



Synthesizing different perspectives on the value of urban ecosystem services

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Date: 15–16 July 2011
Venue: University of Lodz
Faculty of Economics and Sociology, Room T-401
Street address: Rewolucji 1905 r. 39, Lodz, Poland

Scientific committee

Professor Ian Bateman, University of East Anglia, UK
Professor Klaus Hubacek, University of Maryland, College Park, USA
Professor Jouni Paavola, University of Leeds, UK
Dr Jan Sendzimir, International Institute for Applied Systems Analysis, Laxenburg, Austria
Professor Maciej Zalewski, European Regional Centre for Ecohydrology under the auspices of UNESCO
Professor Tomasz Żylicz, University of Warsaw, Poland

Organisers



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www.sendzimir.org.pl



University of Lodz
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European Regional Centre for Ecohydrology under the auspices of UNESCO
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President of the city of Lodz
www.en.uml.lodz.pl



Union of Polish Metropolies
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Marshall of Lodz Province
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Aims

Since 2008 more than half of the world population lives in cities and within the next 40 years the share of urban dwellers is estimated to increase to 70%. Urban populations do not only use ecosystem services from outside urban boundaries (clearly their ecological footprints are much larger than their physical areas) but, often unknowingly, they also rely on urban ecosystems. While researchers primarily focus on distant ecosystems, crucial for the preservation of life on the planet, most local ecosystems in and around urban areas suffer from an increasing pressure from further urbanization and growing consumption within cities. Important urban ecosystem services are often being neglected without the understanding of their importance and value. Meanwhile, they are crucial for the sustainability of life and the wellbeing of residents in urban areas.

Attempts have been made to highlight the value of urban ecosystem services, especially with reference to urban greenery, water and allotment gardens. Different perspectives on the value of urban ecosystem services have been revealed, including economic (benefits and savings), socio-ecological (resilience), psychological (well-being), cultural (e.g. inspiration), and philosophical or ethical. On the one hand, such a multitude of perspectives suggests that at least some of these perspectives should be meaningful to different groups of stakeholders. On the other hand, ultimately, this variety might weaken the message delivered to decision-makers who often only follow narrow economic reasoning. The objective of this seminar and the special issue of *Landscape and Urban Planning* that follows is to bring together the various perspectives on the value of urban ecosystem services and discuss the potential of merging and synthesizing these perspectives. Ultimately, this should lay foundations for a more sustainable management of ecosystem services in urban areas.

Location

Lodz (Łódź) is the third largest city in Poland, located 130 km south-west of Warsaw, in the centre of the country. It is still a relatively green city, in spite of its rapid development in the 19th century as the capital of the Polish textile industry. Lodz provides a particularly interesting case study of the regeneration of urban ecosystem services. Over time the rich network of streams and rivers that once made the development of textile industry possible degraded into a network of subterranean sewage canals. The same system can now serve as a basis for a large scale (planned) urban revitalization programme within the Blue–Green Network, a concept promoted by the European Regional Centre for Ecohydrology under the auspices of UNESCO (a tour of the elements of this network will be organised on Saturday, 16 July 2011).

Venue

The seminar will take place at the Faculty of Economics and Sociology, University of Lodz.

When you enter the premises of the Faculty of Economics of Sociology from Rewolucji Street, go to the tallest building further in the courtyard (building T), marked with letter A in the photo.

You will find the reception desk in the ground floor of that building.



Seminar programme¹

Friday, 15 July 2011

09:00 09:30 Registration

09:30 10:00 Opening

10:00 11:30 *Urban ecosystem services at the local level*

Chair: Professor Tomasz Żylicz, University of Warsaw, Poland

Urban green spaces as providers of urban ecosystem services

Professor Jürgen H. Breuste, Paris-Lodron-University, Salzburg

Local parks and community cohesion in Greater Manchester, UK

Aleksandra Kazmierczak, Ph.D., University of Manchester, UK

Allotment gardens – a valuable ecosystem service

Rute Sousa Matos, Ph.D., University of Évora, Portugal

Calculating Partial Economic Value of Urban Ecosystem Services

Professor Dietwald Gruehn, Dortmund University of Technology, Germany

11:30 11:45 Coffee break

11:45 13:15 *Urban ecosystem services in a greater city area*

Chair: Professor Dietwald Gruehn, Dortmund University of Technology, Germany

Integrating urban ecosystem service(s) provisioning for urban regions

– synergies, trade-offs and losses

Professor Dagmar Haase, UFZ, Leipzig, and Humboldt Universität, Berlin

The value of ecosystem services in traditional gardens around the city of Gazvin in Iran

Naghmeh Mobarghei, Ph.D., University of Shahid Beheshti, Iran

Changes in the value of ecosystem services along a rural-urban gradient:

A case study of Greater Manchester, UK

Kathleen G. Radford, Ph.D., University of Salford, UK

Professor P. James, University of Salford, UK

Marine ecosystem services in urban areas:

do the strategic documents of Polish coastal municipalities reflect their value?

