EcoServ

Poznań 2023

Book of Abstracts

14-16 SEPTEMBER, 2023

Editorial office

Poznan Science and Technology Park
Professional Congress Organizer
Rubież 46, 61-612 Poznań, Poland
e-mail: bok@ppnt.poznan.pl

This volume has been compiled from files supplied by the Authors

DTP/Technical Editor

Reginaldo Cammarano

HONORARY PATRONAGE

ESP Ecosystem Services Partnership

SOCIETY FOR URBAN ECOLOGY SURE

ORGANIZER

Adam Mickiewicz University Poznań

PARTNER

PPNT Poznan Science and Technology Park

CONTENTS

Eco serv
Poznań 2023

Parallel Session 1

Socio-cultural services of ecosystems

Parallel Session 2

Services of water and water-dependent ecosystems

Parallel Session 3

Socio-cultural services of ecosystems

Parallel Session 4

Biodiversity and ecosystem services

Parallel Session 5

Ecosystem services in urban areas

Parallel Session 6

Mapping and assessment of ecosystem services

Poster Session

Parallel Session 7

Ecosystem services in urban areas

Parallel Session 8

Ecosystem services in management practice

PARALLEL SESSION 1

SOCIO-CULTURAL SERVICES OF ECOSYSTEMS

One nature, different approaches. How are cultural ecosystem services shaped, delivered and managed in the rural postglacial landscape?

Sylwia Kulczyk[1], Piotr Matczak[2], Marta Derek[1], Alina Gerleé[1], Krzysztof Mączka[2]

[1]*Faculty of Geography and Regional Studies, University of Warsaw, Krakowskie Przedmieście 30, Warszawa, Poland*
[2]*Faculty of Sociology, Adam Mickiewicz University, Szamarzewskiego 89, Poznań, Poland*

E-mail: skulczyk@uw.edu.pl

Cultural ecosystem services (CES) differ from other ES due to their relational character. Their existence and importance depend on whether (and how) they are perceived by people. As the amalgamation of the objective natural characteristics and their subjective valuation is challenging, including CES into spatial management schemes is difficult.

In this paper, we present the results of the study on the potential and use of cultural ecosystem service in two municipalities in northern Poland, Węgorzewo and Miłakowo. Although the two areas share the same natural characteristics (postglacial, moraine landscape), the intensity of tourism industry differs between the municipalities.

In our study, we implemented a mix of quantitative and qualitative methods. We took into account knowledge, attitudes, and opinions of different stakeholders, including local authorities, activists, representatives of different professions, inhabitants, and tourists. Participation mapping allowed spatial interpretation of the results obtained.

As a result, we obtained an overview of the opinions and attitudes of various groups. In general, CES are of great importance for the quality of life of residents and the attractiveness of the area to tourists. This image is, however, internally diversified. Identification of synergies and trade-offs of CES delivery allowed us to point out management challenges and vulnerable locations where intervention is necessary to keep environmental quality and human satisfaction from contact with nature at the appropriate level.

The results show the value of CES diagnosis for local planning. The study reveals also the importance of detailed elaboration of goals and tools for obtaining meaningful and useful data.

Relax and joy observed from the space. Multi-data and multitool approach to recreation mapping in the Great Masurian Lakes, Poland

Edyta Woźniak[1], Sylwia Kulczyk[2], Marek Ruciński[1], Marta Derek[2]

[1]*Space Research Centre, Polish Academy of Sciences, Bartycka 18a, Warsaw, Poland*
[2]*Faculty of Geography and Regional Studies, University of Warsaw, Krakowskie Przedmieście 30, Warsaw, Poland*

E-mail: ewozniak@cbk.waw.pl

Outdoor recreation is an important factor that influences quality of life. As it is based on natural resources, like water, forest, or visually attractive landscape, it is an important link between people and nature and the most widely recognised cultural ecosystem service. To understand how recreational cultural service (RES) is formed and delivered, a detailed analysis of environmental characteristics, available infrastructures, and visitors demands and behaviours is needed. This implies that different sources of data and tools of analysis have to be combined in order to obtain detailed and meaningful results.

