation stage.

4.3 Urban habitat enhancements – Edinburgh Millennium Woodlands

A co-ordinated approach is being applied across 70 small urban woodlands within the City of Edinburgh. These woodlands were originally established as part of the Millennium Forest for Scotland with the aim of increasing overall woodland cover within the City. However, since the woods were established there has been little management intervention to improve the potential of the sites for biodiversity, landscape or local amenity and to realise their full value as part of a wider functioning forest habitat network.

The aim of this project has been to deliver improvements to woodland structure, understorey vegetation and tree regeneration as assessed through a detailed audit of the sites. This has included a significant amount of canopy thinning to allow more light to permeate the forest floor.

Given the urban nature of the sites, community participation has been considered to be paramount. A secondary aim has been to involve local communities directly in woodland management activities through volunteering programmes and skills training for young people, particularly from socially excluded backgrounds. These social outcomes are considered also to be of high priority in terms of project evaluation. Local communities have also been consulted extensively on the project and their views balanced with conservation objects in the planning process.

4.4 Core development areas; green infrastructure – West Edinburgh framework

Integrating green infrastructure into development master-planning is a key objective of LFGNP and the wider Central Scotland Green Network. During the past two years, however, projected growth has not occurred due to the impacts of global recession on the housing market and on local levels of investment.

Despite the low levels of activity, LFGNP has been assisting in the creation of a Landscape Master-plan for the West Edinburgh Framework, a growth hub which includes Edinburgh Airport and proposed International Business Gateway. IHN modeling has been used to inform the master-plan. The plan incorporates developer contribution as a mechanism for delivery. The following outputs will result form the adoption of the final plan:

• Core area for development expansion including airport and international business gateway

• Creation of a setting for development

• Provision of recreation and active travel opportunities.

• Creation of wildlife habitats, enhancement of biodiversity and development of connectivity

• Contribution to improvement in air quality, water quality and noise attenuation

The aim is to integrate proposed green infrastructure within the Core Development Area into the wider concept for a forest habitat network within Edinburgh and the Lothians as a whole. Increasing functional connectivity of woodlands to adjoining areas is therefore a priority.

4.5 Temporary greening of vacant and derelict land – City of Edinburgh

Economic recession in the Edinburgh City Region has resulted in a slowdown in the development of vacant and derelict sites. LFGNP is seeking innovative solutions to provide temporary greening of Vacant and Derelict sites to improve the visual amenity and contribute to the wider green network. Previously there has been resistance to short term greening solutions.

A strategic audit of sites has taken place with the aim that this will be followed up with enhancements on the ground. Twenty sites have been investigated in detail with a view to undertaking pilot projects. Detailed discussions with site owners, residents and local businesses have taken place.

It is likely that temporary greening options will include establishment of formal greenspaces as well as biodiversity driven approaches including extensive wildflower meadow creation.

5. Discussion and future priorities

Much has already been achieved through the CSGN in the Edinburgh City Region and within a comparatively short timeframe. However the CSGN is a relatively new initiative within and is at an early stage in its development. It is planned that it will operate until 2050, leaving considerable opportunity for ironing out inconsistencies, refining working practices and consolidating partnership structures. However at this stage certain strengths and weaknesses have become apparent; these have been identified by the author as follows:

Strengths:

• The potential delivery of green networks on the ground has been greatly facilitated through the integration of green networks within planning policy at National, Strategic Development Plan (SDP), Local Development Plan (LDP) and Master-planning levels. Topic specific regional indicative strategies (such as for forestry and woodlands) have also been accorded greater priority resulting in more clearly defined and broadly supported policy objectives.

• New toolkits including Integrated Habitat Networks (IHN) models provide a clearly defined rational for managing habitats and for better integration with built infrastructure development. There is greater synergy of data across the CSGN which allows detailed analysis and comparisons to be drawn.

• Better communication between professionals and organisations should assist project implementation, particularly with regard to cross boundary projects and co-operation across the sectors.

• There are increased levels of understanding of the value of green networks with the wider community and the political leadership.

• The varied nature of the CSGN Partnership has allowed a cross-fertilisation of ideas and methodologies between the various organisations involved. The dynamism of the third sector (NGOs and social enterprises) in particular has helped to stimulate a climate of innovation which is in turn influencing the work of statutory agencies and local authorities.

Weaknesses:

• The CSGN has largely been built upon existing structures involving Government Agencies, Local Authorities and NGOs. The overall linkages and relationships between partner organisations have not been clearly defined early on enough in the planning process. This has, on occasions, created tensions between partners and resulted in speculation about hidden agendas.

• The CSGN was envisaged during a period of economic growth. This has however not been the case and the economy has undergone a period of recession since the inception of the initiative. Spending cutbacks and a lack of finance from private developers have limited the amount of resources available for green network development.

• The distribution of State funding to organisations providing a support role within the CSGN structure is perceived by some to be inequitable. Political positioning between the various partners has had some negative, though not significantly damaging, impact.

• The CSGN has not as yet been able to win widespread support from the business community and private developers. To be completely successful it will be necessary to broaden participation beyond what might be perceived as the "usual suspects".

It is clear that for partnerships to be effective there is a need to work at strategic, policy and implementation levels. Partnerships should act as honest brokers and catalysts for action. The aim should be to translate policy into action through facilitating best practice on the ground. A number of key issues which the process has highlighted include;

• The need for ongoing synergy and active participation of key players

• The need for a co-ordinating body to lead the process with clarity of vision

• The importance of ensuring the full integration of green network principles into planning policy at national, regional, local and masterplanning stages

• Robust GIS toolkits which can be used effectively by non specialist practitioners including planners, land agents and developers for defining and integrating habitat networks into programme management. This needs to be backed up with adequate training to ensure the toolkits can be simply and effectively used by practitioners.

• Adequate incentives to ensure project implementation on the ground and participation of land managers.

• Provision of hands on assistance to land managers with applications and administrative hurdles.

• Further engagement with the private sector to deal with resourcing issues and mainstreaming of green networks within development master-planning.

6. Conclusions

The experience of LFGNP has illustrated the requirement for a single partnership led vision and the need for top down strategy to be balanced with bottom up action. This action needs to be informed through provision of quality data and robust tool kits. To secure quick wins, the importance of a "hands on" incentive driven approach has proven essential with support being provided to local stakeholders by enabling bodies such as LFGNP.

The approach has also highlighted the fact that a considerable investment of resources and time needs to be made to initially secure partnership agreements between stakeholders and to develop a robust, mutually agreed vision. This may require overcoming political and institutional barriers but is an essential prerequisite of green network development. Once established, dialogue needs to be ongoing with effective communication structures in place and clearly defined roles and responsibilities of the various partners involved.

Despite the relatively short history of implementing the CSGN within the Edinburgh City Region, experience so far does indicate that this might provide a viable template which could be tailored successfully to other locations; however differing local priorities, geographical factors and cultural variables must be considered and the methodology adapted as required to suit the local circumstances.

In general, however, the Scottish concept of integrating habitat networks with a range of social and economic outcomes is a strong one which might provide an attractive methodology for securing political support and overcoming institutional and funding barriers which can characterise green infrastructure development. The Scottish approach of emphasising action on the ground and linking this upward to the policy agenda is also an admirable one. However the true success of the CSGN within the Edinburgh City Region will only become apparent in the medium to longer term.

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Bio Web City/Region approach to solve ecological issues of “Zwischenstadt”

– Comparison of the Land Use of 2500 km² Zone around Nagoya and Düsseldorf –

Hiroyuki SHIMIZU

Zusammenfassung

Ise Bay Bioregion befindet sich im Zentrum von Japan und ist ein Land-Marine-Komplex mit konkaven Formen rund um Ise und Mikawa Bay. Die Region umfasst gut entwickelte Industriebereiche sowie produktive Landwirtschaft, Fischerei und forstwirtschaftliche Flächen. Die Gesamtzahl der Landnutzung setzt sich aus 65% Wald, 11% Reisfeld und 4% andere landwirtschaftliche Bereiche sowie 13% Gebäude und Straßen zusammen. Im Stadtplanungsbereich, der vom Ministerium für Land, Infrastruktur, Verkehr und Tourismus definiert wird, überlappen sich städtische und landwirtschaftliche Nutzungen und weisen eine typische Form der "Zwischenstadt" auf, wie SIEVERTS sie 2003 beschrieben hat. Die Landnutzung in der Ise Bay Bioregion scheint jedoch eine andere Funktion als jene in Deutschland zu haben. In diesem Beitrag werden daher Landnutzungen von Städten rund um Nagoya in der Ise Bay Bioregion mit Städten um Düsseldorf verglichen.

Abstract

Ise Bay Bioregion is located in the center of Japan and defined as the land-marine complex with concave form around the Ise and Mikawa Bay. It includes well developed industry areas as well as productive agricultural, fishery and forestry areas. The total land use consists of 65% forest, 11% paddy field, 4% other agricultural field, and 13% urban land use as building and road. In City Planning Area defined by Ministry of Land, Infrastructure, Transport and Tourism, urban and agricultural land uses are overlapped under insufficient control and have a typical form of “Zwischenstadt” defined by T. SIEVERTS in 2003. But the land use in Ise Bay Bioregion seems to have a different feature of that of Germany. In this paper I will compare the land use of cities around Nagoya in Ise Bay Bioregion with that of cities around Düsseldorf. The fragmentations of forest and intermediate land uses cities around Nagoya are higher than those of cities around Düsseldorf. The biggest issue to create harmonized mixed land use around Nagoya is to improve the collectivity of forest and intermediate land uses.

1. Preface

Ise Bay Bioregion is located in the center of Japan and defined as the land-marine complex with concave form around the Ise and Mikawa Bay (Figure 1). It includes well developed industry areas as well as productive agricultural, fishery and forestry areas with a population of about 11 million people. The total land use consists of 65% forest, 11% paddy field, 4% other agricultural field, and 13% urban land use as building and road in 2006. In Fig. 2A, 2B and 2C the comparison of land use ratio in City Planning Area defined by Ministry of Land, Infrastructure, Transport and Tourism observed by the two different data sources is shown. Comparing to 100m Mesh Date by Digital National land Information, the land use ratio by Aster/Terra extract by N. USUI is biased to the urban and forest land use. The shift to the urban land use can be explained by the facts that green houses are calculated as urban land uses and some bare grounds are miscounted as urban land uses. The shift to the forest land use can be explained by the facts that in the agricultural land use orchards are included and some agricultural sites are under cultivation abandonment.

In the City Planning Area, urban and agricultural land uses are overlapped under insufficient control and have a typical form of “Zwischenstadt” defined by SIEVERTS in 2003. It is impossible to convert these wide developed areas into few clearly detached compact cities. And it seems to be a clever way to create urban and suburban areas harmonized with nature by developing the concept of “Zwischenstadt.” In our institute we named this harmonized land use approach as Bio Web City/Region Approach. It is a city/region, in which nature structures are weaved into continuous urban and suburban areas and efficient ecosystem networks are created. How can we find resources for creating bio webs in existing urban and suburban structure?

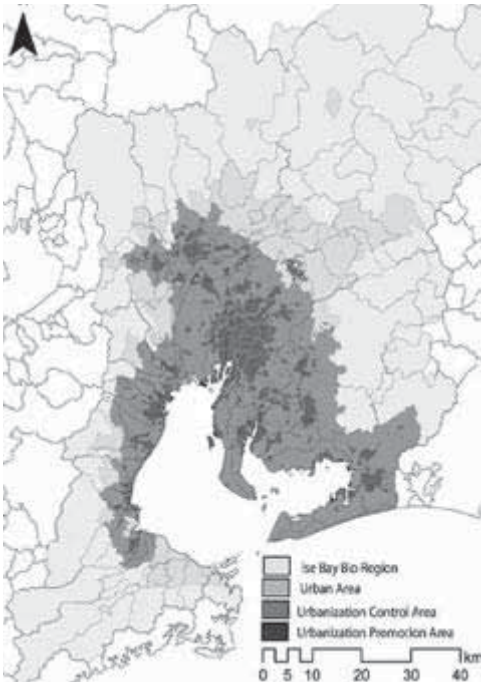


Fig. 1: Planning Areas defined by Ministry of Land, Infrastructure, Transport and Tourism

2. Objectives of Research

In this paper I will show the mixed land use situation in Ise Bay Bioregion using DI (Distribution Index) Scale, and compare it to that around Düsseldorf. From this comparison, I will find out some issues for creating harmonized Bio Web Cities/Regions in future. The focus is on three areas around Nagoya. One is Tsushima City in the South-West Nagoya, in which urban and agricultural small patches are scattered in former wetlands, the second is Konan City in the North-West Nagoya, in which newly developed industries and housing are scattered in agricultural lands, and the third is Nisshin City in East Nagoya, in which newly developed housing areas are scattered in agricultural valleys and forest hills. For the comparison I will examine the land use around Düsseldorf. The satellite images of TERRA/ASTER is used as the data for analysis (Tab. 1, Fig. 2).[1)]

100m Mesh Land Use Data 2006 by Digital National Land Information			
	Urban	Intermediate	Forest
Urban Area	0.31	0.39	0.30
Urbanization Control Area	0.18	0.52	0.30
Farmland Area	0.10	0.86	0.04
Urbanization Promotion Area	0.79	0.18	0.03
Not Urban Area	0.02	0.08	0.90
Aster/Terra Land Use Extract 2005-6 by N. Usui			
Urban Area	0.32	0.35	0.33
Urbanization Control Area	0.22	0.46	0.32
Farmland Area	0.23	0.67	0.11
Urbanization Promotion Area	0.76	0.21	0.03
Not Urban Area	0.02	0.09	0.89

Tab. 1: Comparison of Land Use Ratio observed by the two different data sources

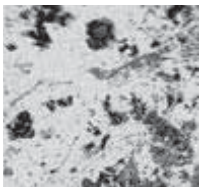


Fig. 2a: Digital National Land Information

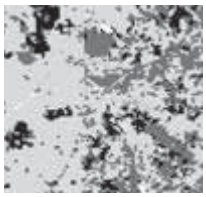


Fig. 2b: Aster/Terra Land Use Extract 2005-6

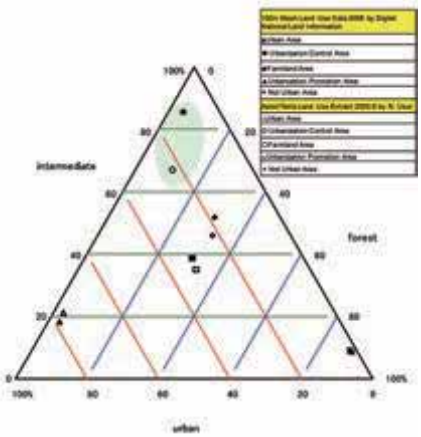
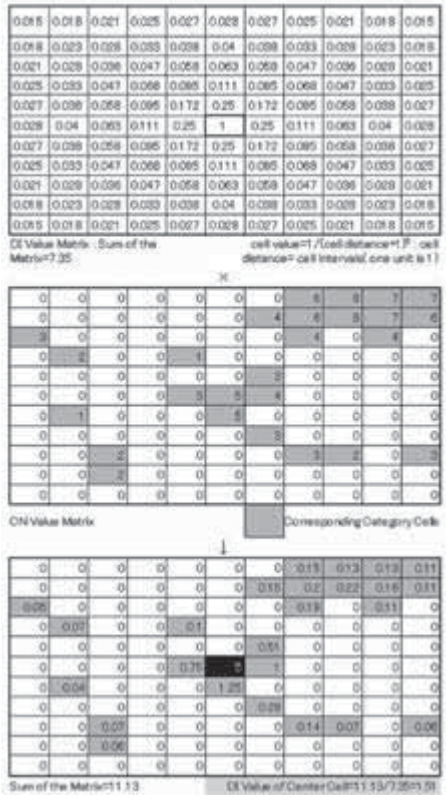


Fig. 2c: Comparison of Land Use Ratio observed by the two different data sources

3. DI value and DI Scale (Rank)

For the observation of collectivity of a targeted land use in a mixed land use, DI Value and DI Scale are developed (MOCHIZUKI et al. 2007).[2)] The calculation process is shown in Table 2. DI Value for a cell is a continuous number from 0 to 9 according the collectivity of the same land uses in neighborhoods. (0 is a value for a non-correspondence cell.) DI Scale is a Scale with 10 Ranks. The characteristics of DI Value and DI Scale are shown in Table 3. A cell with DI Rank 1,2 or 3 is defined as a Fragment Cell, a cell with DI Rank 4,5 or 6 as a Fringe and Arm Cell, a cell with DI Rank 7,8 or 9 as a Core Cell (Table 3 and Figure 3). Average DI Rank is an average value of all correspondence cells in an observed area. The characteristics of collectivity of a land use can be shown by using Average DI Rank and Covering Rate of a targeted land use (Figure 4). If the Average DI Rank leaves upward from the diagonal line, the land use has a tendency of high collectivity.



Tab. 2: Calculation of DI Values from CN Values

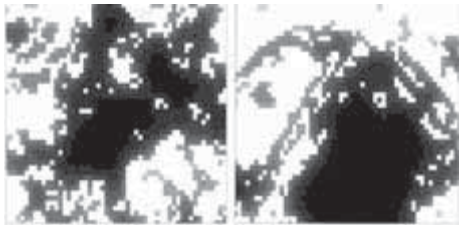


Fig. 3: Patterns of DI Rank

[1)] In this paper the two different extracts from TERRA/ASTER are used. The extracts from TERRA/ASTER by N. USUI covers widely in ISE Bay Bioregion, but has the characteristics in which the urban land use is overestimated than that of the 100m Mesh Data by Digital National Land Information. The extract by F. MOCHIZUKi is narrow but can distinguish paddy filed and other farmland.The extracted cell size around Düsseldorf is 18.8 by 18.8m, and the cell size around Nagoya is 17.6 by 17.6m.

[2)] In this paper DI Rank is revalued.

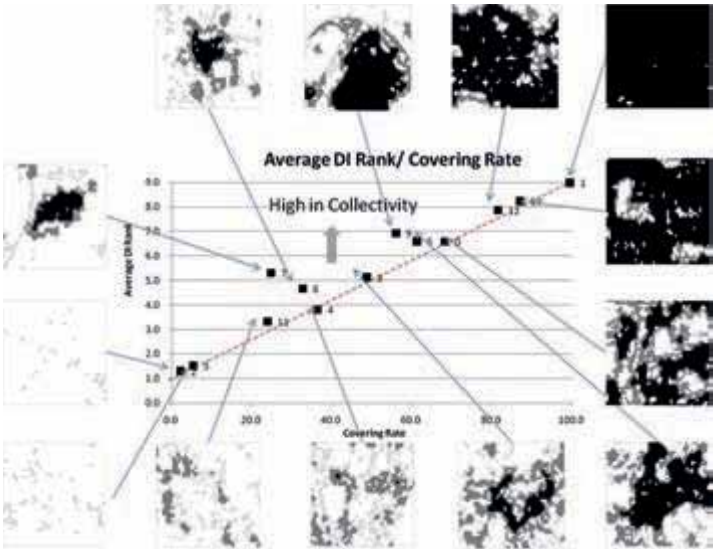


Fig. 4: Average DI Rank and Covering Rate

DI Value	DI Rank	Characteristics	
0	0	Non Correspondence cell	not corresponding
0.00-0.99	1	Scattered cell or thin linear connected cell	scattered and thin collected cells (Fragment Cell)
1.00-1.99	2	Scattered cell or a part of a fringe cell of a collected cells	
2.00-2.99	3		
3.00-3.99	4	a fringe cell of complicated shaped collected cells	low densely connected cells or fringe cells of densely collected cells (Fringe and Arm Cell)
4.00-4.99	5	center cell of small collected cells or a fringe cell of densely collected cells	
5.00-5.99	6		
6.00-6.99	7	adjacent inner cell of DI Rank 5 cells	inner cells of collected cells (Core Cell)
7.00-7.99	8	adjacent inner cell of DI Rank 6 cells	
8.00-9.00	9	Inner cell of densely collected cells	

Tab. 3: Characteristics of DI Values and Ranks

4. Comparison of Land Use around Nagoya and Düsseldorf

From TERRA/ASTER remote sensing data around Nagoya and Düsseldorf, the 2500 km^2 zones are picked out. Comparing with the land use of Düsseldorf, the rate of forest land use around Nagoya is low, the urban land use is high and the intermediate land use including mostly farmland is low (Figure 5). By the comparison of DI Ranks collectivity of the urban and forest land use around Nagoya and the intermediate land use around Düsseldorf is high, and the urban land use in Düsseldorf and the intermediate land use around Nagoya is medium. Generally speaking collectivities of all land uses around Düsseldorf and Nagoya are both relatively high. But by paying attention to the forest land use, the rate of it around Nagoya is low, but the collectivity of it is very high. It depends on the fact that the forest around Nagoya locate mostly on the north-east mountain side.