Joanna Piwowarczyk, Institute of Oceanology, Polish Academy of Sciences, Poland

Jakub Kronenberg, Ph.D., University of Lodz, Poland

Małgorzata Dereniowska, Adam Mickiewicz University in Poznan, Poland

13:15 14:15 Lunch

14:15 16:00 Case study session, attended by local stakeholders
(participants in the social participation project run by the Sendzimir Foundation)

Presentation of the report on the situation of ecosystem services in Lodz

Discussion

16:00 16:30 Coffee break

16:30 18:00 *Urban ecosystem services – social-ecological networks*

Chair: Dr Jan Sendzimir, IIASA, Austria

The essentiality of combining the ecology "of" cities with the ecology "in" cities,

for safeguarding a sustainable delivery of ecosystem services to city inhabitants over time

Dr Åsa Jansson, Beijer Institute of Ecological Economics, Stockholm, Sweden

¹ Keynote speakers marked in bold.

Mapping of social-ecological values in Stockholm: Implications for ecosystem services and urban transition planning

Jeff Ranara, Stockholm Resilience Center, Stockholm University, Stockholm, Sweden
 Anders Telenius, Ph.D., Swedish Museum of Natural History, Stockholm, Sweden
 Andreas Zetterberg, Dept. of Land and Water Resources Engineering, Royal Institute of Technology, Sweden
 Alexander Ståhle, Ph.D., School of Architecture, Royal Institute of Technology, Stockholm, Sweden
 Fredrik Liljeros, Ph.D., Dept. of Sociology, Stockholm University, Sweden
 Harini Nagendra, Ashoka Trust for Research in Ecology and the Environment (ATREE), Bangalore, India
 and Center for the Study of Institutions, Population, and Environmental Change, Indiana University
 Keith Tidball, Dept. of Natural Resources, Cornell University
 Stefan Lundberg, Ph.D., Swedish Museum of Natural History, Stockholm, Sweden
 Professor Thomas Elmqvist, Stockholm Resilience Center, Stockholm University, Stockholm, Sweden

Integrated social-ecological network analysis of user-managed, pollinator-inhabited GreenER roofs and walls enhancing urban resilience and ecosystem services

Jeff Ranara, Stockholm Resilience Center, Stockholm University, Stockholm, Sweden
 Henrik Ernstson, Ph.D., Stockholm Resilience Center, Stockholm University, Stockholm, Sweden

Social-ecological vulnerability assessment of the Cologne urban area to heat waves

Yaella Depietri, United Nations University, Bonn, Germany

19:00 22:00 Conference dinner

Saturday, 16 July 2011

09:00 10:30 Working session on a new joint research project

10:35 11:30 *Urban ecosystem services* – measures/indicators

Chair: Dr Åsa Jansson, Beijer Institute of Ecological Economics, Stockholm, Sweden

Characterization of Non-Urbanized Areas for land-use planning of agricultural and green infrastructure in urban contexts

Daniele La Rosa, University of Catania, Italy
 Riccardo Privitera, University of Catania, Italy

Valuation of water footprint of cities. Example of Wielkopolska Region

Małgorzata Stepniewska, Ph.D., Adam Mickiewicz University in Poznan, Poland

Bringing out the value of ecosystem services in urban planning through spatial indicators

Leena Kopperoinen, Finnish Environment Institute SYKE, Helsinki, Finland
 Tarja Söderman, Finnish Environment Institute SYKE, Helsinki, Finland
 Vesa Yli-Pelkonen, Ph.D., University of Helsinki, Helsinki, Finland
 Seija Väre, SITO Oy, Espoo, Finland
 Anna Strandell, Finnish Environment Institute SYKE, Helsinki, Finland
 Sanna-Riikka Saarela, Finnish Environment Institute SYKE, Helsinki, Finland

11:30 11:45 Coffee break

11:45 12:35 *Urban ecosystem services* – other issues

Chair: Aleksandra Kazmierczak, Ph.D., University of Manchester, UK

Urban Ecosystem Services: Conceptual Tools from Philosophy

John Huss, Ph.D., University of Akron, USA

Preserving the Green: a Challenge to a Desert City

Abdulelah Almayouf, Ph.D., King Saud University, Saudi Arabia

12:35 13:00 Closing

13:00 14:00 Lunch

14:00 17:30 Excursion and presentation of the concept of the Blue–Green Network in Lodz