In this paper, we address the problem using the example of water recreation in the region of the Great Masurian Lakes, Poland. We use an ample spectrum of data sources: from field mapping, thematic databases to satellite images. The analysis of the detailed spatial distribution of various factors influencing RES potential and delivery allows us to detect synergies and trade-offs between them. The natural potential is evaluated basing on spatial data such as: hydrographic, geological and land caver maps, as well as, digital terrain and bottom models, using Analytic Hierarchy Process. The infrastructure is mapped basing on a field inspection and on-line published information. The delivery of RES is monitored with the use of radar satellite images Sentinel-1. This kind of data allowed to observe the area at regular basis and to extract the information about the spatial and temporal distribution of recreational boats.

This study aims to find relation between delivery of RES and natural potential and infrastructure at the local scale. It also highlights the usefulness of new technologies, and in particular satellite monitoring, for the identification and valuation.

Assessing The Potential Supply Of Cultural Ecosystem Services On A Local Scale In Different Postglacial Landscape Types

Marta Kubacka, Sylwia Bródka, Witold Piniarski and Andrzej Macias

Landscape Ecology Research Unit, Faculty of Geographical and Geological Sciences, Adam Mickiewicz University, Poznań, Poland

E-mail: marta.kubacka@amu.edu.pl

Research on the potential of cultural ecosystem services (CES) is characterized by a wide variety of methodological approaches. These include the principles of service classification, the selection of diagnostic indicators and data sources, the quantification methods and tools used, and the spatial scale of analysis. This diversity of approaches is related to the intangible and subjective nature of CES, which hinders their use in environmental management and landscape protection. This paper presents the results of a quantitative assessment of the supply of cultural ecosystem services at the local scale using biophysical landscape analysis methods. To this end, a set of indicators was developed that analyzes ecological, cultural and physiognomic features of the landscape that can be diagnosed from available spatial databases. The typology of CES used in this paper is consistent with current classifications. The assessment was carried out for spatial units representing typical landscapes (ecosystems) of the young glacial zone in Poland. The values of individual and aggregated indicators at the level of CES categories indicate the high potential of ecosystems (forest, water courses, water bodies and wetlands) with little anthropogenic transformation. A group of individual indicators based on specific features of natural landscapes had a significant impact on the results of the study. These indicators determine the potential of CES within the categories of recreation and tourism, natural heritage and natural diversity, and landscape aesthetics and inspiration. The increasing role of humans in rural and urbanized landscapes causes CES potential to be determined by indicators that are more universal in nature and related to the cultural and historical characteristics of the landscapes. The results obtained confirm the validity of the matrix approach, particularly for landscapes in which ecological factors play a leading role.

Cultural ecosystem service assessment in Vidzeme, Latvia

Aiga Spage

Department of Landscape Architecture and Planning, Latvia University of Life Sciences and Technologies, Rīgas Street 22, Jelgava, Latvia

E-mail: aiga.spage@lbtu.lv

Cultural ecosystem services (CES) are becoming more acknowledged by local municipalities and their importance to society is being widely addressed in the scientific world. Local municipalities more and more are willing to use ecosystem services as a basis for spatial planning and to highlight specific landscape areas with high quality for CES delivery.

The aim of this study is to evaluate the delivery of CES in the Vidzeme planning region landscapes in Latvia using two different approaches and a comparison between them. The first approach uses geographical information system (GIS) software to calculate the delivery of CES. The second method uses field observations and interviews with local inhabitants and tourists. Delivery and description of the used method for CES assessment include identical specific indicators and criteria for both methods with the aim to compare both results and both methods as well as method suitability for local municipalities' work with spatial planning.

The outcome of this study is a comparison and analysis of the results of CES delivery with each method, to understand if the assessment of CES delivery using only GIS software delivers trustworthy results in Latvia when specific data can be gathered only in field observations and interviews. An important part of the research is an analysis of data availability and possible usage in CES assessment. Methods will be tested in a pilot territory in the Vidzeme landscape.

How internal and external factors co-create cultural ecosystem services? The typology of urban green spaces in Warsaw, Poland

Marta Derek[1], Edyta Woźniak[2], Sylwia Kulczyk[1], Tomasz Grzyb[1]

[1]*Department of Tourism Geography and Recreation, University of Warsaw, Krakowskie Przedmieście 26/28, 00-927 Warsaw, Poland*
[2]*Space Research Centre, Polish Academy of Sciences, Bartycka 18A, 00-716 Warsaw, Poland*

E-mail: m.derek@uw.edu.pl

Urban greenery is an integral part of the urban social-ecological system and therefore an important provider of cultural ecosystem services (CES). These are formed as an effect of interaction between nature and people; therefore, both ecological and social factors play a role in this process. Although CES are formed in a specific place where people contact nature, e.g. in an urban green area, this process is shaped both by characteristics of the site itself and by the context of its location within the urban landscape matrix. Hence, recognizing a role of a particular green area in CES creation and provision is a complex challenge. At the same time, this type of information is much needed for effective urban space management and planning. In this paper we are facing this challenge by proposing a typology of urban green spaces based on the analysis of ecological and social factors both within the green area and in its surrounding.