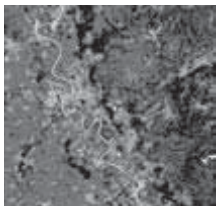


Figure 5a: Düsseldorf 50km×50km

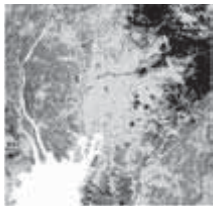


Figure 5b: Nagoya 50km×50km

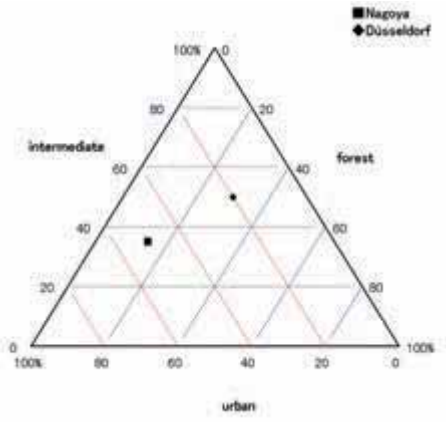


Figure 5c: Land Use in Nagoya and Düsseldorf

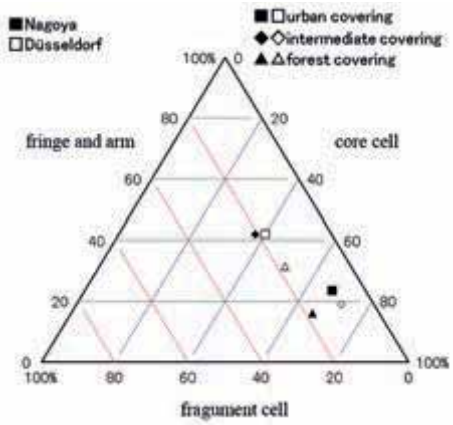


Figure 5d: DI Rank Distribution in 3 Scales of Nagoya and Düsseldorf

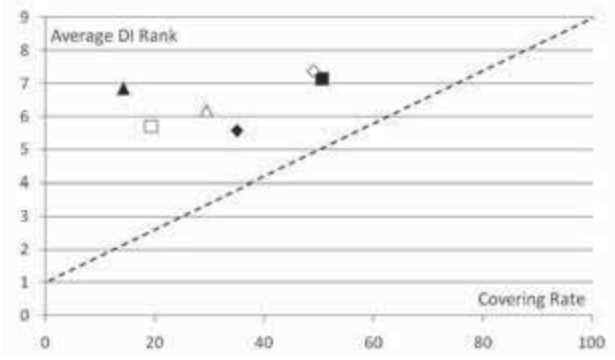


Figure 5e: Average DI Rank and Covering Rate of Nagoya and Düsseldorf

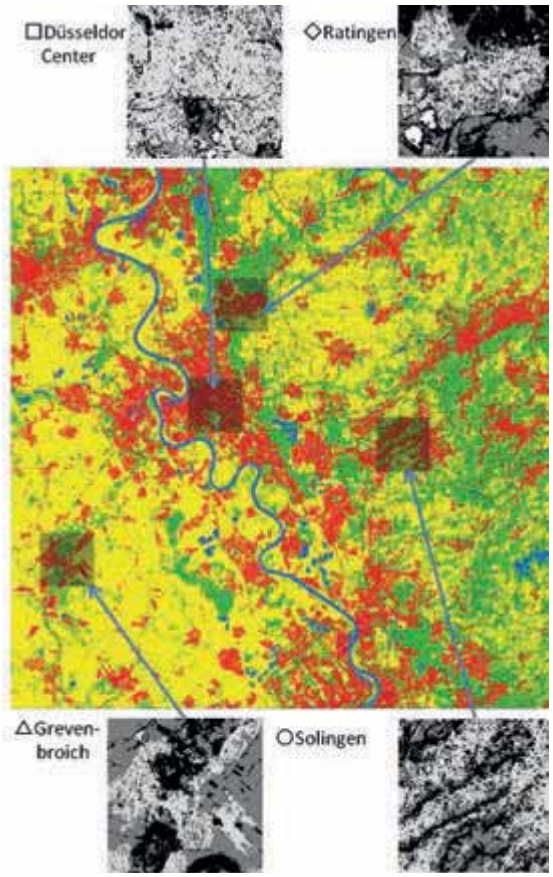


Figure 6a: Cities around Düsseldorf

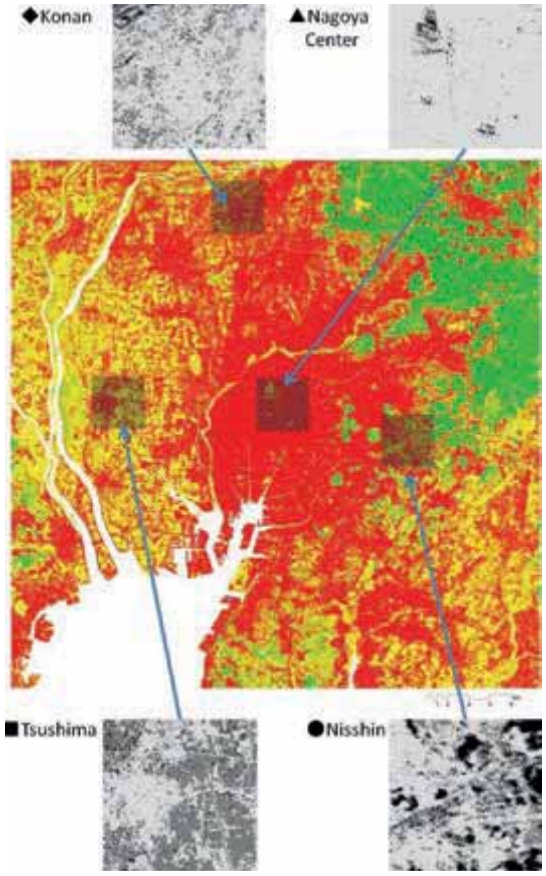


Figure 6b: Cities around Nagoya

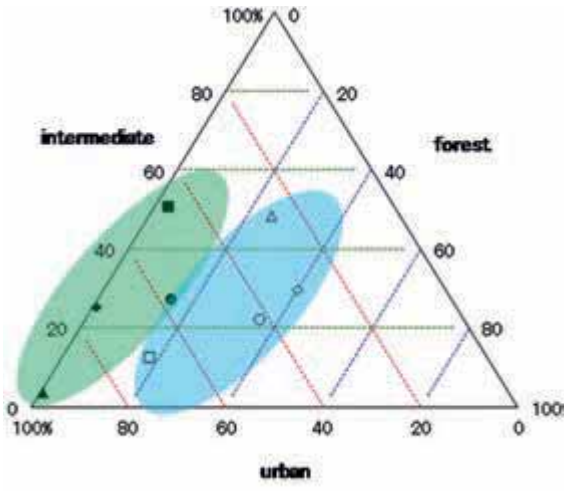


Figure 6c: Comparison of Land Use Rate between Cities around Düsseldorf and Nagoya

The typical characteristic of the cities around Nagoya is the lowness of the forest land use (Figure 6C) comparing to it of cities around Düsseldorf. By the comparison of Average DI Rank and Covering Rate, the forest and intermediate land uses of Tsushima and Konan Cities are specially fragmented, while those of the cities around Düsseldorf are well mixed with the urban land use maintaining relatively high collectivity (Figure 7A, 7B, table 4A, 4B, Figure 8A, 8B). The mixed style of land use of Nisshin is relatively near to that of German cities.

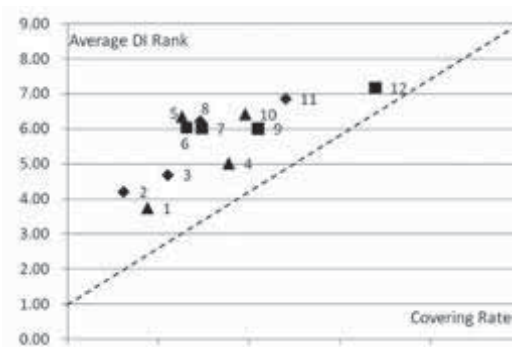


Figure 7a: Average DI Rank and Covering Rate of Cities around Düsseldorf

		DI area rate	DI Rank	Code
■ Urban	Düsseldorf	67.90	7.17	12
	Ratingen	29.61	6.02	7
	Grevenbroich	26.29	6.04	6
	Solingen	42.08	6.00	9
♦ Inter-mediate	Düsseldorf	12.41	4.21	2
	Ratingen	29.27	6.22	8
	Grevenbroich	48.12	6.86	11
	Solingen	22.14	4.69	3
▲ Forest	Düsseldorf	17.72	3.73	1
	Ratingen	39.22	6.41	10
	Grevenbroich	25.29	6.35	5
	Solingen	35.65	5.01	4

Tab. 4a: Land Use Codes of Cities around Düsseldorf

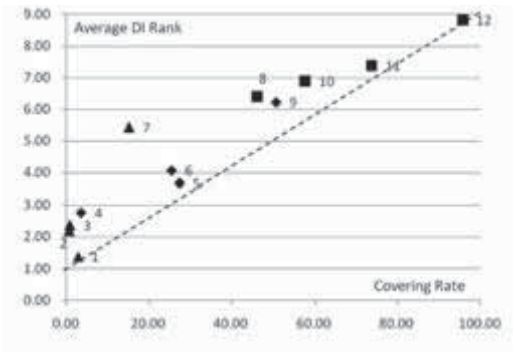


Figure 7b: Average DI Rank and Covering Rate of Cities around Nagoya

		DI area rate	DI Rank	Code
■ Urban	Tsushima	46.02	6.41	8
	Konan	73.70	7.38	11
	Nagoya center	95.75	8.82	12
	Nisshin	57.63	6.89	10
♦ Inter-mediate	Tsushima	50.62	6.22	9
	Konan	25.40	4.07	6
	Nagoya center	3.54	2.76	4
	Nisshin	27.32	3.69	5
▲ Forest	Tsushima	2.79	1.38	1
	Konan	0.85	2.36	3
	Nagoya center	0.71	2.19	2
	Nisshin	15.12	5.43	7

Tab. 4b: Land Use Codes of Cities around Nagoya

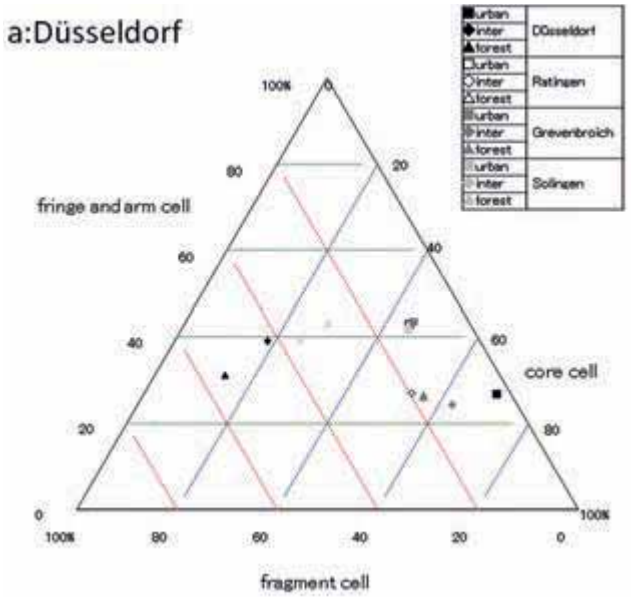


Fig. 8a: Average DI Rank of Cities around Düsseldorf

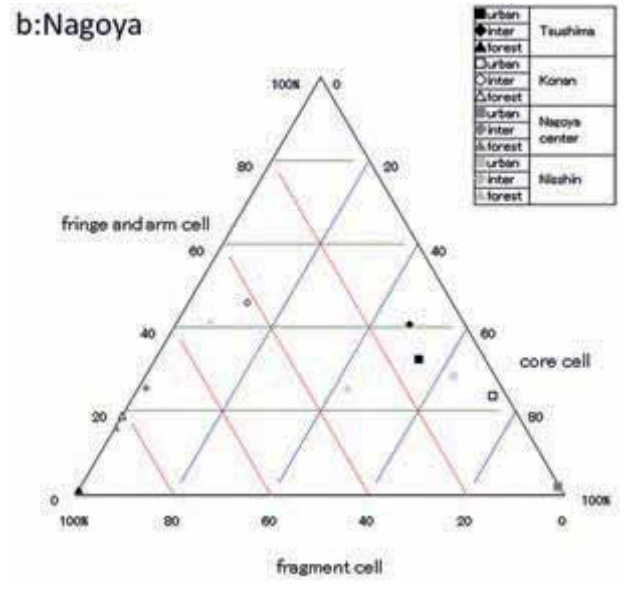


Fig. 8b: Average DI Rank of Cities around Nagoya

5. Conclusion

By using DI Scale and Covering Rate the characteristics of mixed land use situation in different cities/regions can be observed clearly. The situation of the mixed land use, “Zwischenstadt,” of 2500 km^2 around Düsseldorf and Nagoya is very different. The fragmentations of the forest and intermediate land uses of the cities around Nagoya are very high. The biggest issue to create harmonized mixed land use around Nagoya is to improve the collectivity of forest and intermediate land uses in the urban and suburban areas.

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The future role of protected areas in urban landscapes

Sara BORGSTRÖM

Zusammenfassung

Städte stellen für die Mehrzahl der weltweiten Bevölkerung die alltägliche Landschaft dar und profitieren dabei durch Ökosystemdienstleistungen, die durch städtische Grünflächen generiert werden. Daher wird städtische Natur auch zunehmend Bestandteil von globalen Biodiversitätsprogrammen sowie von Strategien zur nachhaltigen Stadtentwicklung. Da sich Stadtlandschaften jedoch in sozialen und ökologischen Merkmalen unterscheiden, erfordert die Umsetzung von Naturschutzmaßnahmen in Städten einer genauen Überprüfung, warum, wo und wie städtische Natur zu schützen ist. Aus diesen Gründen stellt dieser Beitrag eine dreiteilige Beurteilung des aktuellen städtischen Naturschutzes in Südschweden vor.

Abstract

Cities constitute everyday landscape for the majority of Earths' population that thereby benefits from local ecosystem services generated by urban green areas. Therefore urban nature is increasingly becoming part of global biodiversity conservation programmes as well as of strategies for urban sustainability. However, since urban landscapes display distinguishing social and ecological characteristics, implementation of nature conservation policies in cities requires reconsideration of why, where and how to protect urban nature. This paper presents a three-parted assessment of current urban nature conservation in southern Sweden. In the first part nature conservation patterns, described as the number, size, age, land cover patterns and official objectives of designation, of all 1869 nature reserves in southern Sweden, were analysed in relation to municipal degree of urbanisation. In the next part land use changes over time in the proximity of 16 nature reserves in the ten largest Swedish cities were examined. In part three the perceptions of the nature reserves' surroundings, as expressed in management documents and by managers, were assessed in five areas in Stockholm County. It was found that urban nature reserves share certain characteristics that separate them from reserves in rural settings. It was also found that urbanisation adjacent to nature reserves followed the general urbanisation patterns and neither additional increase nor decrease in urban settlements could be detected. Furthermore, the practical management showed limited recognition of potential cross-scale interactions in time and space. In summary the results describe a landscape where urban protected areas become increasingly conceptual and physical isolated. This is a trajectory that risks causing urban biodiversity decline and hence impact the generation of urban ecosystem services and also decrease the public support for nature conservation. For urban nature to become acknowledged as a valuable and integrated part of cities there is a need to shift focus from backward looking protection of nature remains to management of multifunctional landscapes safeguarding the potential for future ecosystem services.

1. Introduction

For long time cities have been excluded from scientific and political discussions about biodiversity (DEARBORN & KARK 2009; KAREIVA 2010 et al.). However, increasingly many urban regions have been acknowledged as biodiversity hotspots (CINOTTA 2000 et al.; KENDLE & FORBES 1997; RICKETTS & IMHOFF 2003), e.g. located in estuaries, along coastlines and in fertile plains. In addition the importance of urban nature for generating various ecosystem services is becoming recognised in programs for urban sustainable development (BOLUND & HUNHAMMAR 1999; CHIESURA 2004; MAAS et al. 2006; UNEP 2011). As a response there is an increasing will to initiate nature conservation programs in cities (ALFSEN-NORODOM 2004 et al.; IUCN 2003; TRZYNA 2007).

The main strategy for biodiversity conservation is to establish protected areas with restricted use and objectives for preservation of natural and social values (BALMFORD 2002 et al.). Today 13 per cent the Earth's surface consists of such protected areas (UNEP-WCMC 2008) and there are numerous national and international institutional frameworks for their establishment and management. Until recently these strategies and tools have had little relevance to urban land use planning, but the current global urbanisation implies two things of importance. First, that urban environment is getting closer to larger protected areas worldwide (MCDONALD 2008 et al.) and second that protection of urban nature becomes increasingly important for sustainable development of cities as well as safeguarding urban biodiversity as part of the global biodiversity (UNEP 2011). Along with urban developments, nature protected areas are now established inside the cities creating a new landscape pattern where strictly nature protected areas are bordered by densely urbanised areas. The overall aim of this paper is to discuss the ecological and social aspects of this new urban landscape pattern. The paper is a synthesis of a three parted study of urban protected areas in southern Sweden and is a condensed version of a PhD thesis in systems ecology defended in February 2011 at Stockholm University (BORGSTRÖM 2011). Details on methods and results is found in following publications BORGSTRÖM et al. (2006), (2011), BORGSTRÖM (2009) and BORGSTRÖM et al. (forthcoming).

2. Southern Sweden as a study site

There are two main reasons for the selection of study site. First, that Sweden has a long tradition of formal urban land use planning (ALFREDSSON & WIMAN 1997) and that Swedish cities largely escaped war damages compared to many other European cities. Second, that Sweden has more than 100 years experiences of formal nature conservation programs (LUNDGREN 2009; SWEDISH PARLIAMENT 1909). These traditions provide long records of land

use strategies that have been implemented in form of urban development and nature conservation and are highly relevant for understanding the emerging urban landscape pattern.

In Sweden 85 per cent of the population lives in cities[1], although the population density is relatively low (23 inhabitants/km^2). Due to large differences in physical and cultural geography between the northern and southern parts, the study was delimited to the southern regions (fig. 1). These are the most urbanised parts, where 32 per cent of the land area hosts 84 per cent of the total population and the ten largest cities are located. Today 10.6 per cent of the Swedish land area is protected and the major part constitutes nature reserves. Therefore the focus of this study was nature reserves. Compared to national parks, land in the nature reserves can be privately owned and the rules are adapted to local conditions. Approximately 70 per cent of all nature reserves in Sweden are found in the south (as of 2006 census).

Even though the urbanisation peaked during the mid 1900s the Swedish urban population is growing continuously. To meet this growth the main Swedish urban planning strategy is densification of built up areas, which means that small green areas within the built up areas are exploited to avoid urban expansions into the larger green structures (BOVERKET 1994). In the largest Swedish cities 27 per cent of the total land area is currently unexploited (ibid), but this proportion, as well as the amount of green area per citizen, is decreasing (STATISTICS SWEDEN 2010). One of the Swedish national environmental objectives is “A good built environment” and includes means of limiting further exploitation of urban nature (SEPA 2010). To fulfil this objective the government assigned the three largest urban regions in Sweden to establish programs for urban nature conservation (SWEDISH MINISTRY OF ENVIRONMENT 2002). The rate of implementation of the programs varies, and is largely dependent on municipal priorities. Still this assignment implies that there is a Swedish political interest in preserving urban nature by establishment of urban protected areas.

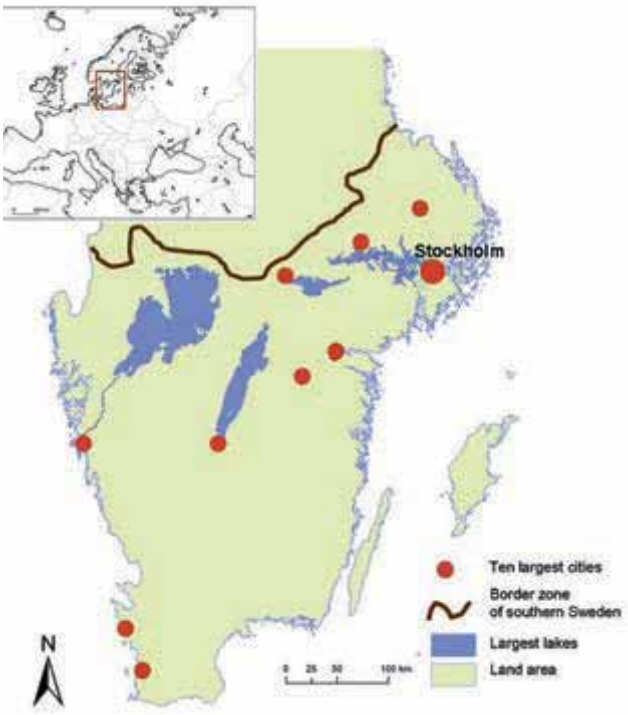

Fig. 1: Southern Sweden (55-60°N, 10-20°E)

3. Aims and methods of the three study parts

The study addressed urban nature conservation at sub-national, regional and local scales and applied both quantitative and qualitative methods.

I: It has been shown that urban landscapes are different compared to for example forests and agricultural lands (ALBERTI 2008). The aim of the first part of this study was to examine if such special characteristics also could be detected for urban protected areas. Furthermore this first part aimed at describing the current pattern of urban nature conservation in southern Sweden. The analyses included 1869 nature reserves in 209 municipalities where the relation between number of nature reserves per municipality, nature reserve size, age, land cover composition and composition of official objectives and municipal degree of urbanisation were statistically analysed (for details see BORGSTRÖM 2009; BORGSTRÖM et al. forthcoming).

II: Studies suggest that urban green areas attract urban settlements (CROMPTON 2005), but such relationship has not been studied specifically for formally protected urban nature. If such relation exists within cities, it implies that urban nature, and especially protected areas, run a higher risk compared to less attractive environments, to become surrounded by built up areas and hence losing ecological connections to other green structures. The second part of this study aimed at examining land use changes in the surrounding of nature reserves over time. In this regional study 16 nature reserves found in the ten largest cities in Sweden were assessed using comprehensive land use maps from 1950-2009. Land use changes in two buffer zones surrounding the nature reserves (500 m and 1000 m) were statistically compared to land use change in the whole city (for details see BORGSTRÖM 2011 et al.).

III: There are important scientific and political incentives for integrating nature protected areas into larger contexts (AHERN 1999; COUNCIL OF EUROPE 1994; EUROPEAN COMMISSION 2000, 2010; SELMAN 2009; TURNER 2005). Also urban planning and urban ecology are promoting large-scale approaches as the future for urban green areas in general (FLORES 1998 et al.; GORDON 2009 et al.; LOVELL & JOHNSTON 2009). From the perspectives of urban nature protected areas, this means relating local measures to neighbouring and regional structures, as well as short term management practices to strategic time frames. In the third part of the study the practical management of five different urban green areas in the Stockholm County was evaluated. The managements were assessed using criteria of ecosystem management that emphasise recognition of spatial and temporal scales and scale interactions (CHRISTENSEN 1996 et al.). Main sources of data were management documentation and interviews with managers (for details see BORGSTRÖM 2006 et al.).

[1] City definition: ”An area with more than 200 inhabitants and 200 meters between the buildings at the most (STATISTICS SWEDEN 2006)

4. Main results

A specific urban nature conservation signature: In the analyses of the first part of this study it was shown that urban nature reserves are different compared to rural ones (fig 2.) (BORGSTRÖM 2009; BORGSTRÖM et al., forthcoming). The more urbanised a municipality was, the fewer and larger were the nature reserves. It was also shown that the urban nature reserves displayed a significantly higher diversity of land covers and a different land cover composition. Similar land cover changes were seen both inside and outside the urban nature reserves but to a different degree. As a result the representation of different land covers also changed with increasing degree of urbanisation (BORGSTRÖM 2009).