Abstracts

Urban ecosystem services at the local level

Jürgen H. Breuste:

Urban green spaces as providers of urban ecosystem services

Paris-Lodron University, Salzburg, Austria

Ecosystem services are provided on different scales. The local level is the basic unit for ecosystem services. These are landscape elements or basic ecosystems differing from their neighborhood by structure and functions. In urban areas the concept of urban (ecological) structural units (USU) has been approved to differentiate micro-climatic, biotic, soil and hydrological conditions (Breuste 2009, Pauleit, Breuste 2011). These USU can be used as basic concept of providers of urban ecosystem service. The USU dominated by biotic elements, the urban green spaces are investigated in their ability to provide these services in different qualities and quantities (James et al. 2009). The different urban green structure types like lawns, bushes, different tree covered areas etc. are effective to use for a semi-quantitative evaluation of its services instead of extreme resource consuming measurements (Breuste et al. 2008).

The study is based on general available knowledge on urban green functions and on example studies especially in Central Europe, but also in Latin America and China. This allows qualifying different urban green space types by its internal structure of vegetation, size, shape and location in relation to at least a semi-quantitative scaling of its urban ecosystem services under different cultural circumstances. The evaluated urban green spaces are street trees, neighborhood parks, district parks, city parks, urban forests and allotment gardens. The assessed urban ecosystem services are provisioning, regulating, supporting and cultural services (e.g. Priego et al. 2008). The URGE-manual (Baumgart et al. 2004), a tool developed by an inter-, transdisciplinary and international team to which the author belonged, is tested for its adaptability to the task of evaluation of urban ecosystem services on the local level for urban green spaces. The actual urban challenges, land use change, adaptation to climate change, demographic change and cultural diversity demand a systematic evaluation of urban ecosystem services with constant monitoring. A new planning paradigm related to urban ecosystem services is urgently needed to develop and to implement.

Aleksandra Kazmierczak:

Local parks and community cohesion in Greater Manchester, UK

University of Manchester, UK

The ongoing socio-spatial polarisation of British cities results in the concentration of poor and culturally diverse communities in inner-city neighbourhoods. In these places, due to the variety of social problems and little commonality between people, the community cohesion is often low. Urban green spaces may help to build ties between people due to their free and accessible character, and the opportunities for social interaction they provide. This paper investigates the role of local parks in building stronger inner-city communities.

A mail-administered questionnaire survey (n=240), supplemented by focus group discussions, was used in three inner-city neighbourhoods in Greater Manchester, UK, characterised by high levels of material deprivation and/or cultural diversity. The research investigated associations between the pattern of visits to local parks, activities performed there, and the number of friends and acquaintances

in the neighbourhood and attachment to place declared by the respondents. In addition, the characteristics of local parks (size, vegetation density and variety, recreational facilities, state of repair) were assessed.

The frequency of visits to local parks was positively associated with the number of friends people had. The respondents whose visits lasted longer and involved pleasurable activities had more acquaintances. Both the frequency and the duration of visits correlated with positive perceptions of the neighbourhood and the willingness to stay. Thus, local parks seem to have the potential to facilitate cohesive urban communities, formed by residents attached to their neighbourhood. Yet, the pattern of visits and social interactions was found to be strongly dependent on both the social dynamics of the wider neighbourhood and the characteristics of the local parks. Currently, good-quality green spaces in the UK are disproportionately concentrated in wealthier areas, and social problems continue to plague inner-city areas. Thus, in reality, the role of local parks in improving inner-city community cohesion may be limited.

Rute Sousa Matos: Allotment gardens – a valuable ecosystem service

University of Évora, Portugal

The allotment gardens are a unique contribution to the cityscape. They challenge the conventional notion of urban space and the design of the open spaces, because they are “in growing” and productive urban spaces. They are an echo, a memory of what the countryside has been - a humanized landscape, still accessible in the heart of the city.

The benefits of these spaces are multifaceted: socially (leisure, community development, rehabilitation); environmentally (development of ecologically balanced areas, renovation of abandoned urban spaces, diversification of urban land use, increased biodiversity, preservation of the water cycle, the soil cycle and air cycle, reducing the ecological footprint); humanly (improving quality of life, better health, more diversity and food quality); economically (stimulation of local economies); emotionally (the pause that might constitute in the everyday lives of citizens).

Considering the interest that allotment gardens have as an urban phenomenon and the existing desire and need of a relationship between the citizens and nature, it's our believe that these spaces could have a fundamental and decisive role in this relationship. These spaces could have in them all that the city and the man need from nature, including an understanding of the landscape with all its multifunctionality.