The study was carried out in Warsaw, Poland. 330 publicly accessible urban green spaces bigger than 2 ha were included in the analysis. The combination of 10 indices allowed the identification of five types of urban green spaces that differ in their role in the formation and provision of CES. The results of a questionnaire survey conducted with Warsaw dwellers revealed that types that are the most internally diverse and well known to the public are the most often visited, which underpin their importance as CES providers.

Regulating and Cultural Services of Urban Ecosystems at The Neighbourhood Scale – a Warsaw Case Study

Anna Kowalska, Andrzej Affek, Jerzy Solon, Edyta Regulska, Bożena Degórska, Jacek Wolski, Marek Degórski

Department of Geoecology, Institute of Geography and Spatial Organization, Polish Academy of Sciences, Twarda St. 51/55, 00-818, Warsaw, Poland

E-mail: aniak@twarda.pan.pl

With the world's population concentrating in urban areas, more and more emphasis is being placed on making them more liveable and healthier. Cities are often most affected by climate change due to the urban heat island effect and extreme weather events, air pollution etc. Urban green spaces and urban vegetation are increasingly recognised as components of urban space that contribute to public health, climate adaptation, pollution reduction, water regulation, biodiversity conservation, i.e. generate multiple ecosystem services (ES). The aim of this study was to assess the capacity of urban ecosystems to provide six ecosystem services that are crucial for the well-being of city residents. The study focuses on methods and analytical procedures that can be implemented in cities at the local planning level. Ten test areas located in Warsaw were selected, which represent five types of urban ecosystems: tenement housing, large-scale housing estates, single-family housing, city park and industrial area. Each type was represented by two areas characterised by extreme values regarding tree canopy density and cover of impervious areas. We concentrated on four regulating services (1. preservation of breeding sites and ecological connectivity between populations and habitats, 2. mediation of nuisances of anthropogenic origin, e.g. smell reduction and noise attenuation, 3. purification of the air from PM generated by humans, 4. regulation of air temperature and humidity) and two cultural services (1. generation of aesthetic experiences and activities promoting health, recuperation or enjoyment, and 2. recreation and recuperation in nature). Services were estimated within the test areas or in their nearest vicinity. We proposed both simple and complex ES indicators. The subject of measurement was the potential or use of a particular service. We observe significant differences in the indicator values not only between the studied urban ecosystems but also between the test areas representing the same ecosystem type. The share of trees seems to have the greatest impact on the indicator values.

The study is a contribution to the project: *Services provided by main types of ecosystems in Poland – an applied approach (ECOSERV-POL)*, financed by EEA Grants 2014-2021.

Water In the City – Łódź Residents' Perception of Blue Ecosystem Services and Blue Infrastructure

Renata Włodarczyk-Marciniak[1], Elżbieta Antczak[2], Agnieszka Kretek-Kamińka[3], Aneta Krzewińska[3], Kinga Krauze[1]

[1]*European Regional Centre for Ecohydrology of the Polish Academy of Sciences, 3 Tylna Str., 90-364 Łódź, Poland*
[2]*Department of Spatial Econometrics, Faculty of Economics and Sociology, University of Lodz, 3/5 POW Street, 90-255 Łódź, Poland*
[3]*Institute of Sociology, Faculty of Economics and Sociology, University of Lodz, 41/43 Rewolucji 1905r Street, 90-214 Łódź, Poland*

E-mail: r.wlodarczyk@erce.unesco.lodz.pl

Water is crucial to sustainable development and human wellbeing. In the face of the climate crisis, it is an increasingly critical element of the urban environment. Our research therefore focused on exploring both public preferences towards different types of blue infrastructure and perceptions of the blue ecosystem services provided by urban rivers and reservoirs.