Motivated by multiple objectives: Also motivations for establishment of protected areas differed between urban and rural nature reserves. Generally urban nature reserves are established based on more objectives that are more socially oriented compared to rural (e.g. outdoor recreation) (BORGSTRÖM et al., forthcoming). The emphasis on social values implies that the nature reserves are not protected from humans, but instead established for human benefits. This pattern corresponds to a strong competition among land uses where multiple values, including social, are needed to achieve broad acceptance of nature conservation decisions. It is also likely that many of the nature reserves were founded upon already articulated values in for example designated outdoor recreation areas. Even if such strategy leads to effective protection of multiple values, it also means that the selection of nature conservation areas is based on other measures than strategic consideration of current social and ecological values and future needs. A positive consequence is that the social focus and multiple values create as strong identity that appeal to the broad public. Even if an important part of urban nature consists of new or restored nature, these categories of official objectives were seldom used for motivating urban nature protection (BORGSTRÖM et al., forthcoming). Hence it seems to be a focus on existing and even former values in Swedish nature conservation and less interest in areas with potential for the future.

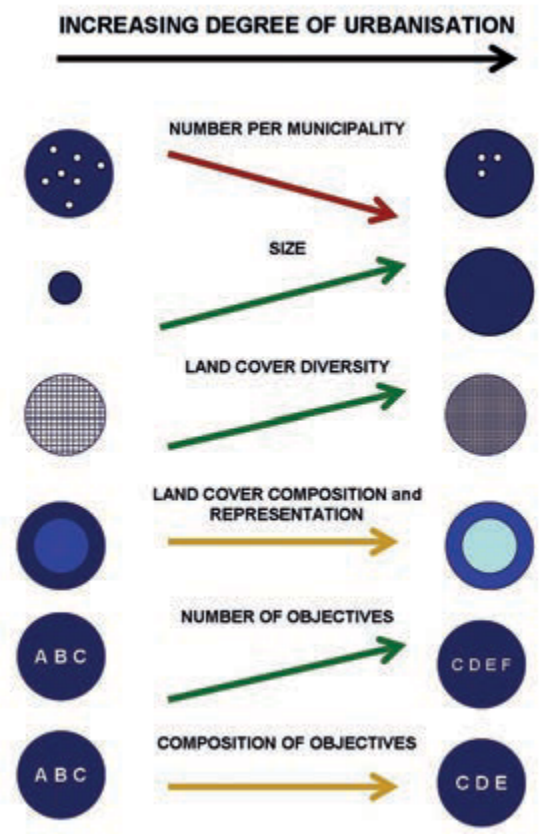

Fig. 2: Urbanisation effects on nature conservation patterns. Green arrows indicate an increase with increasing degree of municipal urbanisation, red arrows a decrease, while yellow arrows indicate qualitative changes (BORGSTRÖM 2009; BORGSTRÖM et al., forthcoming).

Reactive nature conservation: The second part of the study could not detect that establishment of urban protected areas neither enhances nor limits urbanisation at the landscape scale. Instead it showed that the proximate land use patterns largely followed the overall urbanisation trend in the cities (BORGSTRÖM 2011 et al.). The establishments of nature reserves were also found to occur in the aftermath of local urbanisation suggesting that the nature conservation process is directed by perceived and articulated threats from exploitation to certain locally defined values and thus have limited possibilities to impact the surrounding land which is already built up.

Uncoupled management: The evaluation of practical management showed that several spatial and temporal scales were recognized, although interactions across scales were seldom acknowledged (BORGSTRÖM 2006 et al.). Connections between regional and local spatial scales, as well as between long and short time scales, were missing. This is likely a result of the human dominance in urban landscapes that effectively hides many ecological patterns and processes (ELMQVIST 2008 et al.). As an example, a land use division between a nature reserve and a residential area is usually more evident than ecological connections such as a species habitat that stretches over the division or the function of the residential area as an ecological link between the nature reserve and another green area. Since the urban landscape is perceived as hostile by many species, such ecological connections across the urban matrix are highly important (LINDBORG 2008 et al.; MÖRTBERG 2007 et al.).

5. An alternative model for future urban nature conservation

The revealed patterns of urban nature protection described in this study are likely reflections of the urban landscape characters, rather than conscious adaptations to the urban context. However such adaptations are urgently needed to make these areas more useful and functional in the urban landscape. Crucial for future urban nature conservation is the current limited recognition of the surrounding urban landscape, where the nature protected areas risk becoming isolated islands. This is a vulnerable trajectory where these areas are passive receivers of urban dynamics, instead of being active elements of importance for the whole urban system (ERIXON et al., forthcoming). The lack of social and ecological linkages between the protected areas and urban landscape might decrease the public support for conservation and cause degradation of biodiversity and hence impact the flows of ecosystem services. Then the question is if nature protection is at all a useful tool in cities and two arguments promote their continued existence. First, because as long as the different interest of land use in a city is unbalanced in decision making, strong tools are necessary to sustain urban nature and functional ecosystem that provides ecosystem services. Second, because the current renewal of general nature conservation policies needs the urban landscape as a testing

ground since the anthropogenic challenges are especially pronounced here. To make better use of existing and future urban protected areas an alternative model where urban nature, including conservation areas, is perceived, planned and managed as valuable and integrated parts of the urban landscape is needed. This model includes strategies for: i) active planning and management of multiple ecosystem services, ii) focus on border zones and iii) proactive approaches.

5.1 Protecting multiple ecosystem services

The diversity of official objectives used for motivating urban nature protection is challenging in practical management, but given the current shortage of and continued decrease in urban nature, multiple values are necessary and should be actively enhanced and created. An useful concept in this context is multifunctional landscapes that has emerged from discussion on sustainable agricultural landscapes (BRANDT & VEJRE 2004). This concept can be used at different scales in the city and has potential to bridge the division between urban and nature. Still, when using multi-functionality in planning urban land uses, the qualitative questions of what functions and for whom, need to be addressed. Here the concept of ecosystem services is highly relevant since it aims at linking ecosystem functions to human needs and values (MILLENNIUM ECOSYSTEM ASSESSMENT 2005). Crucial questions for the future planning and management of urban protected areas as part of the urban landscapes then become: What ecosystem services are needed now and in the future? Where and at what scale are they needed?, and What kind of urban nature and biodiversity can provide such ecosystem services? An area can for example become protected because of its potential for future local food production, for mitigation of floods due to climate change or because of its importance as an ecological link between core areas at the landscape scale.

5.2 Intermediate urban zones

In an urban setting the promoted large scale approaches means bridging the many divisions and borders throughout the landscape. Conservation areas must be linked to other formal as well as informally managed urban green areas and also to the built up areas. While multi-functionality and ecosystem services can be conceptual tools in this endeavour, there is a need of spatial focus where this bridging needs to take place. Currently urban planning and nature conservation are least interested in the outskirts, near the borders of their authority. However, such edges are since long time known in ecology for their richness and in cities these can be called intermediate urban zones. They are not completely built up and not unexploited. In these locations the co-existence of several ecosystem services can be powerful connectors between the citizens and urban nature. Community gardens, cemeteries, golf courses and other semi-intensive urban land uses are examples of existing important intermediates that need to be highlighted and multiplied. Due to their location, they are likely the areas most prone to urban exploitation, and therefore probably need some kind of formal agreement to be sustained. Such zones are also important since they increase the total area for ecosystem service production in the urban landscape and hence decrease the risk of conflict between incompatible ecosystem services (BENNETT 2009 et al.; KREMEN 2005).

5.3 Increasing the amount of green

Currently urban nature conservation is directed by recent or ongoing urban development possessing threats to existing or former values. This reactive approach offers limited space for strategic planning and leads to increased vulnerability and difficulties in achieving common goals such as sustainable cities. In most cities urban nature is decreasing with consequences such as decreasing accessibility for citizens and ecological connectedness, and conflicts of interests in the remaining areas. If there is a similar shortage in housing or infrastructure, it becomes a political prioritisation and strategic programs for development are often created. A similar strategy would be useful in the case of urban nature, where the forecasted decreases could be met by strategies for how to increase the amount of urban nature. This is not just about greening the built up elements such as roofs, walls and roadsides, but also actually creating new urban nature. Currently there is a strong trend in Europe to build on former industrial sites, railways and harbours. In many cases these sites are nearly zero in nature and hence no nature is lost when they are exploited. However, such locations do not necessarily need to be densely built. They can instead be viewed as opportunities where interest and investments are focused to a particular site and thereby substantially contributing to the overall green structure in urban landscapes. Maybe such industrial and other non-nature sites of potential future importance due to location in the urban landscapes should be assigned as nature protected areas.

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Topic 3

Planning Tools

Ecosystem modelling based on holistic and reductionistic measures in nature conservation planning in urban areas

Alicja SUDER

Zusammenfassung

Dieser Beitrag präsentiert die Ergebnisse einer Vegetationsbewertung in einer mittelgroßen Stadt. Zur Analyse von Vegetationsstrukturen und -funktionen auf einer Patch- und Landschaftsebene sowie zur Prüfung ihrer Anwendbarkeit in der räumlichen Planung und zur Vegetationsüberwachung in städtischen Gebieten werden holistische sowie reduktionistische Ansätze angewandt.

Schlüsselwörter: holistische und reduktionistische Ansätze, Vegetation, Landschaft, Naturschutz in städtischen Gebieten

Abstract

This paper presents the results of vegetation valuation occurring in a medium-sized town, based on holistic and reductionistic approach to recognize vegetation structure and functioning at the patch and landscape levels and to explore their applicability in spatial planning and vegetation monitoring in urban areas.

Key words: holistic and reductionistic approaches, vegetation, landscape, nature conservation in urban areas

1. Introduction

Nowadays the majority of people live in urban areas, thus urbanization is considered as one of the processes which significantly contribute to ecosystem change on the Earth. Human impact on flora and vegetation appears by their qualitative and quantitative changes such as the size of species pool and the variability of species traits, caused by selection pressure as well as their spatial transformations, resulting from different availability of habitats and their spatial arrangements. Reductionistic approaches do not recognize complexity of the landscape features and various factors which govern them, using a single measure i.e. naturalness which is very general and difficult to apply in nature conservation practice in a changeable environment. Although holistic approaches assume more detailed measurement of features of a set of landscape components, they take into account dynamic aspects of ecosystem functioning as a reference measure of vegetation structure rather then the characteristic species composition. The reason is that nature conservation in urban areas is claimed to be different from traditional approaches, because less emphasis is placed on rare species or habitats and considerable weight is given to the values and benefits of urban wildlife to local people. Consequently, vegetation is assessed on the basis of self-organizing theory and diversity-stability models which join the requirements of biodiversity preservation with human economics and human perception of landscape in spatial planning (HEARNSHAW 2005 et al.). As a result, the exploration of social preference play important role during compilation of spatial management plans and tools of social influence to enhance those activities which favour the maintenance of species and ecosystems.

Numerous ecological theories which explain in different ways the complexity of ecosystem structure and functioning, are applied in nature conservation practice, then ecological indicators become a specific conservation value of ecosystems. Consequently, nature conservation based on the information theory give a higher value to ecosystems composed of many elements (species), in contrast to community ecology background which weights the importance of information included in the natural systems. The maintenance of high species richness without community context requires enlargement of green areas in parallel with constant human interference in condition of shortage surface within towns and their expansion into adjacent areas. Because of such a reason, the preservation of rare ecosystems in regional scale within urban areas and species diversity (β) connected with them gain primary importance.

The methodical aspect of preservation state in ecosystems' modelling is an assumption of their intrinsic dynamics, determined by the size of ecological niches of constituent species which is described in conservative terms (correlative models) or adaptation (models based on functional traits and species response to environmental conditions) as well as ecological niche dynamics resulting from genetic variability. Dependently on the measurement scale, species diversity is shaped by microhabitat conditions and the area size (α diversity) but also depends on the average value of environmental parameters and species interactions (β diversity) at the community level. Regardless of established model (additive or multiplicative) the both aspects of species diversity determined γ diversity according to the following formulas: $\alpha + \beta = \gamma$; $\alpha \times \beta = \gamma$, respectively. As a result one may distinguish two kind of habitat heterogeneity: those, resulting from microhabitat diversity and habitat area (α) and those related to habitat feature (β). Both components are influenced by spatial factors, defined by neighbourhood and distance between patches (meta-communities) as well as the history of land use (temporal structure) (ANDERSON 2011 et al.). Although the increment of both components of natural system diversity at the landscape level, their influence on species composition within plant communities is different. The maintenance of stable ecosystem, it means capable to independent functioning is the basic goal of nature conservation, thus estimation of preservation state and the direction of ecosystem change within commune town, which was the main goal of undertaken studies, were done based on characteristic species composition. The supplementing and more detail inside into community structure based on functional diversity of constituent species enhances the power of ecological forecasting of ecosystem change, incorporating demographic features and neighbouring

vegetation in ecosystem modelling (TILLMAN 1994). As the basis of this study, I assumed, that demographic processes and species interactions modified by the method and intensity of land management play an important role in structuring vegetation within particular quarters (local scale) but spatial features affect on vegetation variability at the town scale.

2. Methods

The basic aim of this compilation was to valuate vegetation within commune town – Trzebinia, located in the southern part of Poland, on the border of the Silesian Upland (the northern part) and Krakowsko-Częstochowska Upland (smaller, southern part). The town is distinguished by the long-standing industrial tradition, started at the beginning of the XIII-th century, when the first zinc and lead mines were established and the pick of development in the second part of XX-th century when three coal and one dolomite mines, refinery, ironwork, power plant and many light industry were functioned. Nowadays, the distribution of different economic branch within this urban area is presented in Fig. 1.

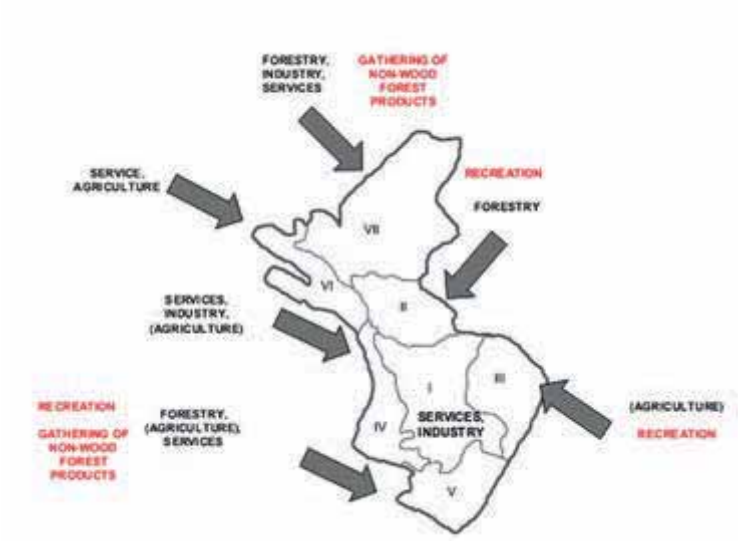


Fig. 1: Location, division and the way of management of investigated area (Coordinates: 50° 09' N; 19° 28' S; Altitude: 315 M)

To identify plant communities, flora and vegetation inventory was done according to Braun-Blanquet approach. Based on the data set of 225 vegetation samples (preferential sampling procedure) and hierarchical clustering (presence/absence data – Jaccard formula, abundance data – Ruzicka formula, UPGMA) 52 plant communities were distinguished. Cophenetic correlation was calculated to compare the accuracy of classifications with the ordination results (PODANI 2001). Based on the land use forms, appointed by the index of built-up areas, vegetation cover as well as dominating type of economy, the town area was divided on seven quarters which partially are consistent with the administrative division. The calculated Simpson diversity index for vegetation within each distinguished part of town was correlated with scores of PCA (for binary data). However, the obtained results showed lack of significant correlation between environmental gradient and species diversity within town centre which might be the result of spatial effect and strong dependability of Simpson index on evenness model, thus this part of analysis was omitted in this compilation.

To estimate the magnitude of environmental influence on preservation state of plant communities, including the length of spatial gradient, raster map was done (municipality order, "Proglob" company) which covered the whole town area. Vegetation cartography was done based on aerial photo and remote sensing data. Vegetation sampling was conducted using stratified random sampling procedure. Preferred method of ecosystem management in relation to expected benefit of local society from natural resources was investigated on the basis of revealed preferences. The estimation of landscape fragmentation was done by calculating aggregation index for distinguished vegetation patches, scaled to value I – IV (range from small to high fragmentation) (URBAŃSKI 2008). The spatial and habitat gradients resulting in different species turnover were investigated using non-metric multidimensional scaling (NMDS, Bray-Curtis formula) and detrended correspondence analysis (DCA). The values of component scores of two DCA axes were correlated with the values of ecological indicators for species (ZARZYCKI 2002 et al.) and scaled distance between vegetation samples using multiple regression analysis to label gradient into ordination axes. Constrained canonical correspondence analysis (CCA) was applied to reveal the influence of spatial and habitat gradients on vegetation groups (forests, meadows, grasslands and bushes). To forecast the direction of species composition change during secondary succession on non-managed grasslands, functional diversity indices were calculated (LEP˝S 2006 et al.; SCHLEUTER 2010 et al.) in parallel with modelling of distinguished as the important species traits using minimum spanning tree (MST) (PODANI 2001). All analyses were done in SYN-TAX, Statistica, ArcGIS software.

3. Results

Vegetation of commune town is composed of 52 natural and semi-natural plant communities representing water, rush, marshy, xerothermic and sandy grasslands, bushes and forest patches listed in Fig. 2. Species richness is more diversified along environmental gradients (the range of dissimilarity: min. = 0.0047, max. = 0.9892 level for dendrogram based on presence/absence data), however less connected with habitat features (cophenetic correlation = 0.7960) suggesting the significance of spatial effect in shaping diversity of vegetation patches. Changeability of species abundance is lower (the range of dissimilarity is more narrow as follows: min. = 0.6349, max = 0.9973 level for dendrogram based on quantitative data) but strongly correlated with habitat characteristics (cophenetic correlation = 0.9783).

Flora analysis revealed the occurrence of 642 taxa of vascular plants, among which 16.2% is *anthropophyta*, most commonly *ergasiophygophyta* (39.6%) and *agriophyta* (30.2%). Nitrophilous species are the most numerous among the habitat groups (18.7%), in contrast with the groups of water plants (1.7%) and heath or species-poor *Nardus* grassland (2.5%). 38 species of town flora are protected under Polish law and 84 taxa are locally endangered which together constitute about 19% of overall town flora. Within particular quarters the distribution of historic-geographical groups is not uniform, revealing the greatest percent of alien species (including cultivated ones) within I and V quarters as a result of their introduction by landscape architects, private persons or foresters.

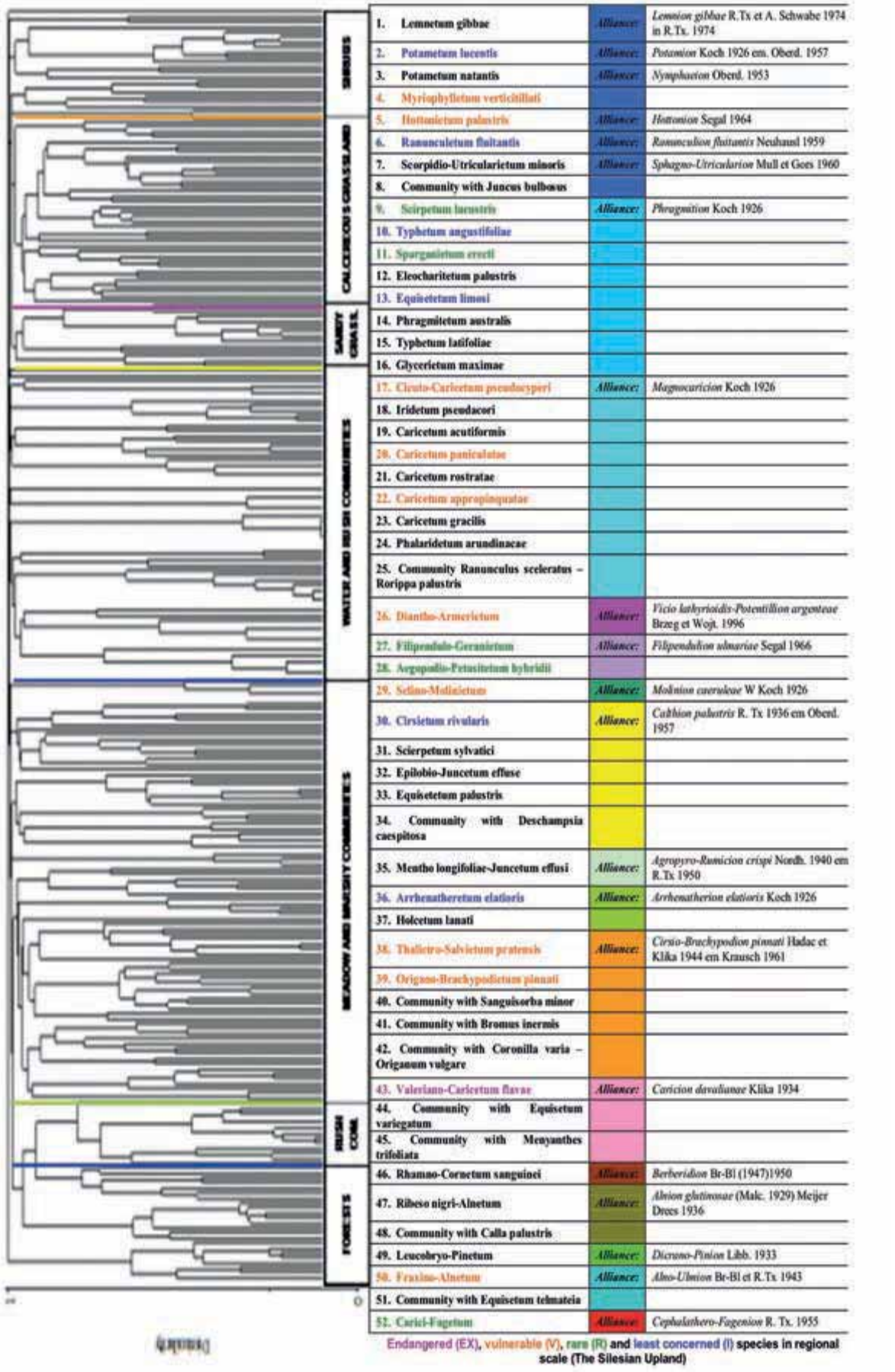
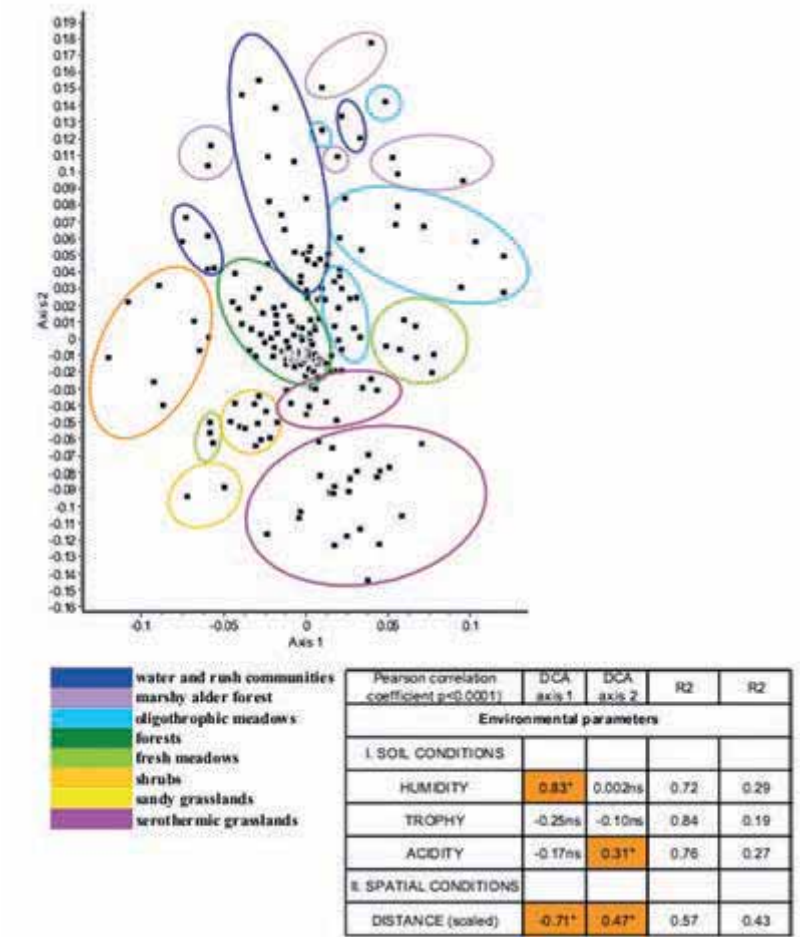


Fig. 2: Unconstrained classification of vegetation samples (abundance data) done within the patches of natural and semi-natural plant communities in the town area.