The aim of this presentation is the inclusion of the allotment gardens in a new design approach to the city's open spaces, aiming at improving the efficiency of multifunctional land uses (production, protection and leisure) and simultaneously ensuring their articulation trough structural and human interfaces able to bring agriculture near to the "urbanscape", to enhance agriculture productivity and added value combined with an increase of biodiversity values and levels of recreational fruition of these different landscapes.

In this study will be used as a theoretical support, the authors which consider these spaces as a work material of great potential and value for the creation of new, aesthetically and ecologically viable spaces, as well as some study-cases, namely the allotment gardens in the Metropolitan Area of Lisbon - Portugal, that illustrate the work that has been developed to include these spaces in the city planning.

The main outcome of this paper is the creation of a productive and recreational landscape infrastructure that will assure the link and the articulation with the several opens spaces of the city and the connection between them and the countryside.

Dietwald Gruehn and Anne Hoffmann: Calculating partial economic value of urban ecosystem services

Dortmund University of Technology, Germany

In many European countries a contradictory debate on the value of and the benefits from urban green or open spaces is going on. On the one hand, they are highly regarded not only due to social, ecological and health related matters, but also increasingly to economic benefits resulting from them. For a rational debate on the economic value of urban ecosystem services it is important to find out more about which kinds of urban ecosystem services can be provided by urban open spaces and what economic benefits actually result from them.

Because the provision of green areas with specific ecosystem services is a public good, their appreciation is difficult to measure as market prices are not available. That is why special methods must be employed to obtain benefit information. Basically there are two methodological approaches for estimating economic values of non market goods: stated preferences and revealed preferences. The former one finds out individual preferences by asking people directly regarding their willingness to pay for certain goods (contingent valuation). The latter approach is to analyze the relationship between private market goods and public goods and to conclude the value of the public good from the price of the private good. That means the benefits resulting from the public good are reflected in private ones. This method is basically adopted within the research project presented here: Statistical analyses of land value data from 26 randomly selected medium-sized and major German cities, including multiple regression analysis, reveal new information regarding economic benefits of urban open space related criteria, such as specific ecosystem services, on land values within the investigated cities. Depending on different types of urban fabric the results indicate a significant impact of urban ecosystem services on land value in German cities.

Urban ecosystem services in a greater city area

Dagmar Haase et al.: Integrating urban ecosystem service(s) provisioning for urban regions – synergies, trade-offs and losses

Dagmar Haase, UFZ, Leipzig, and Humboldt Universität, Berlin, Germany

Nina Schwarz, Helmholtz Centre for Environmental Research – UFZ, Leipzig, Germany

Michael Strohbach, University of Massachusetts Amherst, USA

Franziska Kroll, University of Kiel, Germany

The concept of ecosystem services deals with the benefits the society gains from natural processes and ecological functions. It focuses on the provisioning aspect of ecosystems and landscapes. Particularly when it is about urban areas, ecosystem services assessment becomes difficult due to the fact that we have complex land use patterns resulting in a full range of overlaying ecosystem functions and services. In addition, land use changes in comparatively short periods of time. Particularly in such intensively used urban landscapes, ecosystem services can support but also impair each other and thus produce synergies and trade-offs. In our paper, we discuss a novel framework to integrate different ecosystem services for an urban region and to determine synergies, trade-offs and losses. Five ecosystem services have been selected that are of special importance for urban areas: Local climate regulation, recreation potential, biodiversity potential, food supply and carbon storage potential. We identified patterns of interactions among these five ecosystem services through the analysis of ecosystem service bundles. The paper scrutinises both opportunities and challenges the integration study was encountered with, in particular with respect to its application in land use planning.

Naghmeh Mobarghei:
The value of ecosystem services in traditional gardens around the city of Gazvin in Iran

University of Shahid Beheshti, Iran

Planted or cultivated ecosystems so called semi natural ecosystems, has many non market benefits that there are no market to show their values. Some of the most valuable services in the gardens are absorbing the CO₂ that is very important in reducing the greenhouse gas, producing the O₂, reducing the disturbance like flood and storm prevention, increasing the water supply, preventing the soil erosion, increasing the pollination, reducing the air pollution and absorbing the PM₁₀, and their increasing effect on the price of houses around the gardens.

When the garden is located near the city, there are a high tendency for changing the land use and converting them to the settlement area. Calculating the value of non market services and choosing a way to pay this value to orchardists, is an appropriate way to reducing the tendency for changing the land use and keeping the gardens.