Among 96 protected and rare species within town quarters, three were found only on secondary habitats and one – *Epipactis helleborine* – classified as characteristic for the common beech forests does not show any habitat preference. The high value of species diversity index for the town centre is due to high portion of alien species, but species richness of IV-th part is connected with habitat heterogeneity. The low value of species diversity index in the area of VII-th quarter results from habitat homogeneity and low variability of plant communities, mainly composed by coniferous forests.

The changeability of species composition along gradients suggest the primary role of habitat humidity and distance in shaping the vegetation structure as well as secondary significance of habitat acidity, which may be related to calcium carbonate content or habitat fertility (Fig. 3). However within particular town quarter, the length of environmental gradients determining species diversity and turnover was created by humidity and management.

The influence of spatial and habitat effect on species composition among particular type of habitat (forests, meadows, grasslands and bushes) is not equal. Taking into account habitat age and the way of ecosystem management as well as spatial effect (neighbourhood) in constrained ordination (CCA), species diversity of forest communities is mainly shaped by humidity gradient thus environmental filtering strongly prevail, in contrast with meadows and grassland whose community composition is determined by spatial effect, most probably as a result of the abandonment of mowing practice.



Pearson correlation coefficient p<0.0001	DCA axis 1	DCA axis 2	R2	R2
Environmental parameters				
I. SOIL CONDITIONS				
HUMIDITY	0.83*	0.002ns	0.72	0.29
TROPHY	-0.25ns	-0.10ns	0.84	0.19
ACIDITY	-0.17ns	0.31*	0.76	0.27
II. SPATIAL CONDITIONS				
DISTANCE (scaled)	-0.71*	0.47*	0.57	0.43

Fig. 3: Ordination of vegetation samples along environmental gradients (NMDS, DCA – correlation of component scores for two axes with environmental data in multiple regression analysis)

The highest concentration of not-mown grassland patches was found within the III-th quarter. Incorporating their spatial contact with vegetation of former arable lands, dominated nowadays by *Solidago sp.* patches and classifying vegetation according to their species traits at the community level (MST), the most probable direction of grassland change is their transformation into monoculture built by *Solidago sp.* population or bushes communities (Fig. 4).

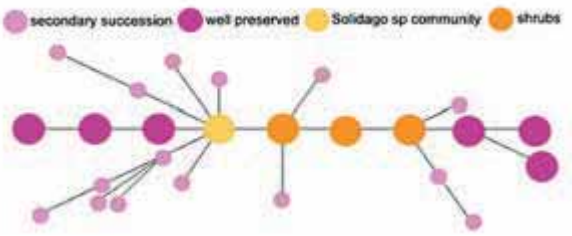


Fig. 4: Minimum spanning tree of vegetation samples based on important traits for secondary succession in unmanaged grasslands

4. Conclusion

Vegetation of commune town, explored during this study, shows high variability and diversified preservation state. The habitat patches with regional importance in terms of conservation value are concentrated within the II-nd and the IV-th quarter. However, local society does not recognize the whole potential and value of some ecosystems thus the abandonment of grassland management prevail which has primary importance in grassland maintenance.

The phenomenon of rare species occurrences on secondary habitats as well as the lack of habitat preference of such an taxa which is classified as diagnostic species, suggest the need of further investigation of their adaptations in broader scale (across climate and human impact gradient) to estimate the scale and magnitude of this effect, to enhance the forecasting of species composition change and mean time to extinction of populations as well as create the adaptive maps.

Balancing the scale of human impact on natural habitats to preserve ecosystem values and to provide healthy environment for people is the core issue of modern spatial planning. The maintenance of ecosystem remnants is more effective strategy from ecological and economic perspectives then habitat creation. Therefore, the preferences of local society, including inspiration for economic development should be weighted by the value and the level of ecosystem vulnerability in broader, it means a regional scale.

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The courtyards of Cordoba in Spain.

Social functions of private spaces in historical neighbourhoods

Carlos PRIEGO GONZÁLES de CANALES, Luis Rodríguez-Morcillo BAENA & Jürgen H. BREUSTE

Fig. 1: Courtyard of a single-family dwelling (Priego, C.)

Zusammenfassung

Städtische öffentliche Räume bieten seit Langem ideale Rahmenbedingung für Sozialisationsprozesse und Austauschmöglichkeiten zwischen den Bürgern. Dieser Beitrag zeigt jedoch, dass auch bestimmte private Räume, wie Hof-Häuser der Stadt Cordoba (Spanien) gleichwertig zu öffentlichen Räumen anzusehen sind und alle sozialen Leistungen bieten, die normalerweise urbanen Räumen zugeschrieben werden.

Dieser Artikel untersucht den Diskurs der Bürger von Cordoba über Häuser mit Innenhofgärten. In der Studie wurden Befragungen mit fünf Diskussionsgruppen unterschiedlichen Alters, Geschlechts und mit unterschiedichen Wohnorten (Häuser mit Innenhofgärten im Vergleich zu Wohnblocks) durchgeführt. Die Ergebnisse zeigen, dass die Innenhöfe der Stadt Cordoba eine unvergleichliche Umgebung für sozialen Austausch innerhalb der Nachbarschaften bieten. Die Hof-Häuser stellen für deren Bewohner einen Raum der Begegnung dar, der ein hohes Maß an persönlicher Entwicklung und Wohlbefinden gewährleistet.

Schlüsselwörter: Lebensstil, Wohlbefinden, historische Stadtviertel, Innenhöfe von Cordoba

Abstract

Urban public spaces have long been considered an ideal setting for processes of socialization and interaction between citizens. This paper, however, shows how certain private spaces, such as the courtyard houses of the city of Cordoba (Spain) are on a par with public spaces and provide all the social benefits to the users, normally attributed to urban spaces. This article examines the discourse of citizens of Cordoba regarding houses with courtyard gardens. The study was conducted with five discussion groups comprised of people of different ages, sex and place of residence (houses with courtyard gardens versus blocks of flats). We conclude that the courtyards of the city of Cordoba provide an unparalleled environment for social interaction within neighbourhoods and a space where residents encounter all that they need to achieve a high degree of personal development and well-being.

Keywords: Life style; Well-been; Historical neighbourhoods; Courtyards of Cordoba

1. Introduction

Studies carried out in Spain by CORRALIZA (2000) on urban public spaces have shown the important role of open urban spaces regarding their use and perception by different cultures. Regarding the cultural perception of these spaces, WARD (2002) states that in the last century, Northern European countries began to view public spaces as settings for cultural exchange and the expression of both personal and cultural diversity. The identity of urban spaces is intimately linked to the social relations that take place within them; be they of a spontaneous nature or the result of commercial, religious and political activity or even the effect of fashions (CANTERO et al. 2000). Studies conducted by MARANS and SPRECKELMEYER in 1981 and later extended upon by WEIDEMANN and ANDERSON in 1985 examined the relationship between the objective conditions, subjective experiences and satisfaction of residents with their environment. These authors demonstrated the importance of the correlation between the physical and social elements of neighbourhoods and the quality of life of their residents.

Other studies have also analysed resident satisfaction as a dependent variable, or as an indicator of quality of life in neighbourhoods. Studies on resident satisfaction with their living environments have been conducted at the national scale (MARANS & RODGERS 1975; CAMPBELL et al. 1976; DAVIS & FINE-DAVIS 1981) and at the local scale (GALSTER & HESSER 1981). The study by PRIEGO et al. (2009) explores citizens' satisfaction with their most immediate natural environment. In the study, the authors conclude that both the education and socioeconomic status of users are variables that influence how citizens use and enjoy urban green spaces.

Other researchers have examined residential satisfaction in different types of neighbourhoods including low-income areas (FRIED & GLEICHER 1961) or public housing developments (YANCEY 1971; AMERIGO & ARAGONES 1990).

However, upon reviewing the literature, we found that few studies examine the correlation between aspects of traditional neighbourhoods and resident satisfaction. The use, perception and satisfaction of residents living in traditional neighbourhoods or the typology of dwellings are therefore socio-cultural aspects that warrant further study.

To carry out this research, we selected the houses with courtyard gardens of historical quarter of the city of Cordoba (Spain). Rather than being simply architectural structures, these courtyard gardens provide a space for social interaction and cultural expression, accommodating a lifestyle that is specific to this particular urban environment and in which the boundaries between the private and the public sphere are blurred.

2. Courtyard gardens of Cordoba

The historical quarter of the city of Cordoba (Spain) has numerous houses with courtyard gardens. Rather than being simply architectural structures, these courtyard gardens provide a space for social interaction and cultural expression, accommodating a lifestyle that is specific to this particular urban environment and in which the boundaries between the private and the public sphere are blurred.

With the arrival of the Muslims to Cordoba (711 A.D), courtyards took on greater importance and came to incorporate new elements such as fountains and gardens to recreate the Muslim vision of paradise. Since that time, courtyards have acquired a social function as a place to engage in social relations, gather with family members and neighbours in the outdoors and enjoy nature within the confines of one's home.

Fig. 2: Courtyard of a single-family dwelling (Priego, C.)

Fig. 3: Courtyard like corridor of multi-family dwelling (Priego, C.)

Fig. 4: Courtyard of a multi-family compound (Priego, C.)

The courtyard gardens of Cordoba have changed little over the years, but stand out for their variety. One type of courtyard can be found in stately homes, convents or former hospitals. A second type is of more modern construction, while the third corresponds to courtyards in traditional homes. This last type of courtyard can be found in private dwellings, the majority of which are inhabited by several families that care for their courtyard garden throughout the year.

The courtyards of Cordoba not only reflect a unique and traditional way of life, but are one of the most popular and folkloric events that take place in the city in the month of May. First held in 1918, the festival of the courtyards of Cordoba seeks to promote the intangible heritage of humanity. The festival emerged in a spontaneous manner following the arrival to the city of a rural population that brought with it a simple lifestyle based on community relations. For several weeks during the month of May, residents in houses with courtyards open their homes to visitors so that they can enjoy the splendour of their gardens and a lifestyle that has been handed down over the centuries in the heart of Cordoba's historic quarter.

3. Objectives of the study

The general objective of this study was to gain greater insight into the perceptions and attitudes of the citizens of Cordoba regarding the city's traditional courtyard gardens and shed some light on how they are (and have been) used on a daily basis and for social purposes.

In addition to this general objective, a series of specific objectives were set out as follows:

• Determine the social and symbolic significance of the city's courtyards for the citizens of Cordoba.

• Explore differences between people living in dwellings with courtyards and those who do not reside in dwellings of this kind.

• Gain insight into general attitudes towards the courtyards as regards their social, economic and festive functions and as a space of coexistence.

4. Methodology

In order to achieve the above objectives, discussion groups were chosen as the most appropriate qualitative method for the study. The discussion groups were comprised of 5-6 participants (group I had only 5 participants). One session was held for each group in which participants were asked to talk about aspects they believed to be most relevant to the topic at hand.

Three structural variables were taken into account when designing the groups; i) citizens who reside or do not reside in the historic quarter of Cordoba, ii) citizens who participate or do not participate in the "Patios Cordobeses" courtyard competition and iii) the age of the participants.

GROUPS WHOSE MEMBERS DO NOT RESIDE IN THE HISTORIC QUARTER OF CORDOBA (NON-RESIDENTS)		
GROUP I	**Age:** 22-30 years of age **Size of group**: 5 individuals **Sex**: 3 males, 2 females **Place of residence**: Outside historic quarter	**Educational level**: Minimum secondary education or first-cycle vocational training. Maximum university diploma or vocational training. **Occupation**: Active population (employed or unemployed).
GROUP II	**Age:** 45-60 years of age **Size of group**: 6 individuals **Sex**: 2 males, 4 females **Place of residence**: Outside historic quarter	**Educational level**: Minimum primary or middle school education. Maximum secondary school or vocational training. **Occupation**: Active population (employed or unemployed) or inactive population (housewives or retirees).
GROUPS WHOSE MEMBERS RESIDE IN THE HISTORIC QUARTER OF CORDOBA (RESIDENTS)		
GROUP III	**Age**: 35-50 years of age **Size of group**: 6 individuals **Sex**: 2 males, 4 females **Place of residence**: Historic quarter of Cordoba **Competition**: People who have participated in the courtyard competition at least three times in the last 15 years.	**Type of dwelling:** - Single-family dwelling with courtyard. Minimum three members in household. - Multi-family compound with a shared courtyard: minimum 2 or 3 people.
GROUP IV	**Age**: Over 50 years of age **Size of group:** 6 individuals **Sex**: 6 females **Place of residence**: Historic quarter of Cordoba **Competition**: People who have participated in the courtyard competition at least three times in the last 15 years.	**Type of dwelling:** - Single-family dwelling with a courtyard: minimum 3 people. - Multi-family compound with a shared courtyard: minimum 2 or 3 people.

Tab. 1: Characteristics of Discussion Groups

The study was designed in this manner to obtain the maximum amount of information from people of Cordoba about an issue on which it was assumed that different groups had varying opinions. For this reason, more importance was given to the variable "live in the historic quarter in a courtyard house or live outside the historic quarter in a flat".

5. Attitudes and perceptions of citizens towards the courtyards of Cordoba

The significance of courtyard houses for the citizens of Cordoba is a complex topic that encompasses many aspects of both their social and personal lives. Although the courtyards have a special significance for all the groups, clear differences can be observed due to the specific characteristics of each social class represented by the groups.

5.1 Cultural heritage

While the discourse of non-residents (Group I, II) places greater emphasis on aspects having to do with their social life and the heritage value of the courtyard houses, residents (group III, IV, V) attach more importance to personal and private aspects. The reason for this difference could be due to the fact that the members of the first group (non-residents) do not own courtyard houses, nor do they have easy access to them. Although the courtyard houses are privately owned, placing importance on the social and heritage value of these dwellings is a way for non-residents to make this type of dwelling their own.

For the group of older adults (Group II) courtyard houses are the most important festive tradition during the month of May in Cordoba. Courtyard houses are viewed as being an element of their cultural heritage that must be preserved and promoted through measures to encourage young people to live in them. The courtyards are perceived in terms of cultural tradition. As the members of this group state, courtyards are more than just an architectural structure, but serve to safeguard traditions. For this reason, the courtyard festival is a very popular event and a meeting place for social interaction.

W: They are part of our history, our heritage, what happens is that they are not built... They are something more than just a structure, they are what they are, I mean, houses with courtyards and then the tradition of the festival… (Group II)

According to this group, the courtyards are synonymous with adopting and respecting traditional architectural structures and the urban legacy left by the Romans and Arabs. Preserving this tradition therefore means accepting one's own culture and interacting with one's ancestors. Respecting the lifestyles and traditions handed down over the generations (in this case the courtyards) is a way to reunite with one's ancestors and link the past to the present. For this group, the annual courtyard event symbolises the veneration for and remembrance of ancestors whose memory is kept alive through the courtyard houses. In short, the annual ritual encounter with ancestors transcends generations.

The three groups of residents (Group III, IV, and V) make few references to the heritage value of their dwellings, although they do attach importance to the fact that they own such homes. The group of middle-aged residents who participate in the competition (Group III) view the courtyard houses as being part of the city's heritage and believe that is important to implement measures to facilitate and promote their conservation. In contrast, the older women in Group IV do not make mention of the heritage value of their homes, whereas the group that does not participate in the competition (Group V) places more importance on the lifestyles and customs attached to these dwellings rather than their value as architectural heritage. In short, the three groups differ in terms of how they perceive the heritage value of these dwellings, their role as owners and the use to which they are put, with the most marked differences being found among older women.

According to the group that does not participate in the competition, the courtyard houses represent a traditional way of life that the festival has kept alive. The members of this group identify these homes with the image of an elderly woman caring for and adorning her courtyard and without whom both the house and the courtyard would merely be a lifeless architectural structure.

5.2 An enormous privilege

Those who live in courtyard houses are viewed as being privileged. As with the question of heritage, a distinction can be made between the public and private sphere of this type of dwelling. According to one of the groups of non-residents, it is a privilege to live in these exclusive homes as they permit their owners to come in contact with nature. Furthermore, non-residents highlight the high heritage value of these homes, equating them with other important cultural and artistic monuments. The group of young non-residents (Group I) expressly refers to courtyards houses as a privilege, highlighting the fact that the courtyard festival is the only one of its kind in all of Andalusia. They also believe that the owners of courtyard houses are privileged to live in such a unique architectural setting and place such dwellings on a par with the Mosque-Cathedral of Cordoba; declared a world heritage site. They view the courtyard houses as being unique and equate them to other world famous monuments. The unique nature of the courtyards is further corroborated by the fascination and awe of visitors, thus reinforcing the idea that those who live in such an exclusive and enchanting setting are privileged.

W: …But I don't think that the Eiffel Tower is better than the courtyards, for example. Because, even though the Eiffel Tower is a very pretty tower, there are lots more towers. It's like what someone was saying before, that the courtyards are one of a kind, they are one of a kind, you said so before, they are one of a kind. There aren't any other courtyards anywhere in the world.

M: The courtyards are only in Cordoba. (Group I)

The most widely-extended feeling among residents is that living in a house with a courtyard is a privilege that people who live in barren and unwelcoming urban areas replete with blocks of flats are unable to afford. Indeed, these residents consider themselves to be just as privileged as people who live in houses in the middle of nature and believe that their elaborately decorated courtyard gardens provide a "ray of hope" for those who live in crowded, built-up areas. They also feel privileged to be able to preserve a unique, small-town way of life (that of the historic quarter and its spatial organisation) in their very own neighbourhoods; a lifestyle which is gradually being lost. In contrast to the confined and cloistered lifestyles so typical of large cities, quality of life is a concept that is associated to these homes.

M: …well, yes, I am one of the few privileged people that can be counted on the fingers of your hand, in the sense, […] Think about the people who live in Madrid, in Barcelona, in those huge blocks of concrete…

W: It's a little ray of hope that we offer them. (Group III)

5.3 Personal development

The courtyard houses are closely linked to the personal development of those who live in them. For the group of older non-residents (Group II), the courtyard gardens are viewed as an extension of those who plant and care for them and an opportunity for family members and neighbours to collaborate together. The true meaning of these dwellings lies in the enjoyment gained from caring for these gardens; a sentiment that is even stronger among those who had courtyard gardens during their childhood.

M: I really like the courtyards, the trees and plants. For me they're … and when I was a kid, a child, I have six brothers and sisters, I had 300 flowerpots in my house, they were mine, not my mother's. They were mine, I took care of them, I painted them and that was just wonderful, nowadays no one does that. (Group II)

The three groups of residents view the courtyard houses as being of special importance to their personal development, albeit in a different manner. For the group of young adults who participate in the competition (Group III), the courtyard houses are a reaffirmation of the fact that they are owners of these spaces, while taking care of them is viewed as a manifestation of their creative ability. For the group of older women (Group IV) who take part in the competition, the courtyards provide the opportunity to put their gardening know-how to use, while the competition gives them the chance to integrate into a society which views them merely as housewives. For the group of residents who do not participate in the competition (Group V), the courtyards are a form of self-affirmation that distinguishes them from other citizens who are unable to enjoy the pleasures the courtyards offer.

5.4 Socialisation

Social interaction is one of the dimensions that respondents with courtyard houses comment upon most in their discourse. But this dimension does not hold the same meaning for all the groups. The non-residents groups (Groups I and II) and the residents who do not participate in the competition (Group V) refer to social interaction in terms of privacy and strong ties with others. Here we include privacy because although it occurs in the private domain, it is another form of social interaction, that is, another aspect of socialisation. For example, the younger non-residents (Group I) consider owning a courtyard house is synonymous with being in constant contact with nature. The older non-residents (Group II), however, state that the courtyard gardens encourage interaction with neighbours, but they do not make reference to family relations within the garden setting itself. In the opinion of the residents who do not participate in the competition, life in the courtyard garden is an extension of the rooms of the house, which depending on the weather, takes place either indoors or outdoors within the natural setting of the courtyard. Hence, they consider courtyard houses to be very versatile for socialising with friends and family.

W: That's beautiful. Can you imagine what it's like to get home when it's not open to the public and realise that all of this is mine, that you live among flowers? That's just great! (Group I)

However, the two groups of residents that participate in the competition (Groups III and IV) develop social ties of a different scope. They highlight relationships with friends, families and across generations in addition to broader social relations such as those they engage in with visitors, the public administration and other citizens with whom they share their knowledge.

Blocks of flats are interpreted by the young residents as lonely places inhabited by an anonymous multitude compared to the harmonious coexistence that occurs within courtyard houses. These dwellings and the urban setting in which they are located form a whole comprised of family members and neighbours; a sort of hamlet which provides the security and love that is missing in the multitude.

Another level of social interaction is that which occurs between neighbours who come together to care for the courtyard garden and share their gardening know-how. Through this social interaction, knowledge about gardening techniques is passed down from generation to generation by mothers and other close relatives. In this way, courtyards also serve to maintain family traditions and customs alive. The courtyard competition also stands out in the discourse as an occasion to engage in social relations of this kind since the event encourages the sharing and transmission of knowledge about gardening. During the competition, social interaction occurs with people from all over the world, to whom the dwellers often transmit their knowledge. This role is further reinforced by the satisfaction and social recognition they gain from doing so.

6. Conclusions

This research study shows how the typology of a particular type of dwelling, the courtyard houses of Cordoba, positively influences personal development and enhances the quality of life of its dwellers.

The citizens of Cordoba attach special importance to the courtyard houses as they not only provide a setting for social interaction, but also a sense of community. The courtyard gardens are an important social event that encourages social relations and the conservation of cultural heritage, while providing a sense of identity that goes beyond the identity attached to the city's historic monuments.

Our analysis has shown that courtyard houses are not simply dwellings inhabited by people, but reflect a lifestyle full of close and varied social relations based on community values. The courtyard houses of Cordoba symbolise a past in which people lived in close contact with one another in large multi-family compounds with other families of their same social status.

Contact with nature and enhanced quality of life

Today, the courtyard gardens are the setting for a wide range of social relations and activities that lend them their particular meaning and significance. In the private sphere, courtyard houses offer numerous advantages. These include providing a space to come in contact with nature and stimulate the senses, contemplate and care for plants and flowers. These are all activities that those who dwell in these homes hold to be a privileged; a privilege they share in common with inhabitants of other courtyard houses. Unlike the lifestyle in blocks of flats, living in a courtyard house is considered to be therapeutic and synonymous with quality of life.

Courtyard houses and the personal development of their inhabitants

In terms of social relations, the courtyard is a space for families and neighbours to gather and interact on a day-to-day basis. For women, the courtyard is also a place to relax, but is perceived more as a space to do some gardening or decorate either alone or in the company of other family members. The courtyard is also a setting for family celebrations associated to rites of passage or weekend leisure activities, which are almost always enjoyed in private removed from the gaze of others. Thus, the courtyard is a place where owners

and friends interact socially, achieve personal development and preserve cultural heritage. Accordingly, the courtyard constitutes an important element for personal development.

The courtyard as a place for community relations

In this study, we have made a clear distinction between type of dwelling and the relations or activities engaged in by those who use them. While those who live in houses with a private courtyard interact with neighbours who dwell in similar homes, residential townhouse developments that share a common courtyard engage in social relations that are more characteristic of blocks of flats.

This study, however, shows how certain private spaces, such as the courtyard houses of Cordoba, are the primary places where the neighbourhood residents interact (Groups III, IV and V). For the owners of this type of dwelling, caring for and decorating their courtyard garden, particularly for those who take part in the courtyard competition, improves relations among neighbours and helps to create a sense of community and strengthen social ties. Exchanging gardening know-how and materials, chatting about the best way to care for plants and flowers or discussing the competition are activities that bring neighbours together on an almost permanent basis; a situation that sometimes even includes family members who are not involved in caring for these gardens.

In this study we show that the courtyards of Cordoba compete with the city's public green spaces not only in terms of bringing citizens in contact with nature, but in terms of the social benefits they provide. The article reveals that those who live or care for their courtyards, maintain them in good condition or take part in the courtyard competition attain greater personal satisfaction than people who live in other kind of houses without courtyards or private gardens. In cities, like Cordoba, where historic neighbourhoods have few green and social spaces and where citizens can not interact and keep in contact with nature, courtyards play an important role in the social life of the neighbourhoods where they are found as they provide a space in which to interact, exchange information, forge identities and come in contact with nature; but most importantly, they are a space for personal development and well-being.

We consider that further research is needed to improve our understanding between owner satisfactions of the courtyards with nature of theirs houses. In historic neighborhoods of Cordoba, the only contact some citizens have with nature is in the courtyards of their homes.

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Recognition of the ecological structure of mining areas as a premise for landscape shaping

Katarzyna FAGIEWICZ

Zusammenfassung

Im polnischen Flachland (NIZ Polski) findet man Bergbaufolgelandschaften in verschiedenen Stadien der Entwicklung (Öffnung, Extraktion und Rückgewinnung). Diese sind geprägt vom offenen Braunkohletagebau, der seit über 50 Jahren in Betrieb ist. In diesen Gebieten wurde die ökologische Struktur der Landschaft untersucht und dabei ein besonderes Augenmerk auf ihre Verbindungen mit den angrenzenden Geosystemen gelegt. Dadurch können Veränderungen in den Geosystemen durch Bergbautätigkeiten identifiziert werden und die ökologischen Vernetzungen in der Landschaft zwischen Geosystemen und überdurchschnittlich natürlichen Merkmalen beurteilt werden.

Die Identifizierung der Bereiche, die regeneriert und zurückgewonnen werden sollen, um die strukturelle Konnektivität der natürlichen Systeme in den Prä- und Post-Bergbaugebieten zu erhalten, ist von entscheidender Bedeutung für die Festlegung von Richtungen der Landrückgewinnung und der Beurteilung der Wirksamkeit von durchgeführten Rekultivierungsmaßnahmen. Die Ergebnisse der Untersuchungen können verwendet werden, um laufende Rekultivierungsmaßnahmen anzupassen sowie zukünftige zu planen.

Abstract

There are mining landscapes in various stages of development (opening up, extraction and reclamation) in the Polish Lowlands (Niż Polski), shaped by open-pit lignite mine that has been operating there for over 50 years. The landscape ecological structure was examined in those areas and a particular attention was paid to their connections with adjacent geosystems. This allowed for determining the changes caused by mining activity in geosystems and to assess the landscape ecological connectivity between geosystems with natural features above average. Identifying the areas which needed to be reshaped and reclaimed in order to maintain structure connectivity of the natural system in the pre- and post-mining terrains is vital for defining directions of reclamation and assessing effectiveness of the conducted reclamation works. The conclusions may be used to adjust the reclamation activities in progress, as well as to plan future actions.

1. Introduction

In the Polish Lowlands (Niż Polski), there are mining landscapes in various stages of development (opening up, extraction and reclamation) shaped by open-pit lignite mining, which has been going on there for over 50 years. In the past, the process of shaping the structure of new post-mining landscapes used to focus mainly on the technical and biological aspects of reclamation, which did not account for natural determinants nor principles of landscape ecology.

In landscape ecology, it is assumed, that the spatial structure of landscape and spatial configuration of ecosystems, play an essential role in the conservation and management of biodiversity. The possibilities of survival and spread of particular species depend, not only on the size and shape of ecosystems, but also on the distances between them, the existence of the corridors and ecological barriers (SOLON 2004; FORMAN & GORDON 1986; DOERR 2010 et al.). All these factors are of great significance for for landscape connectivity. Landscape connectivity is the degree to which the landscape facilitates or impedes movement among the resource patches (TAYLOR 1993 et al.). The analysis and assessment of landscape connectivity takes two aspects into consideration:

- structural connectivity, which defines the physical characteristics of the landscape between patches of occupied habitat (HILTY 2006 et al.)
- functional connectivity, which defines the functional relationship among habitat patches, owing to the spatial contagion of habitat and the movement responses of organisms to landscape structure (WITH 1997 et al.)

Connectivity is therefore a feature of a whole landscape, where the scale of the landscape is determined by the habitat use and movement scales of the organism in question (TISCHENDORF & FAHRING 2000; GOODWIN & FAHRING 1998). In this study, a special attention was paid to the issues of structural connectivity of the post-mining landscapes, and particularly connectivity between the post-mining ecosystems and natural ecosystems (not transformed by the open-pit mining), which are in their surroundings.

The main purpose of this study was the recognition of the ecological structure of mining areas (identification of ecosystems and their spatial distribution) and assessment of the character of the ecological relationships (connectivities and non-connectivities) between the ecosystems as a premise for shaping post-mining landscapes in reclamation process.

Reclamation of the post-mining areas, preceded by the analysis of the landscape structure and taking into consideration the necessity of reconstruction of the spatial connectivity in the post-mining area, should become an essential and permanent element of spatial planning in the areas degraded by open-pit mining.

2. Methods

Diagnostic studies included identification of the ecological structure of the landscape and its analysis. The ecological structure of the landcape is treated as the mosaic of the basic soils, which were

determined according to the category of land use. Analysis was conducted on the basis of the patch-corridor-matrix model, according to which the landscape is created by different combinations of patches and corridors situated within the matrix.

Topographical maps and thematic maps (sozological and hydrographical) in 1:50 000 scale were the source material. The detailed analysis (1:10 000) of the layout of the landscape structure and the relations between the post-mining geosystems and the original ones was conducted on the basis of the teledetective materials: ortophotomaps, aerial pictures and the works in the terrain. Results were presented as a case study of the area which is within the scope of influence of the Brown Coal Mine Adamów, which, along with presently exploited deposits Adamów, Koźmin and Władysławów, consists of municipalities Brudzew, Turek, Przykona and Władysławów, which are part of the Turek District (Wielkopolska Voivodeship).

3. Diagnosis of the ecological structure of the post-mining area of Adamów

3.1 Identification and evaluation of the spatial layout

Identification and evaluation of the spatial layout of the basic forms of land use, especially essential for keeping ecological balance and biological variety: forests, meadows, pastures, river valleys, reservoirs. Within these areas one can also find lands which are exceptionally valuable and environmentally protected by law. There are two areas of landscape conservation which were listed within the researched area. The first one is Złotogórski Obszar Chronionego Krajobrazu (The Area of Złotogórski Lanscape Conservation) and Uniejowski Obszar Chronionego Krajobrazu (The Area of Uniejowski Lanscape Conservation); both of which are part of Great Spatial Network of the Protected Areas. The second one is the area Nature 2000 "The Valley of the Middle Warta River" – with a bird colony of European value. The spatial layout of the anthropogenic geosystems, which were created as a result of the mining activities, was presented against a background of recognized ecological network (fig.1).

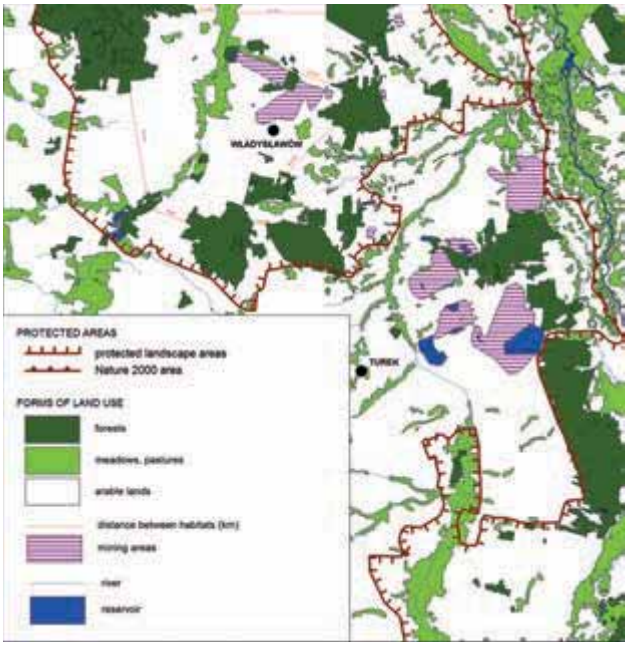

Fig. 1: Ecological structure of the mining area Adamów

3.2 The analysis of the ecological structure

The valley of Warta and Teleszyna Rivers as well as the valleys of the smaller water courses – Struga Janiszewska, Kiełbaska, Topiec, are predominant elements within the layout of the ecological structure of The Liginite Mine Adamów. The valleys of the longitudinal course determine the main axes of the structure. They create the ecological corridors which are greatly significant (both at the regional and local levels) for realization of the ecological connections. That is because they make up the path for migration of substance, energy and organisms in the landscape. In the great majority they are the meadow-moss paths, which are afforested at the small sections (fig.2).

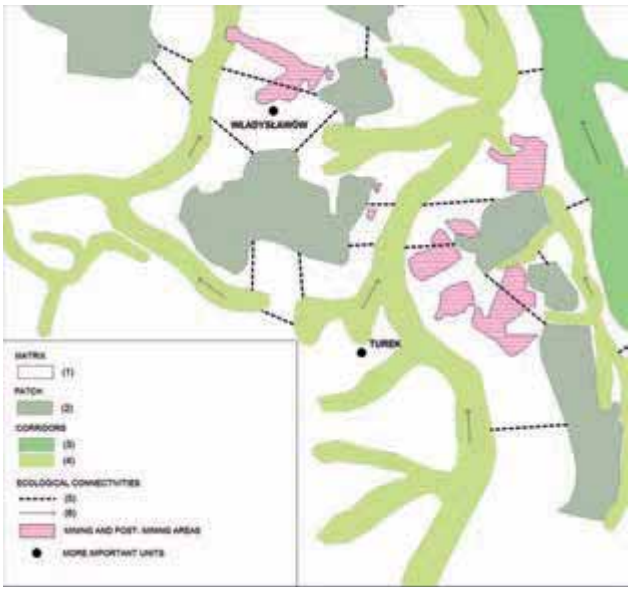

Fig. 2: Analysis of the ecological structure of the mining area Adamów
1 – arable and fallow lands, 2 – height and valley forest , 3 – the main ecological axis – the valley of Warta River, 4 – stream continuity and river corridors, 5 – ecological connectivities realized by forests areas, continuity of trees and shrubs, which require shaping, 6 – ecological connectivities realized by the river valleys and smaller watercourses

The breakage in the continuity of the ecological corridors as well as in the continuity of the nature, resulting from the mining activities, is a characteristic phenomenon for post-mining areas, which can also be observed in the researched terrain (fig.3).

The structure is replenished by forest areas. South of Władysławów there are three forest complexes covering an area over 2300 ha. A forest covering an area of 4073 ha extends between the areas of open-cast mine in Koźmin and Adamów and further towards South. Within the whole researched land, the total area covered by both the natural and reclaimed forest ecosystems amounts to 12700 ha, while the ecosystems of meadows and pastures cover 14350 ha. The natural resources of the analyzed area, on the basis of the area size index, can be considered as abounding and stable, creating good conditions for existence and species development. The problem, however, is the isolation of the habitats, which limits the possibilities of migration and exchange of species. The distances between the habitats are wide apart, which shows a high level of

their isolation. For instance, the forest complexes south of Władysławów are separated by 500, 800 and 1200 m, whereas to keep the ecological connections this distance should not go beyond 500 m.

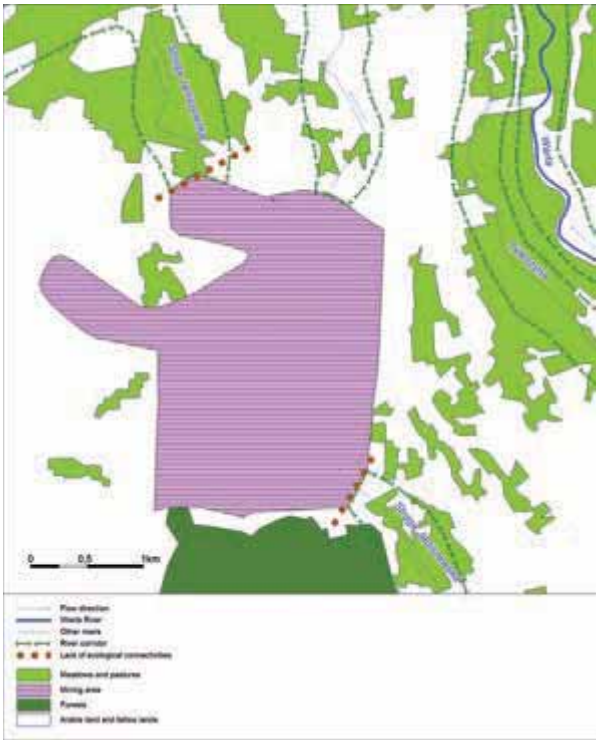

Fig. 3: Breakage of the continuity of the ecological corridor of the valley of Struga Janiszewska as a result of lignite exploitation in the open-cast mine Koźmin

3.3 Analysis of the diversity of the ecological structure on the basis of Shannon's diversity

Analysis of the diversity of the ecological structure on the basis of Shannon's diversity index reflects a degree of heterogeneity and variety of landscape structure.

In this analysis the index was used to evaluate the diversity of changes of ecological structures on the mining area of Adamów in reference to the condition before brown coal exploitation in this area. Low values of the index in the pre-exploitation period are connected with the domination of the agricultural way of spatial utilization.

$SHDI = -\sum_{i=1}^{n} (Pi * \ln Pi)$	SHDI – Shanon's diversity index
	Pi – proportion of I category
	n – number of categories

Tab. 1: Shannon's diversity index (MC GARIGAL & MARKS 1995)

	Pre-mining period (year 1944)	Presently (year 2011)
Shanon's diversity index SHDI	0,52	1,94

Tab. 2: Values of Shannon's diversity index on the post-mining area of Adamów before the mining activities and present

There were also vast, dense forest areas in the landscape. The increase of the index within the period of mining activities is connected with the increase of the mosaic which is a result of the fragmentation of the vast, homogeneous habitat patches (both forest and meadows), simplification of the shape of patches' boundaries, especially those, which were formed as a result of the reclamation works.

4. Ecological-landscape principles for shaping the structure of post-mining areas

On the basis of conclusions on the diagnosis and having taken into consideration the principles of landscape ecology, the main principles of shaping the structure of post-mining areas have been formulated.

1. According to the rule of the continuity of a particular habitat, one can consider the possibility of re-creating the habitats which were existing in the particular area before the exploitation took place; this rule refers particularly to the forest habitats.

2. One should harmoniously connect the elements of natural structures of the post-mining areas with the ones which are local to them – the natural areas ("in agreement with the boundaries").

3. One should create vast habitats, which are more stable and more conducive for keeping and enlarging the number of plant and animal populations inhabiting theses areas. At the local level (municipality) one should strive for creating at least one forest stronghold covering an area not bigger than 500 ha and other stable transitional strongholds. Adopting the method of forest reclamation one should design possibly vast forest areas consisting of a great number of species and enlarge the already existing habitats or connect the smaller forest complexes.

4. One should shape the boundaries of the anthropogenic geosystems. The boundaries of the natural geosystems are developed (winding) and mild. The anthropogenic forms cut themselves off from the environment by straight and sharp lines. The winding boundaries with bights and peninsulas create a greater variety of habitats, which favor species diversity and have positive influence on limiting the processes of denudation. Boundary-shaping refers also to their spatial development, which means the creation of a transitional zone between anthropogenic and natural geosystems by thickening them with permanent vegetation. It refers mainly to the boundaries between forests and other forms of utilization. The well developed vegetation of the border zone of forests enables faster formation of the conditions, which are characteristic for the interior of forests (e.g. microclimate) and it creates a barrier protecting the interior of forests from the penetration of unfamiliar species.

5. One should sustain and restore the ecological connectivity and continuity between the geoecosystems by creating a network of ecological chains and corridors as structures which are the most essential for the migration of substance, energy and organisms within the landscape. Planning and creating the ecological corridors on post-mining areas is the most essential for the optimization of the ecological structure. Ecological corridors enable the connection of the isolated spatial structures, which were separated as a result of mining exploitation. With reference to the evaluation of the degree of habitat isolation depending on their distribution, we talk about a low degree of isolation between similar habitats when the distance between them is not greater than 200 m and there is no barrier influences from roads, for instance. If the distance between the habitats is great than 500 m we can say that the degree of isolation is

high.Thus, one needs to create strip-like structures between the scattered patches of land in the landscape (forest, meadow habitats), and spatially connect the forest areas with valleys and river troughs with a system of corridors.

6. One should strengthen the ecological microstructure by introducing and replenishing midfield forests on the reclaimed areas for agriculture, along the small watercourses and waterways, around water basins and depressions with no outlet (ANDRZEJEWSKI 1986; CHMIELEWSKI 2005; GACKA-GRZESIKIEWICZ & CICHOCKI 2001; ŻARSKA 2006)

The essence of the idea of landscape shaping based on ecological premises can best be presented by the "3m rule": magnification of the number of nature strongholds, magnification of the number of ecological corridors and magnification of the hierarchical strongholds and ecological corridors (ŻARSKA 2006). Implementation of this idea for planning the directions of reclamation will enable the achievement of a new balance in geosystems which were transformed by the open-cast mining.

5. The concept of shaping the ecological structure of post-mining areas (a case study of open-cast mine Władysławów)

The open-cast mine Władysławów is situated in the north-west part of The Liginite Mine "Adamów". It spans from the north-west to the south-east, taking the elongated shape tipped with two arms in the south-west and south directions. The exploitation of deposits is presently realized in the eastern part of the mine, while the remaining part is the post-mining area. The western part of the mine is an outer waste bank covering the area of 40 ha and the relative height is 20-28 m and is situated in the bottom of the river Topiec. This unfamiliar form, clearly separated from the environment, constitutes the barrier, which limits the proper functioning of the right bank of the ecological corridor of the Topiec valley. In the immediate neighborhood of the waste bank there is a fragment of an opening pit, which is presently, simply collects dirty water. Towards the eastern arm and further on to the south-western and southern arms, there is the outer waste bank zone, reclaimed mostly for agricultural purposes. There is just a small part of the land, mostly advanced towards the East which underwent forest reclamation. The main elements of the ecological structure of the open-cast mine Władysławów are the valley of the River Topiec, which has the longitudinal course and the vast forest strongholds situated on the eastern bank. There are three vast forest complexes in the South (1043 ha, 1140 ha, 257 ha), two dense forest areas in the north-eastern part and also the north-western part of the analyzed area afforested. All the forest areas cover vast areas; are dense and can be called natural strongholds. Within them there are conditions, which are good for sustaining the continuity of the existence of both flora and fauna species. However, the distance between the strongholds (8.2 km, 7.3 km, 7.8 km) does not allow for keeping the connectivity between the ecosystems. The mining and post-mining area of O/Władysławów is the characteristic element of the landscape. It forms an elongated structure, perpendicular to the axis of the valley, which in the East adjoins the forest complex (fig.4). Thus, with such layout of the structure, shaping the landscape should be based mainly on:

• protection of the valley of River Topiec as the main natural structure and its consolidation by introducing trees and bush planting, especially in the upper reaches of the river

• creating, in a form of network, connectivities between the already existing stable forest nodes and between the node areas and the valley of River Topiec; forming the spatial continuity should be realized mainly by forestations and filling-up with the elements of ecological microstructure (introduction of the system of forest and midfield bush planting)

• correcting the shape of the forest areas and shaping the marginal zones of forests

• shaping the ecological continuity, within the post-mining area of O/Władysławów, which would connect the forest stronghold (739 ha) with the valley of River Topiec. The realization of this task means correcting the established directions of reclamation and requires forestation of the northern part of the open-cast mine on ca. 3 km length and a width of 200 m, between the forested outer waste bank and eastern part of the mine reclaimed for the forest; in the plans of reclamation of presently exploited deposit, one expects to create a water basin in the ending cavity. It is proposed to plant forest around the area in order to create a node which would be a basis for building ecological continuity along the arms of the open-cast mine for forest complexes situated in the South of the analyzed area.