Gazvin is an industrial city in central part of Iran. Around the city has covered by traditional gardens with approximately 2 500 hectare area. The most important products of these gardens are grape, almond, apricot, walnut and pistachio. Unfortunately nowadays the market value of agricultural products is very low and it is not comparable with benefit obtain from other land use like industrial or settlement using. Calculating the real benefit obtains from these gardens and payment the difference benefit to orchardist can lead to conserve these gardens.

Transferring the development right (TDR) and giving the alternative land to the orchardist to use them for other kinds of land use is other solution that have been recommended in this paper. The non market value of these gardens has been calculated by using cost based valuation and benefit transfer methods that are some of the main valuation methods in environmental economics. The results show that each hectare of these gardens has a value more than 500 US\$ just for seven ecosystem services. Knowing this value can help policy makers to choose an appropriate decision.

Kathleen G. Radford and Philip James:
Changes in the value of ecosystem services along a rural-urban gradient: a case study of Greater Manchester, UK

University of Salford, UK

The degradation and loss of vital ecosystem functions and services have been an uncontested result of urbanisation. An understanding of how ecosystem services are provided along rural-urban gradients is crucial in the task of conserving and enhancing vital services in urban environments, increasing the quality of life of urban dwellers, and working towards a sustainable future. Focusing on nine ecosystem services – aesthetic, spiritual, recreation, water flow regulation, carbon sequestration, climate change adaptation, pollination, biodiversity potential, and noise attenuation – regarded as important to urban areas the authors detail the changes in the values of these services along a gradient comprising four categories of urbanisation: urban, suburban, peri-urban and rural, in Greater Manchester, UK. The data on which the discussion is based are derived from an interdisciplinary assessment tool, developed from a selection of previously used assessment methods including the Residential Environment Assessment Tool and the Green Flag Award. Based on a mixture of a field and desktop study, the new tool assigns non-economic values of 0–10 to the selected services, allowing for evaluation of quality between, as well as within, each category of ecosystem service. Trends in the results are discussed, as are drivers for the changes in values along the rural-urban gradient. It is foreseen that this new body of knowledge will allow both practitioners and academics to gain further insight into the provision of ecosystem services along a rural-urban gradient to allow them to tackle the problems associated with them and to optimise open space planning.

Joanna Piwowarczyk et al.:
Marine ecosystem services in urban areas: do the strategic documents of Polish coastal municipalities reflect their value?

Joanna Piwowarczyk, Institute of Oceanology, Polish Academy of Sciences, Poland

Jakub Kronenberg, University of Lodz, Poland

Małgorzata Dereniowska, Adam Mickiewicz University in Poznan, Poland

Marine ecosystem services condition the development of coastal municipalities. But is their value obvious to local decision makers in Poland? We attempt to answer this question using the publicly available demographic and economic data and the official municipal documents, such as city and town development strategies. We limit our study to coastal municipalities with more than 10,000 inhabitants, 10 localities in total. Analysing the strategic documents we investigate whether the authorities of each town and city referred to: (i) local seaside conditions, (ii) particular types of marine ecosystem services and disservices, (iii) trade-offs between different ecosystem services, (iv) interactions between marine and terrestrial ecosystem services, and (v) the economic value of marine ecosystem services. In addition, we analyse (vi) whether references to ecosystem services are consistent in different documents of the same municipality, and (vii) whether the municipalities treat ecosystem services as the foundation for sustainable development. Finally, (viii) we examine if the strategic documents reveal any gaps between the objectives, implementation plans and the actions that have been undertaken with reference to ecosystem services.

Our analysis reveals that although most municipal strategies acknowledge seaside location, neither marine ecosystem services nor specific conservation and protection measures are considered in detail. Moreover, marine ecosystem services seem to be one of the most underestimated elements of urban ecosystems. One would hardly notice if the word ‘sea’ were replaced in these documents by a ‘lake’ or a ‘forest’. This reveals a dire need for evidence-based valuation of coastal marine ecosystems capacity to provide benefits under the changing anthropogenic pressures. Even more importantly, this science-based evidence needs to be made available to local decision makers to foster its inclusion in the local and regional governance processes and these processes need to be made more professional and participatory. Had these steps been taken, the dependence of seaside towns and cities on marine ecosystem services would have been more explicit.