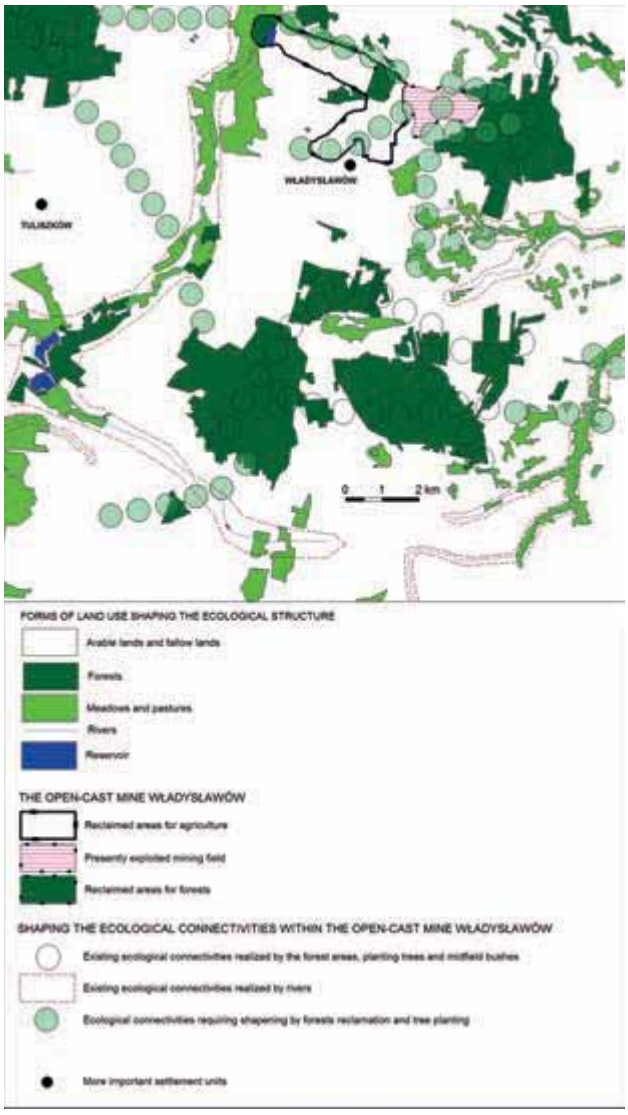

Fig. 4: Concept of shaping the ecological structure within the area of the open-cast mine Władysławów

The concept of shaping the ecological structure within the O/Władysławów and in the immediate environment is presented in figure 4.

6. Summary

The rules of shaping the ecological structure of post-mining areas presented above as well as the examples of their application within the area of Adamowskie Zagłębie Węgla Brunatnego (Adamowski Brown Coal Basin) show interchangeably, that the planning of reclamation works cannot be limited to the areas degraded by the process of exploitation. One must take into consideration its relations with the environment. We can, therefore, conclude that it is a diagnosis of the ecological structure which has main significance when determining the direction of reclamation and evaluation of the effectiveness of the covered works. The conclusions reached from this analysis can become the basis for corrections of reclamation activities as well as planning for reclamation works according to the rules of environmental protection in the future.

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The environmental quality profiles of Polish cities in the context of air and water pollution (2000-2009)[1)]

Mariusz KISTOWSKI

Zusammenfassung

Um die Qualität der Umwelt in 307 Städten Polens zu bewerten, wurden Daten zur Luftverschmutzung (NO_2 SO_2, PM_{10}, C_6H_6, B (a) P) und Qualitätsklassen für Gewässer (Fließgewässer in zwei 4-Jahres-Perioden sowie unterirdische Gewässer) und Wassersedimente in den Jahren 2000 bis 2009 herangezogen. Die qualitative Beurteilung der Umweltqualität in den Städten zeigte, dass die schlechtesten Umweltbedingungen immer noch im südlichen Polen (Oberschlesien, die Region von Krakau und süd-westlich von Polen) sowie in den Umgebungen der größten städtischen Ballungsräume (Łódź und Warschau) vorzufinden sind. Neben den alt bekannten negativen Umwelteinflüssen durch Industrie und Landwirtschaft kamen neue Faktoren wie Transport und Nutzungsdruck durch Kommunen hinzu.

Abstract

In order to assess the quality of the environment in 307 Polish cities, having analyzed the accessibility of sozological data, we used information of a proper level of completeness with regards to concentration of air pollution (NO_2, SO_2, PM_{10}, C_6H_6, B(a)P) and the classes of the quality of waters (flowing waters in two 4-year periods and the underground waters) and water sediments in the years 2000-09. Qualitative (bonitac) assessment of environmental quality of the cities showed that the worst environmental condition is still characteristic for Southern Poland (Upper Silesia, the region of Cracow and south-west of Poland) as well as the surroundings of the biggest urban agglomerations (Łódź and Warsaw). The old – industrial and agricultural – factors of pressure on environment were completed with newer ones: transport and communal.

1. Introduction

The issues concerning environmental protection and quality of life in the cities are one of the essential research trends of natural and social sciences. Its importance is acknowledged in the policies of European Union (CEC 2006) and finds its reflection in the research and monitoring programs carried out (e.g. EEA 2009). The studies on the urban environment in Poland have also had quite a long tradition and vast range of application (e.g. BRÓDKA 2008). However, as a rule, they consider either particular cities or selected issues. There have been no review synthesis, in Polish scientific literature, of environmental quality in the cities over a long period of time. Available synthesis refers to the entire country or voivodeships (e.g. CIEP 2010). The author of this article carried out the research on the sozological diagnosis of Polish cities. The index method of complex sozological diagnosis was employed, taking into consideration earlier studies on working out and applying the system of measures of sustainable development and environmental protection for Polish regions (GOŃCZ & KISTOWSKI 2004). This method was described in more detail in the author's publication (KISTOWSKI 2011). The term "sozology"[2)] means the field of study dealing with the issues of environmental protection, causes and the effects of the anthropogenic changes on the structure and functioning of natural systems as well as the ways of preventing and reducing their effects. It was introduced by GOETEL (GOETEL 1966) and is used in Poland quite often. This method is based on the analysis of ca. 75 measures in regard to the environment, its quality and actions within the scope of environmental protection for almost 2500 basic Polish administrative units (communes). The research presented in this article refers to the indices of environmental quality for the selected 307 urban municipalities.

2. Data sources and study methods

In view of the way of aggregating statistical data regarding communes, 307 cities were selected for the study. They have their own city councils, which do not govern the neighboring rural communes. They make up 34.7% of Polish cities, with a human population of about 18.8 millions (49.3% of population of country), which is quite representative. Small towns (1.000 – 25.000 inhabitants) – 48% and the medium ones (25.000 – 100.000) – 39% are the majority. Above half a million people live only in five cities.

Majority of data needed in order to calculate the indices of the pressure on environment and its protection were taken from the Local Data Bank (LDB) of the Central Statistical Office. However, with regards to environmental quality, this source has got very limited information. The main institutions which gather data from the monitoring of environment are State and Regional Inspectorates of Environmental Protection, which annually publishes the reports on the condition of the environment. Data was gathered mainly from these 160 reports prepared for 16 Polish voivodeship cities in the years 2000-2009. There was a need for standardization as, within the study period the forms of these reports were very different and some of them were accessible only in the "paper" form. It had to be

[1)] Article prepared in the framework of researches financed by the Ministry of Science from the science budget in the years 2009-2012 as the research project N305 033937 „Spatial diagnosis of environmental quality and protection in Poland during the first decade of XXI century in light of Polish and EU environmental policy".

[2)] After ancient Greek language term "sódzo" means protection.

done in order to make the data comparative and applicable for all the cities. Some data were also obtained from the State Sanitary Inspectorates and the Polish Geological Institute. Having analyzed the data in regards to environmental quality, using the criterion of percentage of the cities, for which they are accessible, the research has taken into consideration data considering:

• quality of air – the annual average concentration in the air: nitrogen dioxide, sulfur dioxide, suspended particulate matter, benzene ($\mu g*m^{-3}$) and benzo-α-pyrene ($ng*m^{-3}$);

• quality of waters and water sediments – their classes of quality: flowing waters within the period of the years 2000-2003 (4 classes) and 2004-2007 (5 classes)[3], underground waters (5 classes) and water sediments (4 classes).

In case of air quality, raw data of the concentration of selected air pollutions was used, while in case of water and water sediments processed data referring to the classes of their quality, defined according to the legal regulations in force was used.

Unfortunately, data considering the quality of the other components of the environment (soils, noise level and biotic elements) were accessible for less than ¼ of the studied cities so we gave up on using them. Moreover, we notified the lack of satisfactory data considering changes in the area coverage. The lack of data considering the area coverage is due to the lack of cadastral system for the Poland as a whole. In LDB at the city level, only data on the forest acreage is gathered. Maps drawn in the framework of CORINE Land Cover base for the years 2000 and 2006 are not detailed enough for the sake of this research. Thus, 9 indices were analyzed.

It shall be noticed, that there are great differences between the scopes of data accessible for the cities (Fig. 1). For 11 of them (located in the Warsaw and Upper Silesian agglomeration and near state border) data was non-existent, which made the assessment of environmental quality impossible. Data for 1-3 out of 9 indices were accessible for 50 cities, which essentially lowered the reliability of the assessment. Data, just, on the quality of water was accessible for 40 cities, data only on quality of the air for 15 cities, which also limited the complexity of assessment. 20 cities had full set of data and 100 of them information on 7-9 indices. All the voivodeship cities were among them. The completeness of data[4] increases with the number of people living in the cities (Fig. 2, Tab. 1). Taking the indices into consideration, the completeness is highest for the concentration of NO_2, SO_2 and PM_{10} pollution in the air (70-80%) and the quality of flowing and underground waters (65-75%), while the lowest for the concentration of B(a)P and the quality of the water sediments (28-40%).

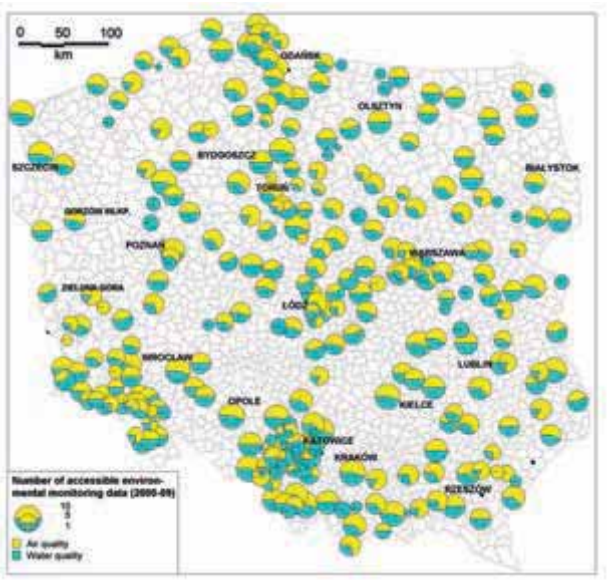

Fig. 1: Number and a kind of indices considered in the assessment of environmental quality in the cities

For each of the selected 9 indices for the cities, the average values for the period of data accessibility were calculated. These values were calculated as arithmetic means for the average annual values for the years taken into consideration. The range of values of each index was divided into 10 sections to which qualitative values were ascribed: from 1 point – which is the best quality of the environment to 10 points – the worst. The obtained points were summed up and divided by the number of indices accessible for the particular city. The result was a complex assessment of environmental quality of the cities in regards to the quality of the air and waters. The obtained results were presented for all the cities on the maps in the form of cartodiagrams and for the section of population in the form of charts.

Group of cities (x1000 dwellers)	Number	Completeness of data (%)									Average concentration in air ($\mu g*m^{-3}$) or waters/water sediments quality class									Av. completeness
		NO_2	SO_2	PM_{10}	Benzene	B(a)P	River waters		Underground water	Water sediments	NO_2	SO_2	PM_{10}	Benzene	B(a)P	River waters		Underground water	Water sediments	
							2000-2003	2004-2007								2000-2003	2004-2007			
1-10	52	52,0	52,0	23,0	13,5	9,6	59,6	48,0	69,2	23,0	12,8	8,8	23,5	3,83	5,63	3,73	3,73	2,81	1,33	38,9
10-20	96	66,7	72,0	55,2	32,3	8,3	54,2	61,5	67,7	33,3	16,8	6,9	25,7	2,86	5,06	3,70	3,93	2.91	1,73	50,1
20-50	73	93,0	93,0	93,0	37,0	28,8	71,2	65,8	67,0	42,5	21,0	7,3	28,1	2,65	6,16	3,60	3,86	2,80	2,05	65,8
50-100	47	93,6	93,6	89,4	61,7	44,7	68,0	70,2	91,5	61,7	21,9	9,6	33,5	3,11	6,43	3,72	3,99	2,92	2,12	74,9
100-250	28	96,4	96,4	100	96,4	82,0	89,3	85,7	82,0	43,0	24,3	12,5	37,5	3,69	8,39	3,85	4,27	3,10	2,10	85,7
250-500	6	100	100	100	100	83,3	100	100	100	33,3	22,3	9,3	29,1	2,52	3,63	3,65	3,94	2,79	2,50	90,7
>500	5	100	100	100	100	100	100	100	100	60,0	30,9	9,4	37,3	3,26	4,44	3,99	4,21	3,14	3,00	95,9
Av. completness		78,5	81,1	69,7	43,0	28,7	66,1	65,1	73,9	39,4										
Average concetration/class											19,7	8,4	29,8	3,04	6,41	3,71	3,95	2,89	1,95	

Tab. 1: Information on data completeness and average values of the assessed indices (2000-09) in the studied cities depending on the number of population

[3] This division is due to changes in the methods of measuring and classification of the quality of surface waters. Data on the ecological water state/potential from the years 2008-09 were not taken into consideration – as a result of the process of the complete alignment to the requirements of Framework Water Directive – the number of water monitoring points does not reach the threshold of 25% of the cities.

[4] Means the percentage of existing data in relation to the available data at large; that is the situation in which data on all the studied years and/or all the cities under study (in the particular class of population) was assessed.

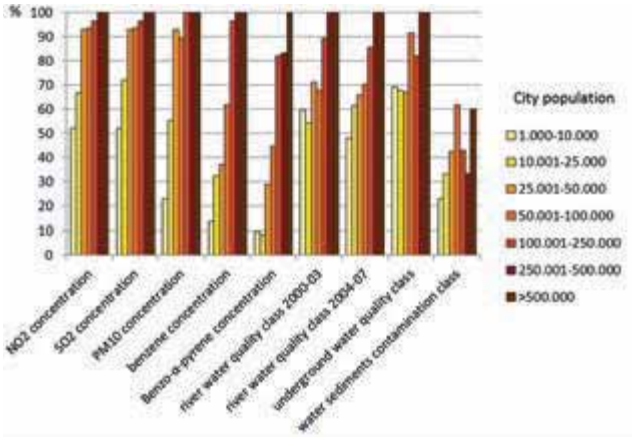

Fig. 2: Percentage of the cities which included data on environmental quality depending on the number of population

3. Study results

The results of the research were presented in a spatial layout with reference to the population sections of the cities for each index in Table 1 and Fig. 3-6. The average concentration of NO_2 in the air in the selected cities reached 19.7 $\mu g*m^{-3}$ in the years 2000-2009, with an annual norm of 40 $\mu g*m^{-3}$, going beyond the norms in 5 cities: with 4 of those cities located in the Upper Silesia and Soc-chaczew, west of Warsaw (Fig. 3a). In light of WHO guidelines (WHO 2006), the recommended annual concentrations are: up to 40 $\mu g*m^{-3}$ for NO_2 and up to 20 $\mu g*m^{-3}$ for PM_{10}. The average concentration of SO_2 within this period is 8.4 $\mu g*m^{-3}$. Acceptable annual concentration (20 $\mu g*m^{-3}$) was exceeded in 17 cities, including 15 cities in Upper Silesia, Żywiec, south of the Silesian voivodeship and Boguszów-Gorce nearby Wałbrzych (Lower Silesia) (Fig. 3b). The concentration of PM_{10} reached in the cities on average is 29.7 $\mu g*m^{-3}$, so the annual norm (40 $\mu g*m^{-3}$) was exceeded in 45 cities, mainly in Upper Silesia but also in Cracow, Nowy Sącz, Nowy Targ, Zakopane (Lesser Poland), which are located in valleys or mountainous basins, which is conducive for the phenomena of smog (Fig. 3c). Similar reasons, connected with emission not only of industrial pollutions but also from the traffic and communal pollutions, as well as the location of the cities, created also concentration of benzene and benzo-α-pyrene respectively. The average concentration of the former reached 3 $\mu g*m^{-3}$ and exceeded the acceptable level (5 $\mu g*m^{-3}$) in 8 cities: 5 in Upper Silesia, Kędzierzyn-Koźle in Opole voivodeship, Szczawno-Zdrój in Lower Silesia and, quite surprisingly, in Kostrzyn at the Polish-German border (Fig. 3d). The average concentration of B(a)P in the studied cities reached 6.4 $ng*m^{-3}$, while the norm (1 $ng*m^{-3}$) was exceeded in 76 cities in Poland, mainly in Upper Silesia, but also in those located in the valleys and mountainous basins. It needs to be emphasized that data on the concentration of B(a)P were from the second half of the study period and were incomplete. Studies carried out over shorter periods, e.g. the years 2005-2006 (IOŚ 2007) confirm the results obtained in the author's studies (e.g. the highest concentration of NO_2 occur in the following agglomerations: Upper Silesia, Łódź, Warsaw, Cracow and PM_{10} concentration in the following agglomerations: Warsaw, Cracow, Upper Silesia), however, with partially regard to a small number of measure points, the results are divergent considering the concentration of benzene.

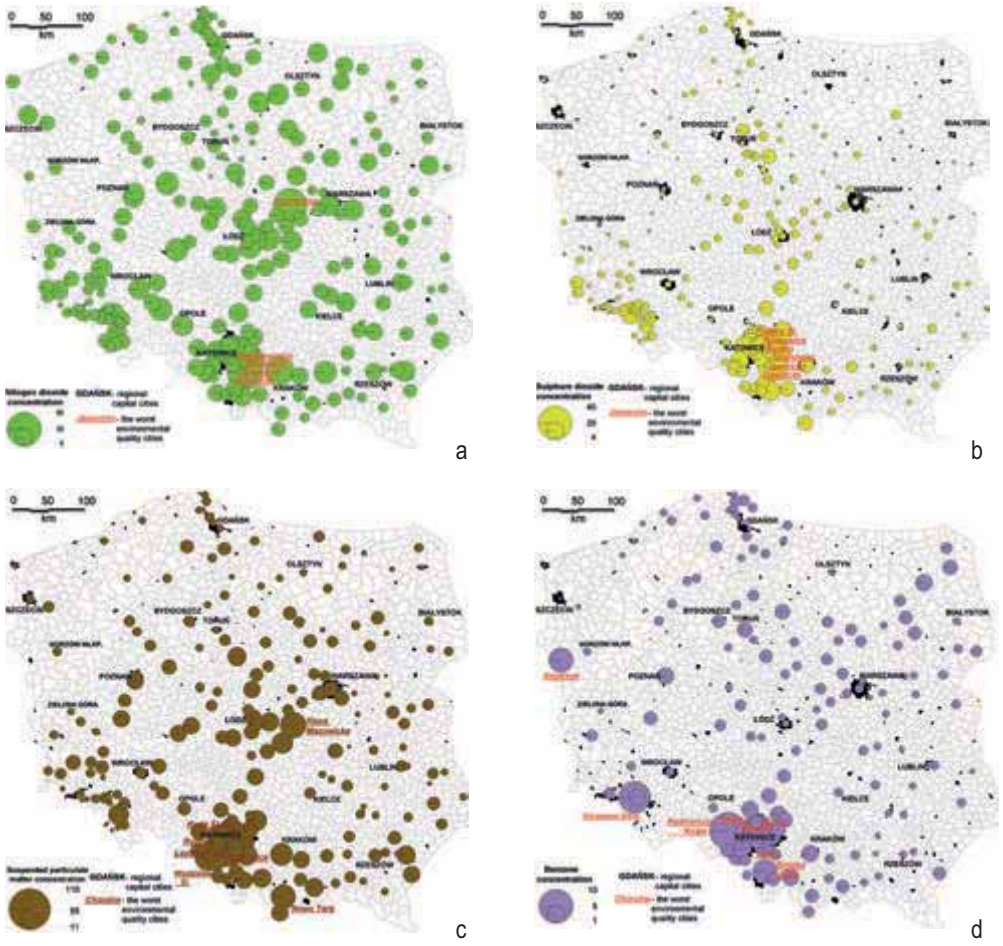

Fig. 3: Average concentration of the air pollution ($\mu g*m^{-3}$) in the selected cities in the years 2000-09: a) NO_2, b) SO_2, c) PM_{10}, d) benzene

With regards to the concentration of NO_2, SO_2 and PM_{10} we can observe the increasing tendency of pollutions along with the increase of the cities' population. This tendency is clearly uneven in the case of cities inhabited by 250.000-500.000 people (Gdańsk, Szczecin, Lublin, Bydgoszcz, Katowice, Białystok), where the accessible results show lower concentration than in the more populated cities and a bit smaller ones (Fig. 4).

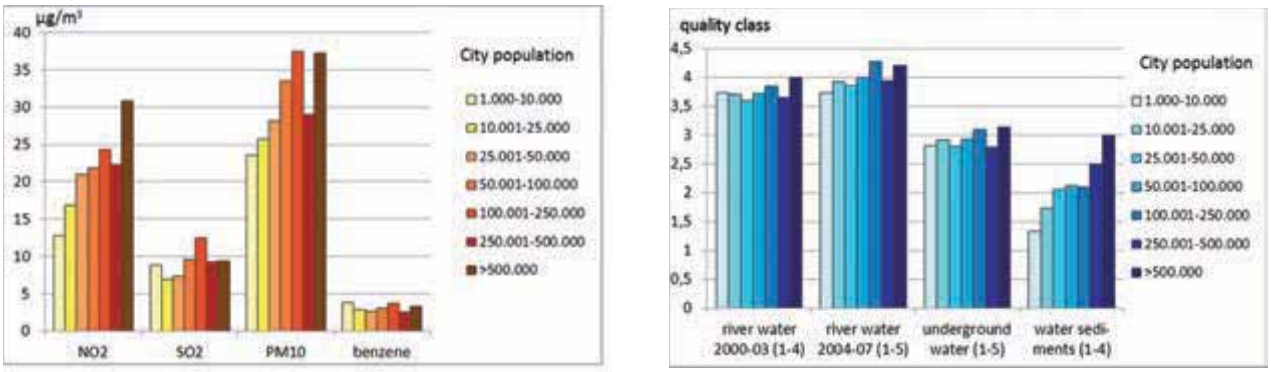

Fig. 4: Average concentration of the air pollution (µg*m^{-3}) and classes of cleanness of the waters and water sediments within the years 2000-09 depending on the population

The reasons of this situation are quite obvious. It may result from both the lower pressure on environment, which is due to the preventive actions, advantageous location of the cities (good urban ventilation) but also due to the false localization of the measuring points or underestimation of the results in order to improve the values of the indices of environmental quality, which influences the assessment of the living quality and the image of the cities. Similar tendencies are observed in other European cities (EEA 2007, EUROSTAT 2007). The annual NO_2 concentration in many cities in northern Italy, western part of Germany and England, are higher than in majority of Polish cities; while the concentration of PM_{10} in southern Poland corresponds to the highest concentrations in other European cities (southern Italy, southern Spain, Bulgaria, Romania, Serbia).

Among the indices referring to the quality of waters, we can observe the lower (except the class of pollution of the water sediments) tendency of worsening environmental quality along with an increase of population in the cities, although this still exists. Data on the quality of flowing waters show very bad conditions of these in Polish cities. On the basis of the results of water monitoring in the years 2000-03 it was determined, that their middle class (in the range of 1 – being the best, 4 – the worst) reaches 3.7. The worst grade (4) was given to 111 cities relatively and evenly distributed across the entire country, while the rivers in the eastern and northern Poland were cleaner than the ones in southern and central Poland (Fig. 5a). This situation is due to less untreated and partially treated communal sewages disposed into the waters and less introduction of chemical substances into agriculture in eastern and northern than in the western, southern and central Poland. Within the next four years (2004-07), the condition of waters slightly improved, which only seems apparent, as it results from a change in the criteria of assessment of their quality. In the range 1 (the best waters) – 5 (the worst waters), the average assessment of the quality of the flowing waters in the cities reached 3.95. 26 cities were diagnosed with the worst quality of water. Majority of those cities are located around the biggest urban agglomerations (Upper Silesia, Warsaw, Łódź, Trójmiasto, Wałbrzych) (Fig. 5b).

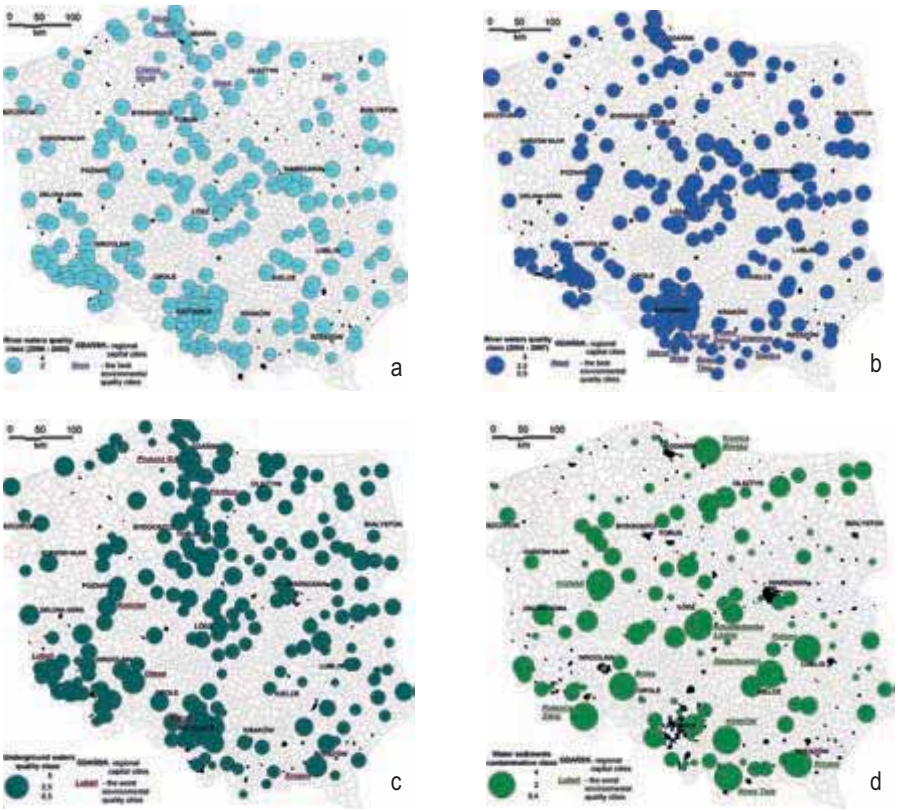

Fig. 5: Average classes of quality of waters and water sediments in the selected cities within the years 2000-09: a) river waters (2000-03), b) river waters (2004-07), c) underground waters, d) water sediments

The underground waters were of significantly better quality. Their average assessment in the range 1-5, reached 2.9. The worst quality of water (grade >4) was found only in 7 cities, across the entire country, however, majority of those were in the southern and northern parts (Fig. 5c). The causes

of the poor quality of the underground waters can have both anthropogenic (input of the industrial, mining, agricultural and communal effluents) and natural (shallow-lying of the water-bearing levels, poor isolation from the surface by geological formations, infiltration of the salty sea waters) character, and most often there are their synergic connectivity.

The assessment of the quality of water sediments, in range 1-4 shows that they are relatively slightly polluted (for the cities on average 1.95). 10 cities in the whole of Poland were given the worst note (4) (Fig. 5d). It seems that the quality of sediments is generally worse in the southern and central part of the country and better in the eastern and northern, however, the local factors connected with the input of effluents were significant. In case of water pollutions, the cities with population 250.000-500.000 were assessed higher, which can support the opinion of underestimation of data on effluences in regards to the quality of air.

The complex assessment of the quality of urban environment on the basis of indices in regard to waters and the air was presented in Fig. 6. It depicts that the greater concentration of the cities with poor environmental condition is in Upper Silesia as well as in some other industrial centers (e.g. Cracow, Tarnów, Rejowiec Fabryczny with metallurgy, chemical and cement industry) or in the disadvantageously located cities with tendency for concentration of effluents (Nowy Targ, Nowy Sącz, Bielsko-Biała). The condition of environment was assessed the lowest in Łaziska Górne south-west of Katowice. The poor assessment of quality refers also to several smaller cities situated in more peripheral regions of the country (e.g. Brańsk, Sławno, Zielonka), however, due to a small number of assessment criteria with reference only to the waters, it cannot be considered as fully reliable. The best condition of the environment among the studied cities was in Wałcz (Western Pomeranian). Generally, the main reason for a better quality of the environment in the cities of eastern and northern Poland than the ones in southern Poland is the diversity of anthropogenic pressure on environment, more than the differences in environmental resistance and its ability for pollutants dispersion.

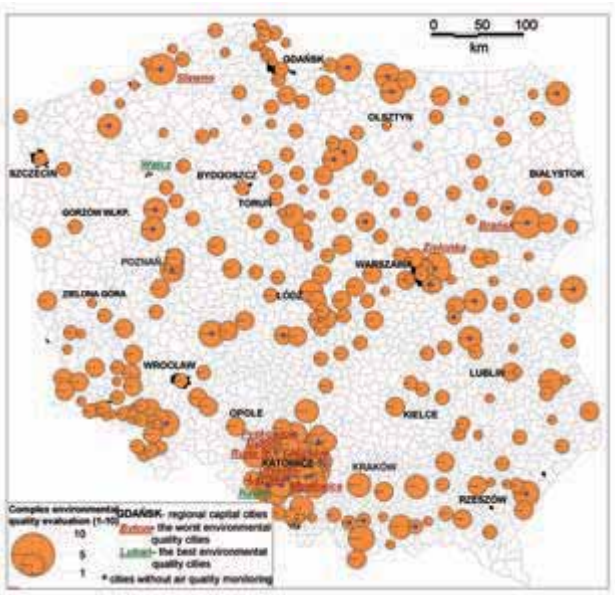

Fig. 6: Complex assessment of environmental quality in the selected cities on the basis of indices of air and water quality in the years 2000-09

4. Discussion and conclusions

An attempt to carry out a complex environmental quality assessment for 307 Polish cities, which have their own city councils, showed a limited possibility of the objective study on the basis of accessible data. There is lack of data for a small number of cities (4%) and for another 25%, data was either incomplete or referred only to a quality of one or two considered components of the environment. Completeness of data was lowest (50% and less) in the small cities (below 20 thousand dwellers) which limited the reliability of the assessment. This situation can be explained by the financial limitations and restrictions in environmental monitoring, which has – according to the European tendencies – cautionary character and is introduced in the areas with the highest probability that the norms of air and water pollution standards would be exceeded. The incompleteness of data on the quality of soil and the biotic elements was the greatest limitation to the complexity of assessment. Another problem was also the diversity of the study methods and the assessment of environment within the study period (2000-2009).

Despite the above-mentioned difficulties, we obtained a partially reliable picture of the environmental quality of cities in the aspects of quality of the air and waters. It shows, that despite the significant limitation of industrial influence, within the last 20-year period, on the environment, the worst quality is still observed in the southern part of the country – the cities of agglomerations of Upper Silesia, Cracow, south-west of Poland and Łódź and Warsaw agglomerations. Adverse conditions characterize also cities, which are located e.g. in the mountainous basins (Nowy Targ, Nowy Sącz), which is favorable for concentration of pollutions, especially the air. Lawful standards for the annual air pollutions exceeded permissible concentrations in case of all the analyzed indices – less frequent for NO_2 (5 cities), and most frequent for benzene (65 cities) and PM_{10}, where – applying the national regulations – annual concentrations were exceeded in 45 cities, however, applying the twice as rigorous WHO recommendations – concentrations were exceeded in as many as 126 cities.

Transport sources have much greater significance among the sources of air pollution, although locally, the industrial sources play a significant role. A few industrial companies still do not fulfill legal requirements of BAT. Emission of untreated or partially treated communal sewages is the main cause of water pollutions, especially in the rural areas, where the sewage disposed into river waters reaches the cities. Another cause is an excessive and inappropriate usage of mineral fertilizers and plant protection chemicals in agriculture. In southern Poland, the quality of waters is worsened by collection of salty waters from the mines, while in the northern part by the natural processes of diffusion of sea waters into the hinterland.

More detailed recognition of the picture of environmental quality in Polish cities will require broadening the network of environmental monitoring on some terrains, and a precise definition of the causes of the described regularity, e.g. better assessment of the condition of the environment in a few large voivodeship cities (population of 250.000-500.000), than in the smaller centers, requires recognition of several factors, including reliability of data.

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Landscape modeling and metrics for improved integration of urban land change processes and biodiversity indicators in urban management in Mediterranean coastal zones

Angela HOF & Elisa MICHEL

Zusammenfassung

Die Zielsetzung des Beitrags ist (1) die Ableitung raum-zeitlicher Biodiversitätsmaße und Landschaftsveränderungen, (2) die Modellierung des Landbedeckungswandels und der Habitatgefährdung, und (3) die entscheidungsunterstützende, praxisrelevante Visualisierung und Präsentation der Ergebnisse für eine nachhaltige Gestaltung urbaner Transformationsprozesse in Küstenregionen des Mittelmeerraumes. Die Landschaftsanalyse integriert Daten über das Verbreitungsgebiet einer Zielart mit multitemporalen Landbedeckungs- und Biotopkarten unterschiedlicher Maßstabsebenen. Die Auswertungen erfolgen mit Geoinformationssystemen und der integrierten Softwareumgebung „Land Change Modeler for Ecological Sustainability", die Funktionalitäten zur Analyse und Vorhersage von Landbedeckungsveränderungen bietet und sich am sehr spezifischen Analysebedarf zum Biodiversitätsschutz orientiert. Der landschaftsanalytische Ansatz, hier am Beispiel Mallorcas dargestellt, dient der Vertiefung des Systemverständnisses und ist übertragbar auf vergleichbare urbane Kontexte und Regionen.

Abstract

This paper pursues three objectives: (1) derivation of spatially explicit information on past and present biodiversity measures and land change processes; (2) modeling vulnerability to land change, and (3) presentation of results in a suitable format to inform decision-making in urban conservation and planning. Data and maps on species range, land cover and biotopes over a range of temporal and spatial scales are analyzed. The GIS software extension Land Change Modeler for Ecological Sustainability is employed for land change analysis, prediction, and the examination of impacts on habitat and biodiversity. Results may be used for ecological sustainability studies and land planning scenarios. Illustrated for a case study in Mallorca, the workflow could serve as an analysis framework in similar contexts.

1. Background and Motivation

The characteristic process of spatial transformation in an increasing number of Mediterranean coastal municipalities is the expansion of urban and tourist areas. Land cover change detected from comparison of CORINE Land Cover data for 1990 and 2000 showed that already highly populated coastal strips were hot spots of urban sprawl and fragmentation (EEA 2006). Often linked to the development of second homes and an increasing preference for suburban environments, more disperse land use and land cover patterns evolve that can have significant impacts on land resources and ecosystem services. Urbanization typically results in a reduction in biodiversity of native species and landscape diversity, and these effects may be manifest for several decades following urban development and sprawl (HANSEN et al. 2005). In the framework of ecosystem services, biodiversity is one of the most abstract concepts. Biodiversity is rather part of complex mechanisms and processes that generate supporting and provisioning services than an ecosystem service per se (HAINES-YOUNG & POTSCHIN 2010). Current scientific evidence is indicative rather than conclusive as to which causal links exist between biodiversity and human well-being. In the face of the ongoing semantic and analytical challenge and debate, the present paper follows "the contention that for various measures of biodiversity there is a positive association with a number of different measures of ecosystem functioning." (HAINES-YOUNG & POTSCHIN 2010, 122). Hence, monitoring of biodiversity responses in relation to land cover change is an important contribution to the assessment of the effects of environmental change drivers on ecosystem services (HAINES-YOUNG 2009).

The objective of this paper is to demonstrate and discuss landscape ecological methods and workflows to support the knowledge to action transfer into urban management. Landscape ecological knowledge that is condensed via appropriate methods, means of visualization, and mapping is relevant for urban and conservation planning. Moreover, it may inform decision-making that aims at urban development patterns which avoid land conversion where the richness of spatial patterns exhibited by habitat mosaics and landscapes is high and thus potentially supportive to biodiversity and ecosystem functioning. The usefulness of scientific information for urban practice and the likelihood of its integration in decision-making are probably related to the question whether or not biodiversity or conservation issues are already on the agenda of urban planning, policy, and decision-making.

These key aspects are outlined for a case study in Mallorca. The island illustrates the transformation of the economy, society and environment of Mediterranean coastal zones. Links between landcape

[1)] The term 'land cover' refers to physical surface characteristics of land as opposed to its economic and social functions that are usually referred to as 'land use' (HAINES-YOUNG 2009). For ease of reading and convenience, no distinction is made and the term 'land cover' is used throughout the remainder of the text.

pattern, land change processes, and biodiversity indicators are explored for the spur-thighed tortoise (*Testudo graeca*), a long-lived endangered terrestrial tortoise inhabiting the Mediterranean region. The species is in serious decline throughout its range due to habitat loss and fragmentation (COX & TEMPLE 2009). The analysis draws on data and maps on species range, land cover, and biotopes over a range of temporal and spatial scales. Land Change Modeler for Ecological Sustainability is used for landscape modeling and metrics calculation. Land Change Modeler (LCM) is an integrated modeling environment of IDRISI Taiga and also available as ArcGIS extension (EASTMAN 2009; PAEGELOW & CAMACHO OLMEDO 2008). The focus is on the conceptual issues of integrating field and sample-based approaches with broader scale information on habitat distribution (e.g. from remote sensing). Another aspect is the integration of biodiversity indicators with empirical information on land change, in particular when intending a use of these tools and their output to inform decision-making and planning.

2. Materials and Methods

2.1 Study area, maps and geodata sources

Mallorca is the northernmost distribution of *T. graeca* whose range is restricted to Calvià municipality in the southwest of the island. Conservation efforts in Mallorca have been in practice since the 1980s, with conservation legislation for the species in effect since 2005. Species range maps of 2007 show an 80% decrease since 1979 (Figure 1), with most of the habitat loss (-63%) occurring between 1990 and 2007 (AGUILAR 1990; LÓPEZ JURADO et al.1979; PINYA & CUADRADO 2008). Habitat loss and species decline in the municipality of Calvià is a facet of the impacts of coastal urbanization on biodiversity in one of the major Mediterranean tourist resorts with an internationally acclaimed Local Agenda 21 and sustainable development as its overarching policy objective (compare HOF & SCHMITT 2008).

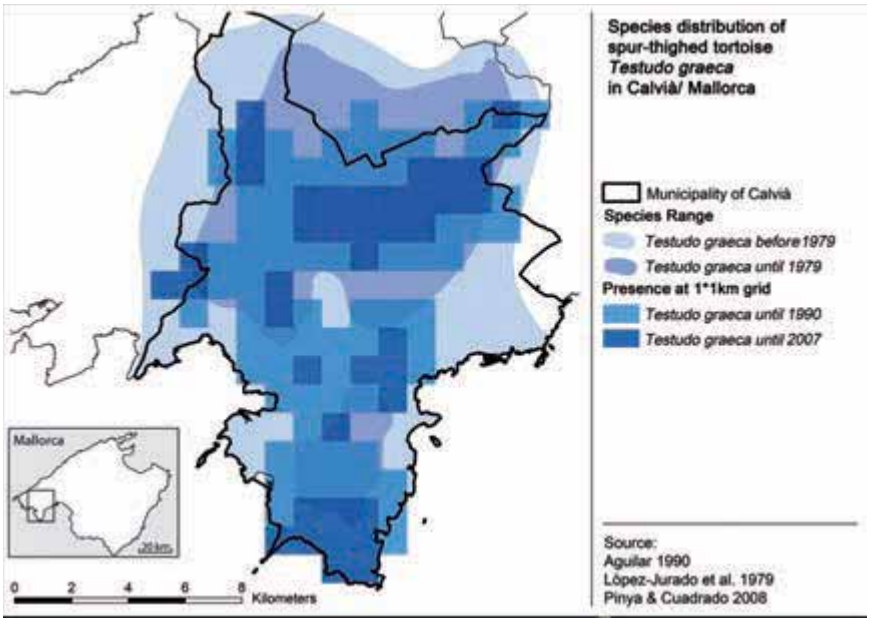

Fig. 1: Distribution range and multitemporal species range grids for *Testudo graeca* in Mallorca. The Balearic Islands are the northernmost distribution range of *T. graeca*, which is found in Mallorca only in Calvià municipality.

Like other reptiles, *T. graeca* has low movement capabilities with home ranges of around 3 hectares for male and 1.5 ha for female individuals. The species is bound to natural and semi-natural Garigue and Maquis vegetation and is very sensitive to anthropogenic disturbance and fragmentation of its habitats (ANÁDON et al. 2006). The lack of information identified in a conservation plan of the Balearic Environment Agency (CONSELLERIA DE MEDI AMBIENT 2009) is taken as a starting point. In this conservation plan, the need to assess the current habitat status and species range of the spur-thighed tortoise (*T. graeca*) is outlined with explicit reference to landscape analysis (e.g. fragmentation and connectivity), but tangible tools or methods are not specified.

Implementation of the conservation plan for the species would ideally consider priority areas for urban nature conservation in the next municipal land use plan revision. However, improved urban management requires a more integrated valuation of biodiversity. In the present analysis framework, the concern is for the vulnerability of tortoise habitat because its protection has wider implications as it stands for semi-arid Mediterranean shrublands that are protected under European directives and agro-environment schemes (ANÁDON et al. 2006). Therefore, either an optimization approach for reserve selection is taken or the focus is on multifunctionality of the landscape that is represented as species range of *T. graeca*. The latter approach is presented here and LCM is employed for the spatially explicit prediction of vulnerability to land cover change to map out the potential consequences of a business-as-usual scenario. Biodiversity, landscape pattern and change process analysis are carried out to convey the process of landscape transformation and its impacts on tortoise habitats in the past.

For landscape ecological analysis the approach integrates data and maps from broader to larger spatial scales. Long-term species range data for 1 km x 1 km grids is available in geodata portals and published literature (AGUILAR 1990; GOVERN DE LES ILLES BALEARS 2009; LÓPEZ JURADO et al. 1979; PINYA & CUADRADO 2008). Land cover maps at scale 1:50,000 for the whole island of Mallorca in 1956, 1973, 1995, 2000, and 2006 were provided by Geographers at the Earth Science Department of the University of the Balearic Islands in Palma de Mallorca (GIST 2010; PONS 2003). Semantically, the maps follow the CORINE land cover classification scheme with 11 classes in 5 categories. The present analysis was carried out for 8 land cover classes and three aggregated land cover 'regions' (artificial surfaces, agricultural areas, and forest and semi-natural areas).

Biotope maps at 1:2,000 scale based on field research in 1992 (SCHMITT 1999) in 2008 (MÖRTL 2008), and 2010 (scale 1:5,000) were used. The biotope maps adhere to the classification methodology described in SCHMITT (1999). All analyses were carried out with the Geographic Information System (GIS) software ArcGIS 9 and the extension Land Change Modeler for ArcGIS.

2.2 Biodiversity, Landscape Pattern and Change Process Analysis with Land Change Modeler for Ecological Sustainability (LCM)

The change process option in LCM was used to compare the 1973 and 2006 land cover maps (GIST 2010). The output map is in the form of a map that depicts the nature of the change underway within each land cover class. Edge density, as a spatially explicit measure of fragmentation, was calculated in LCM for the earlier and later land cover maps and the results were combined with map algebra to map out areas where fragmentation changed (increase or decrease) between 1973 and 2006 or not.

Biodiversity analysis with LCM links species presence and land cover data to produce spatially explicit mapping of regional richness for the land cover maps of 1973 and 2006 and species turnover for the land cover maps of 2006 and the biotope map of 2010. LCM first calculates species richness (total number of species at each location, alpha diversity) for a user-defined focal zone around each pixel. Computationally, regional richness (gamma diversity) is calculated as the total number of species over a region (e.g. land cover class). Species turnover (beta diversity) is calculated as gamma diversity divided by the average alpha diversity within each region (EASTMAN 2009). With a single species used to exemplify the concept here, maximum species richness is 1. All raster cells within a region are assigned the regional species richness as an index value. Regional richness maps can be understood as abstractions of a region's capacity to deliver supporting services such as biodiversity-enhancing landscape structures. LCM yields a mapping of species turnover that is conceptually a measure of the change in species diversity between different locations or regions. With a single species mapped, species turnover is a measure of dissimilarity of species presence between land cover and biotope classes.