Urban ecosystem services – social-ecological networks

Åsa Jansson:
The essentiality of combining the ecology "of" cities with the ecology "in" cities, for safeguarding a sustainable delivery of ecosystem services to city inhabitants over time

Beijer Institute of Ecological Economics, Stockholm

Today the majority of the total human population and over 70% of the Europeans live in cities. Urbanites, as all humans, depend on functioning ecosystems for their welfare and survival. Unfortunately, the ability of the world’s ecosystems to deliver these essential ecosystem services is being eroded (MA 2005). This crude fact, in combination with an accelerating global urbanization trend, demands new strategies for sustainable urban development. In this context it is essential to keep in mind that most of the services consumed in cities are generated by ecosystems located outside of the cities themselves (Folke et al. 1997), not seldom half a world away (Deutsch and Folke 2005). Thus, as urbanites, we need to concern ourselves not only with what is sometimes referred to as “the ecology in cities”, mainly focusing on designing energy efficient building, sustainable logistics and

providing inhabitants with healthy and functioning green urban environments, but also focus on “the ecology of cities”. This ecology of cities-framework acknowledges the total dependence of cities on the surrounding landscape and the ever ongoing dance between urban and rural, viewing the city as an ecosystem (Grimm et al. 2000). It is thus motivated to concern ourselves with both the generation potential of ecosystem services by ecosystem within as well as outside cities, simultaneously. To illustrate the dependence of city inhabitants on functioning ecosystems, whether these systems are located within the boundaries of the city or not, I, in this presentation, will look at some essential ecosystem services appropriated by urbanites in the city of Stockholm, and discuss this appropriation from a sustainability, ecology of/ecology in perspective.

Jeff Ranara et al.:

Mapping of social-ecological values in Stockholm: Implications for ecosystem services and urban transition planning

Jeff Ranara, Stockholm Resilience Center, Stockholm University, Stockholm, Sweden

Anders Telenius, Swedish Museum of Natural History, Stockholm, Sweden

Andreas Zetterberg, Dept. of Land and Water Resources Engineering, Royal Institute of Technology, Stockholm, Sweden

Alexander Stähle, School of Architecture, Royal Institute of Technology, Stockholm, Sweden

Fredrik Liljeros, Dept. of Sociology, Stockholm University, Sweden

Harini Nagendra, Ashoka Trust for Research in Ecology and the Environment (ATREE), Bangalore, India and Center for the Study of Institutions, Population, and Environmental Change, Indiana University

Keith Tidball, Dept. of Natural Resources, Cornell University

Stefan Lundberg, Swedish Museum of Natural History, Stockholm, Sweden

Thomas Elmqvist, Stockholm Resilience Center, Stockholm University, Stockholm, Sweden

Theories linking complex systems of people and nature – social-ecological systems – are well-developed in resilience research, but empirical data linking the social and the ecological is not as widely available. Stockholm has uniquely pioneered surveys of recreational use of open spaces (sociotopes), and of the distribution of ecological habitats (biotopes). We present a framework and method for ranking and spatially linking the elements of these separate social and ecological maps, using a two-factor index to create a unified, understandable social-ecological map identifying areas of low-low, low-high, high-low, and high-high social-ecological rankings.

Social-ecological maps can improve our understanding of ecosystem services – “a heuristic device for making human-ecology interaction more visible in decision making” – and are important for mapping their spatial distribution. We could determine, for example, where and how social corridors could improve accessibility to cultural ecosystem services, and for whom. We could also understand whether areas of high or low ecological ranking tend to be associated with particular kinds and levels of social ranking, and how these areas are spatially clustered. We could then correlate these findings with other spatial socioeconomic and institutional factors such as income, crime, or property rights.

Such analyses can provide input to policymakers navigating sustainable urban development paths. For example, identifying actions in areas of low social and ecological ranking could, after comparison with areas of high social and/or ecological ranking, involve transitions along ecological – e.g. restoration – or social – e.g. stakeholder involvement – pathways, or both. Identifying these pathways could involve key stakeholders in a participatory, scenario planning process that envisions possible futures and concrete steps for realizing them. The whole process could serve as an urban development model for most cities in Sweden and in other countries.

**Jeff Ranara and Henrik Ernstson:
Integrated social-ecological network analysis of user-managed, pollinator-inhabited GreenER roofs and walls enhancing urban resilience and ecosystem services**

Stockholm Resilience Center, Stockholm University, Stockholm, Sweden

Identification of the benefits of green roofs and walls have largely focused on their engineering functions such as storm water retention, climate mitigation, and/or the aesthetic value of their plant life. By incorporating an understanding of ecological processes into the design and construction of green roofs and walls, the provision of habitats and/or foraging grounds for pollinators, seed dispersers, or particular red-listed species is also possible. Taken individually, such habitats and foraging grounds would be isolated habitats, at risk for population extinction. However, a network of green roofs and walls, designed with an ecological understanding of species movements in and between fragmented habitats, could maintain viable species populations providing expanded ecosystem services in a wider urban landscape, especially when existing surrounding ground level habitats and foraging areas are incorporated into this ecological network. By further incorporating social networks - active citizen involvement and management - in the use and maintenance of this fragmented ecological network, additional ecosystem services connected with educational, social, cultural, recreational, and health benefits are also possible. These linked social-ecological networks would be an inherent part of a larger green infrastructure that could for example enhance urban resilience by providing increased capacity for climate change mitigation.

The provision of these expanded greenER roof and wall ecosystem services can be studied by examining the interaction of user and management social networks with the ecological networks on which they impinge, and vice-versa, as integrated social-ecological networks. Such work builds upon studies that have begun to use a network perspective in understanding the resilience of social-ecological systems as well as a particular study sketching a typology of four approaches to integrated social-ecological network analysis: (1) Analytical integration of separately examined social and ecological networks; (2) Analysis of the social network with ecological elements as node attributes, or vice versa; (3) Integrated social-ecological network analysis removing social and ecological distinctions between network nodes and flows between nodes; and (4) Translating interactions between social and ecological entities into two-mode networks, possibly complemented by one-mode social and/or ecological networks.

**Yaella Depietri:
Social-ecological vulnerability assessment of the Cologne urban area to heat waves**

United Nations University, Bonn, Germany

In Europe, 75% of the population lives in urban areas and the proportion is increasing (EEA, 2006). The socio-economic processes that accelerate rapid urbanization, population movement and population concentrations, substantially increase vulnerability of cities to hazards, and particularly of low-income urban dwellers (Srinivas, 2007). On the other hand, ecological and social vulnerability are linked through the dependencies of communities and their economic activities on ecosystems (Adger, 2000). The link between social and ecological systems is made explicit in the term “ecosystem services” which are the “benefits people obtain from ecosystems” (MA, 2005). The objective of the research is to assess the social-ecological vulnerability of an urban area to heat waves and floods. The study area is the Cologne urban area situated in a floodplain in central-western Germany in the North Rhine Westphalia (NRW) Federal State along river Rhine. Through the identification of the relevant ecosystem services which may influence the vulnerability of the population in urban areas, the methodology makes use of GIS applications to spatially assess the vulnerability of different districts to heat waves and floods. According to the presence, state and characteristics of the ecosystem services (e.g. climate regulation, air quality regulation, water supply) the districts considered present different degrees of vulnerability.

Urban ecosystem services – measures and indicators

Daniele La Rosa and Riccardo Privitera: Suitability analysis for Agricultural and Green Infrastructure in a metropolitan region

University of Catania, Italy

Non Urbanised Areas (NUAs) are outdoor places with significant amounts of vegetation, mainly semi-natural patches that represent the last remnants of nature in metropolitan areas. As part of agricultural and green infrastructure that provide ecosystem services, NUAs play an important role in reducing environmental pollution as well as the consequences of climate change. They provide services such as: purification of air and water, mitigation of floods and droughts, re-generation of soil fertility, moderation of temperature extremes, provision of landscape. Like all natural ecosystems, NUAs are today endangered by urban sprawl, which represents the main cause of their fragmentation and loss of evapotranspiring features. For these reasons the protection of these areas is a fundamental issue for land use planning and it needs appropriate strategies for their management.

We propose a land use suitability model to orient land uses of NUAs, based on four different analytical steps. Land Cover Analysis (LCA) quantifies the percentage of evapotranspiring surface for each land use. Fragmentation Analysis (FA) assesses dimensions and density of NUAs. Evaluation of Proximity (P) to residential areas takes into account the degree to which NUAs are close to housing units. Results from these analyses are integrated in a suitability matrix, which returns new potential land uses for NUAs. The last analytical step verifies the correspondence of these new land uses with the current ones, defining a set of rules that can confirm or modify the proposed land uses. The model allows to enhance the production of ecosystem services, defining and addressing new appropriate land uses for NUAS within the agricultural and green infrastructure fabric.

The model has been developed with GIS, using a set of data which includes high-resolution orthophotos, vectorial cartographies and field surveys. The case of three municipalities within Catania metropolitan area (Italy), characterized by a considerable urban sprawl, is presented.