2.3 Statistical test

While the identification of important landscape properties that are supportive for *T. graeca* and hence biodiversity is based on spatially explicit analyses, non-spatial approaches deliver supplementary insights into the patterns of change. For an assessment of the impact of tourist and urban land cover change on the habitat status of the species, it is first tested whether differences in landscape composition or long-term rate of land cover change are apparent between species grids where the tortoise persisted in 2007 versus those grids where its occurrence was observed only until 1990. The species range grids and population densities where adapted from the online geodata Bioatlas and the literature (CONSELLERIA DE MEDI AMBIENT 2009). The proportion of biotope types in each grid was summarized by category from the biotope map (2010) at 1:5,000 scale and the long-term rate of land cover change (1973, 1995, 2000, and 2006) was assessed for each grid from the land cover maps at 1:50,000 scale. The differences between the species' presence and absence grids are tested with the Mann-Whitney U-test, the non-parametric alternative to Student's t-test that is most commonly used when there is one nominal variable with only two values (here species absence or presence) and one measurement variable (proportion of biotope types or long-term rate of land change), and the measurement variable does not meet the normality assumption. After ensuring that the observations in the absence and presence grids have the same shape of distribution, the following null-hypotheses were tested:

• Based on the biotope map of 2010 at 1:5,000 scale, the proportion of biotope types in the species range grids (1 x 1 km) where *T. graeca* was absent (n=20) is equal to the proportion of biotope types in the species range grids where the species was present in 2007 (n=15).

• Based on the multitemporal land cover maps at scale 1:50,000, the mean long-term rate of land cover change per species range grids (1 x 1 km) where *T. graeca* was present in 2007 (n=40) is equal to the mean long-term rate of land cover change for those grids where *T. graeca* was present from 1979 until 1990 but absent in 2007 (n=64).

2.4 Land cover change prediction with Land Change Modeler

The land change analysis and modeling process uses 1:2,000 scale biotope maps for a 1,045 ha subset of the *T. graeca* distribution range in Calvià in 1992 (SCHMITT 1999) and 2008 (MÖRTL 2008). It is important to note that the modeling logic for the spatial allocation of change and the temporal rate of change implemented in LCM assumes that the *nature* of change stays the same. Planning interventions (e.g. new reserves) and infrastructure maps (e.g. roads) can be considered in the change prediction. Static (e.g. elevation) and dynamic (e.g. distance to already built-up land) driver variables can be included that are recalculated during modeling steps. The biotope maps of 1992 and 2008 were used to model the future transition of natural and semi-natural biotopes to artificial surfaces in a business-as-usual scenario until 2015. Transitions from eight natural and semi-natural biotope types to artificial surfaces were grouped in the sub-model "soil sealing". Proximity to the coast and empirical transition potentials were set as static driver variables, and proximity to existing artificial surfaces as dynamic driver variable. The modeling approach was described in detail in an earlier article where the focus was on habitat suitability mapping and observed as well as potential habitat loss (compare MICHEL & HOF 2011). In this paper, the multi-criteria workflow is similar and the resulting continuous mapping of vulnerability to the modeled change, i.e. urbanization, is used for a what-if scenario to identify and map biotope structures at scale 1:2,000 that have functional importance for *T. graeca* and are vulnerable to change (Figure 2).

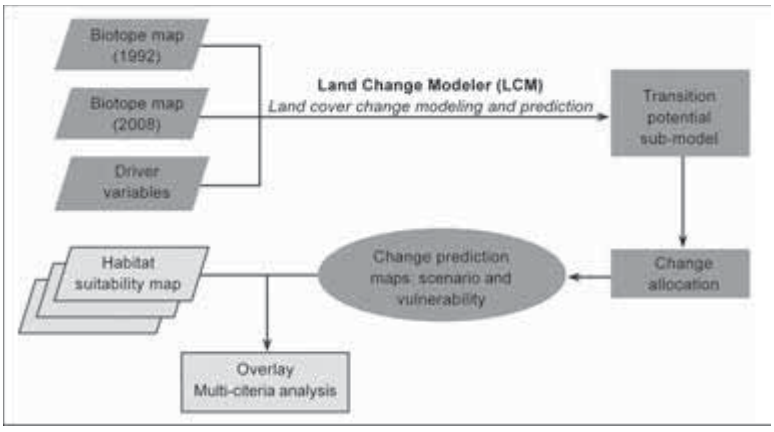

Fig. 2: Schematic workflow for integrating land cover change modeling and prediction to solve multi-criteria problems such as priority site selection for urban nature conservation or habitat management.

3. Results and discussion

3.1 Land change process

In terms of absolute gain, urbanization dominated the land cover change process from 1973 to 2006 in the distribution range of *T. graeca* (Figure 3). Two thirds of the urban fabric in 2006 had transitioned since 1973 from other land cover classes, with urbanization targeting mainly for forest, permanent crops, and arable land. Relative to the initial area of each land cover class in 1973, agricultural areas experienced the highest losses by 2006, followed by forests and semi-natural areas (scrub and/or herbaceous vegetation associations and open spaces).

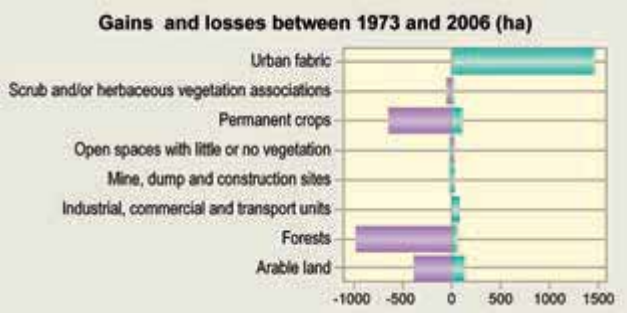

Fig. 3: Quantitative assessment of past land cover change in the distribution range of *Testudo graeca* in Calvia municipality, Mallorca. Own analyses of 1:50,000 land cover maps (GIST 2010).

Long-term change resulted in an artificialisation of the landscape, in particular along the coast (Figure 4, left). This change process map is the result of a decision tree procedure that compares the number of land cover patches present within each class between the two time periods to changes in their areas and perimeters. Three change processes occurred:

• **Attrition** of forests and agricultural areas with a decrease in number and area of patches

• **Aggregation** of urban fabric and open spaces, i.e. the number of patches is decreasing but the area is constant or increasing

• **Creation** of urban fabric: increase in number and area of patches

The analysis of long-term changes in landscape fragmentation (edge density) shows that *T. graeca* tended to persist where edge density hardly changed or decreased (Figure 4, right). In 90% of the *T. graeca* range grids in 2007 (n=40), the majority of raster cells experienced a decrease in fragmentation since 1973, in 53% of the range grids, edge density purely decreased. The biodiversity analysis discussed in the next section focused on the southern part of *T. graeca's* species range (Figure 4, right) because long-term urbanization and recent urban sprawl (1990-2006) were concentrated in this area (compare HOF & SCHMITT 2008).

3.2 Biodiversity analysis: Species turnover and regional richness

The focus for discussing the results is on the regional richness of *T. graeca* mapped to land cover classes in 1973 and 2006. The spatial extent of the analysis is that of the biotope map of 2010 which covers 32.2% of the species range in 2007 (Figure 4 and 5). In this area, continued urban sprawl, pressure on nature conservation areas and highest species densities coincide. In addition, sizable parts of the area may be designated as land for future urban development in the next planning revision and therefore, the analysis concentrates on this part of the species range. Regional richness decline between 1973 and 2006 follows the intuitive pattern of decrease in species range (Figure 5). The shift in regional richness conveys the impact of change processes (Figure 4) on biodiversity (Figure 5), and for planning purposes an additional juxtaposition of regional richness of land cover classes in 1973 and 2006 is instructive (Table 1). Clearly, presence of *T. graeca* is high in forests and semi-natural areas.

Relative to 1973, agricultural areas have recorded higher presence in 2006 which may be related to qualitative alterations of land cover, mainly due to abandonment of agricultural land and consequent proliferation of habitat patches at different successional stages. Species turnover is mapped to land cover classes and biotopes to show the effect of map scale and thematic depth (Figure 6). Owing to smaller scale, the mapping of species turnover to land cover classes (2006) suggests a steeper wild-urban gradient when compared to biotope dissimilarity (2010). Landscape heterogeneity is better represented when species turnover is mapped to the biotopes, in particular in the forest and semi-natural areas (Figure 6). The Natura 2000 site (Cap de Cala Figuera) covers 13 km² and clearly stands out in the biotope map as an area where species turnover is medium to low and landscape heterogeneity is high. The proximity of the Natura 2000 site to urban areas and the major tourist resorts is a reason for concern and the land change modeling concentrates on this area. The maps of change process, edge density change, regional richness, and species turnover complement each other and convey spatially explicit information on biodiversity-enhancing landscape structures (Figure 5, Figure 6).

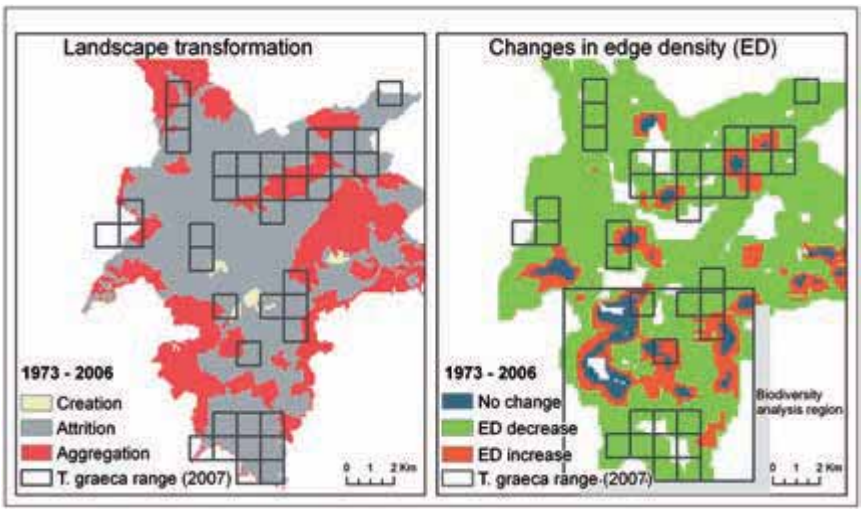

Fig. 4: Change process and landscape fragmentation in the distribution range of *Testudo graeca* in Calvià municipality, Mallorca. Own analyses of land cover maps at 1:50,000 scale from GIST 2010.

Rank	Land cover class (1973)	Rank	Land cover class (2006)
1	Forests	1	Forests
2	Scrub and/or herbaceous vegetation associations	2	Permanent crops
3	Permanent crops	3	Arable land
4	Open spaces with little vegetation	4	Scrub and/or herbaceous vegetation associations
5	Urban fabric	5	Urban fabric
6	Arable land	6	Open spaces with little vegetation
7	Industrial, commercial and transport units	7	Industrial, commercial and transport units
8	Mine, dump and construction sites	8	Mine, dump and construction sites

Tab. 1: Regional richness of *Testudo graeca* mapped to land cover classes. The values were converted to standard scores and ranked for better comparison. Data source: Own calculations with land cover maps at 1:50,000 scale (GIST 2010).

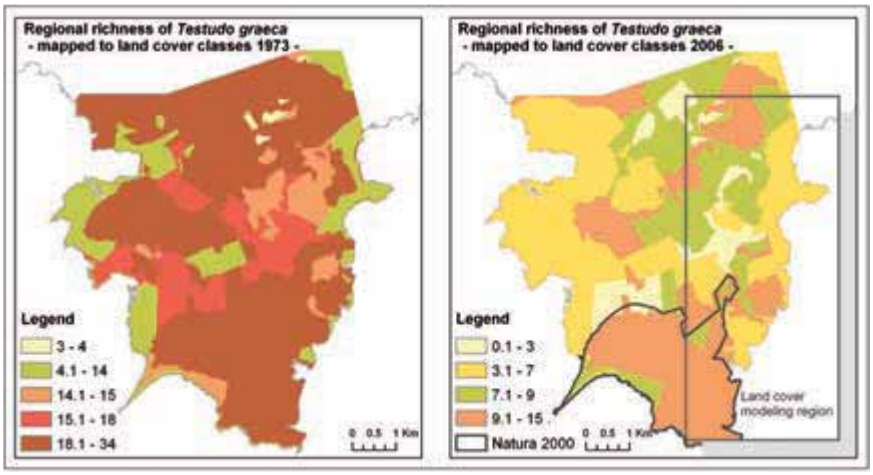

Fig. 5: The richness of *T. graeca* over land cover classes at 1:50,000 scale (GIST 2010) as regions. The value recorded at any raster cell represents the richness within the region to which it belongs and not the richness at that particular location.

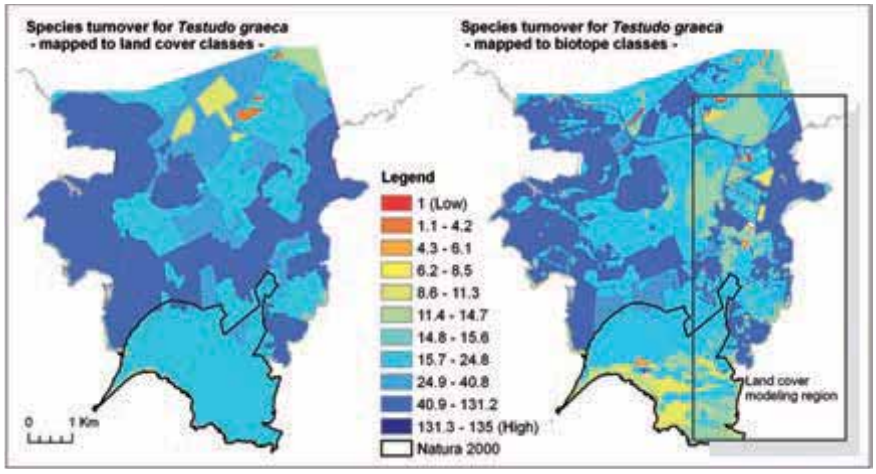

Fig. 6: Species turnover measured as dissimilarity of species presence between 1:50,000 scale land cover (GIST 2010) and 1:5,000 scale biotope classes.

3.3 Species presence or absence and land cover change modeling

Significant differences exist for the proportion of artificial surfaces and semi-natural biotopes at different successional stages between presence and absence grids of *T. graeca* in 2007. The results are significant at and beyond the .05 level for a non-directional test (Table 2).

The mean ranks of the long-term growth rate of artificial surfaces (1973 to 2006) are significantly different among the presence and absence grids of *T. graeca* (.02 level for a non-directional test). The null hypothesis cannot be rejected for the long-term rate of change in agricultural areas, forests and semi-natural areas (Table 3).

It can be concluded that the urbanization rate has played an important role in influencing the decrease in population and species range of *T. graeca*. These results are consistent with the observation that the species prefers intermediate successional vegetation stages and that the maintenance of a fine-grained landscape mosaic with patches of different complexity and land covers has a positive effect on habitat availability for the species (ANÁDON et al. 2006). Regional richness mapped to biotopes (2010) was highest for Maquis, Garigue-Pine forests transitional complex and Maquis-Pine forests transitional complex. The proportion of these biotopes to land cover is highly positively correlated to species density of *T. graeca*, while the proportion of artificial surfaces is highly negatively correlated with species density (r=0.82 and -0.91, respectively; Pearson's correlation coefficient). The Natura 2000 site is testimony to the biodiversity value of this part of the island. At the same time, urban sprawl, the proximity to urban areas and the major tourist resorts is a reason for concern. Future revisions of the municipal land use plan may target areas that are transformation and harmonization land which is potentially at stake to be designated as land for future urban development (Figure 7). Therefore, the discussion of the land change prediction focuses on that part of the species range. The combination of maps on vulnerability to land change and habitat suitability informs decision-makers who ask: what areas are optimal for future urban development with the least impact on biodiversity while maintaining landscape

Biotope type	z-value	p-value	Level of significance (non-directional (two-tailed) test)
Fallow land	-2.18	0.0293 (p<0.05)	0.05 (significant)
Artificial surfaces	-4.22	p<0.001	0.01 (highly significant)
Coastal biotopes	1.4	0.1615 (p>0.05)	Not significant
Ruderal sites (Very low vegetation cover)	0.45	0.6527 (p>0.05)	Not significant
Garigue	0.82	0.4122(p>0.05)	Not significant
Garigue-Maquis transitional complex	1.1	0.2713	Not significant
Garigue-Pine forests transitional complex	2.95	0.0032 (p<0.01)	0.02 (highly significant)
Maquis	0.68	0.4965	Not significant
Maquis-Pine forests transitional complex	2.65	0.008 (p<0.01)	0.02 (highly significant)
Pine forests	1.47	0.1416 (p>0.05)	Not significant
Permanent crops	-0.78	0.4354 (p>0.05)	Not significant
Arable land	-1.05	0.2937 (p>0.05)	Not significant
Grassland	0.02	0.984 (p>0.05)	Not significant

Tab. 2: Results of the Mann-Whitney U-test for difference in biotope type proportions (2010) between 1 km x 1 km presence (n=15) and absence grids (n=20) of *Testudo graeca* in 2007. Data source: Own calculations with biotope map at 1:5,000 scale.

	z-value	p-value	Level of significance (non-directional (two-tailed) test)
Artificial surfaces	2.85	0.0044	0.02 (highly significant)
Agricultural areas	1.31	0.1902	Not significant
Forest and semi natural areas	1.19	0.2340	Not significant

Tab. 3: Results of the Mann-Whitney U-test for the difference in the long-term land cover change rate (1973, 1995, 2000, and 2006) between 1 km x 1 km presence (n=40) and absence grids (n=64) of *Testudo graeca* in 2007.

aesthetical values? How will these ecosystem services be impacted by a continuation of the historic trend in land cover change? A crosstabulation or overlay of the vulnerability map with the habitat suitability map derived from the biotope map (compare MICHEL & HOF 2011) shows that the areas that are highly vulnerable to change to artificial surfaces are exclusively Maquis and Maquis-Pine forest transitional complexes (Figure 7). These biotopes were impacted by land cover change between 1992 and 2008 and covered only 10.2% of the modeled area in 2008. The bigger part of this area is in the urban land zone (42%) or within the transformation and harmonization zone (18%) that successively may be designated as land for future urban development. However, a sizable proportion (40%) is found in the Natura 2000 site which underscores the importance of this site for biodiversity conservation but also its vulnerability if land cover change follows the business-as-usual scenario.

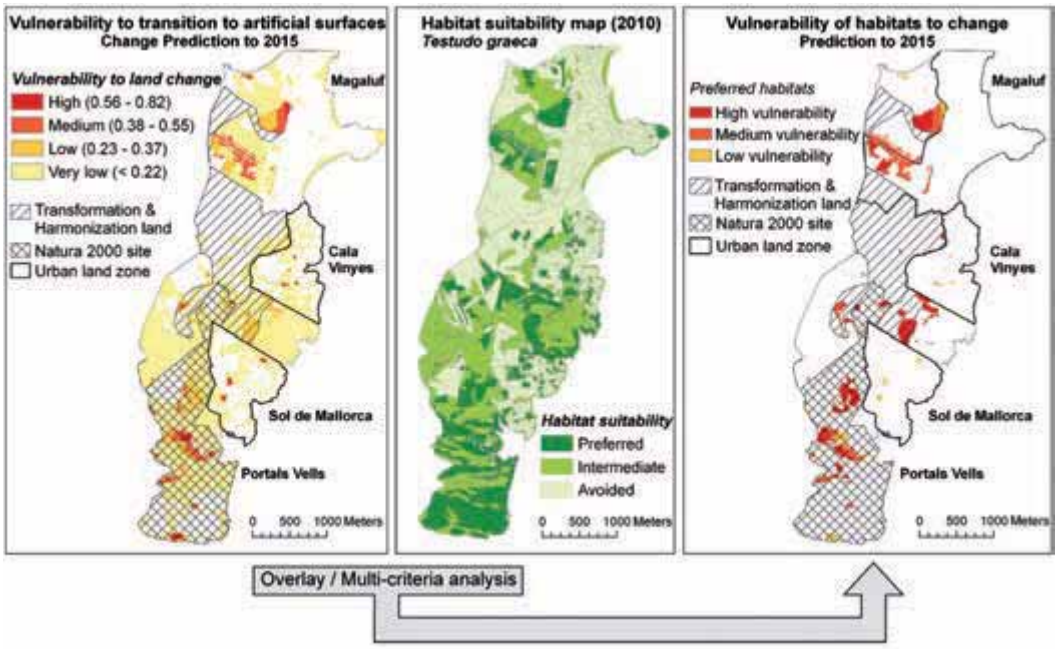

Fig. 7: Continuous mapping of vulnerability of eight natural and semi-natural biotope types to transition to artificial surfaces by 2015 in a business-as-usual scenario. The combination of vulnerability and habitat suitability maps indicates how preferred habitats might be impacted by a continuation of the historic trend in land cover change. Own analyses of biotope maps (1:5,000) from MÖRTL (2008) and SCHMITT (1999).

This is just one example for an overlay analysis to solve multi-criteria problems such as site selection and suitability models (Figure 2). The weights and importance assigned to the input layers are ultimately the outcome of a definition of goals and objectives. If biodiversity were an objective, the change process and biodiversity measures maps and the prediction of vulnerability to change could be used by decision-makers to reflect past land change processes for improved integration of landscape ecological knowledge into future urban conservation, management, and planning.

4. Conclusions and outlook

With an emphasis on applicability and usefulness of landscape ecological knowledge for decision-making in conservation and planning as integral parts of urban management, this paper demonstrates a workflow of mapping land change processes and biodiversity measures that could be further used in multi-criteria analyses. Accessible data were used in conjunction with Geographical Information Systems functionality; in particular Land Change Modeler for Ecological Sustainability, an application that is oriented to the problem of accelerated land change and the specific analytical needs of biodiversity conservation. The workflow to generate information on the long-term pathway of landscape functions is exemplified for land cover change and a single key species. Available data allow including all endangered species' range grids on the island of Mallorca (GOVERN DE LES ILLES BALEARS 2009) for comprehensive mapping of biodiversity measures to land cover regions at the island scale (GIST 2010). The visualization of land change processes and biodiversity measures is one of the main benefits of the approach. Maps communicate the effects past land cover changes have had on landscape structure and fragmentation, species richness, and dissimilarity of land cover classes. This is a novel perspective on the biodiversity impacts of coastal urbanization in the Mediterranean and a basis for discussing future land planning scenarios.

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