Małgorzata Stępniewska: Valuation of water footprint of cities. Example of Wielkopolska Region

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The subject of this paper is assessment of services connected with meeting the water needs of population and national economy on the regional and local level, which should support the decision-making processes. The purposes of the study are to quantify the total water footprint of cities and show the possibility of its valuation based on the example of Wielkopolska (Greater Poland Voivodeship). Traditional regional water usage accounts refer only to the direct water use reported as the amount of water abstraction. The water withdrawal indicators, however, do not give information about the actual people's water demand in relation to their consumption. The study also takes into account indirect water use – the volume of water used to produce goods and services that are consumed by the population of the region (virtual water). The calculated water footprint of cities includes the total amount of direct and indirect water usage by their inhabitants (m³/yr/region). The water footprint is considered in division into two components: the internal and the external water footprint, as use of domestic and outside water resources respectively to supply the water needs of inhabitants of region. The generated map of water footprint is the basis for assessing the impact of cities of Wielkopolska on the water resources both domestic and external. To determine the degree of pressure on water resources, the relation between the water demand and water availability is examined. The paper also analyses the dependency of voivodeship on the virtual water import considered as the ratio of the external to the total water footprint of the region. The research results

show the importance of export of virtual water to the water-scarce area. By importing virtual water embodied in commodities, the region saves the amount of water it would have required to produce those commodities domestically. The concurrent economic effect comprises avoided costs related to additional water supply.

Leena Kopperoinen et al.: **Bringing out the value of ecosystem services in urban planning through spatial indicators**

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The concept of ecosystem services is not yet widely known among land use planners in Finland. Many ecosystem services, such as green space serving for outdoor recreation and dust binding, are considered in planning but some others have been disregarded without wider understanding on the value of services provided by healthy ecosystems. To provide tools to land use planners for evaluating and valuing ecosystem services, ecological criteria and spatial indicators were developed in a project led by the Finnish Environment Institute. In addition, social and economic criteria were developed alongside the ecological criteria to enable evaluation of all three aspects of sustainability.

Ecological criteria comprise five main criteria giving substance to ecological sustainability of an urban region in relation to land use, green structure, recreation, water cycle, and transport system. The 18 second order criteria describe in more detail which objectives of ecological sustainability will be achieved when the criteria are fulfilled. Finally, the 29 spatial indicators are either exact numeric values based on spatial analysis or more qualitative cartographic representations when numeric values are not sensible due to quality of source information or the nature of the issue. These indicators can be used when assessing sufficient ambition levels of variables to maintain desired ecosystem services.

Spatial indicators were tested in urban regions of Lahti and Oulu in Finland. Furthermore, because of the actual need of the planning department in Lahti some of the indicators were also used to assess the impacts of three different general land use plan options with different future scenarios, on ecosystem services. The outcome of this as well as experience on how the appreciation for the value of ecosystem services can be enhanced through spatial indicators will be discussed in this paper.

Urban ecosystem services – other issues

John Huss: **Urban ecosystem services: conceptual tools from philosophy**

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The study of urban ecosystem services crosses disciplinary boundaries of the various pure and applied disciplines of the natural and social sciences, engineering, and urban planning. Because each of these disciplines has its own conceptual framework, a certain amount of conceptual bridge-building is necessary for successful interdisciplinary collaboration. Philosophy of science provides tools for the analysis of conceptual frameworks, but this is only a first step. A crucial second step is to bridge any conceptual gaps so that action may be taken toward the achievement of shared goals. This may be done on the basis of pragmatic criteria, provided that various stakeholders can arrive at a set of shared goals. To set goals requires a system of valuation, and environmental ethics provides an alternate system of valuation to that of ecological economics. It is an especially useful framework for assigning value to “inspirational” benefits of the urban ecosystem but may extend further.

Abdulelah Almayouf:
Preserving the green: a challenge to a desert city

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Creating sustainable strategies for urban development can be achieved if the built and natural environments are integrated and not separated. Promoting urban natural green services in cities should be the objective to make livable, beautiful, and ecologically sustainable places. Typically, such places allow for the protection of green spaces, trails, water course and habitat for a variety of wildlife. Furthermore, well maintained green spaces are a good sign of comprehensive ecological health of the ecosystem. In keeping with this principle, embracing such a concept as to preserve environmental resources is of paramount importance, especially in cities located in desert climate and lack adequate natural resources. It is known that most of the desert settlements evolved and developed along Wadis (dry water course). Wadis are natural formations that function as water drainage system during rainy season, and comprise various natural resources. Wadi Hanifa is regarded a vital resource for Riyadh city, the capital of Saudi Arabia. It abounds with characteristics of the natural desert environment such as small villages surrounded by palm groves, farms and main flood streams. These elements are essential for local tradition and recreational activities. Unfortunately, during the past few decades, the Wadi context suffered from many negative issues that affected its vital function. This has encouraged the official authority responsible for the city management to carry out initiatives targeting the restoration of its natural place in order to strengthen the environmental systems in the city. This paper reviews the key features of the Wadi rehabilitation project proposed to facilitate its position to house substantial green spaces at the city level, with a focus on applicable approaches and the rehabilitation strategies.