We conducted our research in Łódź, which is one of the large, post-industrial cities in Poland, suffering the consequences of rapid urbanization due to the development of the textile industry in the 19th century. The city and its inhabitants not only face environmental problems, but also social and economic. Eighteen small rivers flow through the city, most of which have been channeled or enclosed in underground channels in the city center, but nevertheless form important elements of the cityscape. In 2010, the City of Łódź adopted the concept of the Blue-Green Network as the basis of the life support system, restoring the great importance of the greenery and water bodies for sustainable and restorative redevelopment of the city.

In order to gather information on the needs of stakeholders regarding blue infrastructure and its services and the possibilities to increase its availability in the city, we conducted a survey and asked residents to engage in participatory urban design. In addition, we tracked current discussions on blue infrastructure to gauge public engagement and attitudes. Our research showed that residents identified a wide range of ecosystem services related to the aquatic ecosystem and distinguished between natural and modified rivers and water bodies. They also supported the presence of natural solutions in the city over artificial ones, appreciating their role for regulating ecosystem services. The presentation will show the opportunities for providing blue infrastructure, the needs of residents and residents' views on the topic.

PARALLEL SESSION 2

SERVICES OF WATER AND WATER-DEPENDENT ECOSYSTEMS

Lithuanian lake ecosystem services: a multi-temporal national assessment

Miguel Inácio, Paulo Pereira

Environmental Management Laboratory, Mykolas Romeris University, Ateitis g. 20 LT-08303, Vilnius, Lithuania

E-mail: miguel.inacio@mruni.eu

Lake ecosystems have been subject to accentuated ecological degradation, diminishing their ability to support human well-being by supplying ecosystem services. Restoring the ecological status of these ecosystems and ensuring the sustainable provision of ecosystem services is imperative and the objective of several international environmental agendas. For this, it is vital to map and assess ecosystem services. However, most studies mainly focus on a single study area and restricted time. Comprehensive nationwide and multi-temporal studies are lacking. This study aims to assess and map lake ecosystem services in Lithuania, covering multiple periods. A quantitative methodological framework was developed for five ecosystem services: water for non-drinking purposes, fibres and other material for construction, nutrient regulation, maintenance of nursery condition and recreation. Over 1000 lake ecosystems were assessed, covering the period from 1990 to 2018. In general, there was an increase in the supply of fibres and other materials for construction, nutrient regulation, and recreation ecosystem services. A decrease in the supply was observed to maintain nursery conditions and ecosystem service. No supply changes were observed for the service water for non-drinking purposes. Statistical differences between the years for all services were found except for water for non-drinking purposes ES. Spatial changes are observed in the provision of the analysed ecosystem services. In the northwest part of Lithuania, the supply of lake ecosystem services is generally higher than in the central part. These changes are mainly attributed to land-use characteristics. The central part of Lithuania is composed of agricultural areas, while forests mainly occupy the western part. The results of this study contribute to a better understanding of the spatial and temporal dynamics of lake ecosystem services supply, and key information in the context of spatial and environmental management and planning.

Ecosystem services of freshwater systems – making them visible for strategies and planning.

Kinga Krauze[1], Joanna Jaskuła[2], Mariusz Sojka[2], Iwona Wagner[3], Renata Włodarczyk-Marciniak[1]

[1]*European Regional Centre for Ecohydrology PAS, Tylna 3, 90-364 Łódź, Poland*
[2]*Institute of Land Improvement, Environmental Development and Geodesy, Poznań University of Life Sciences, Piątkowska 94, 60-649 Poznań, Poland*
[3]*UNESCO Chair on Ecohydrology and Applied Ecology, University of Łódź, 12/16 Banacha St., 90-237 Łódź, Poland*

E-mail: k.krauze@erce.unesco.lodz.pl

The analysis of services of freshwater ecosystems, from the perspective of adequate indicators, is both an interesting scientific challenge - due to rather limited number of studies in Europe - and a necessity, in the light of Poland's limited water resources, the availability of which is steadily decreasing [1]. The reason for this state of affairs is human activity affecting freshwater ecosystems directly, through unsustainable use of resources: space, water, species, and indirectly - through climate change and consequent ignoring of cause-and-effect relationships, e.g. the impact of species diversity decline on water cycle regulation, or destruction of habitats associated with water-dependent ecosystems. Both result in recurrent meteorological droughts, prompting an intensification of the use of freshwater ecosystems as a source of water for irrigation, an increase in groundwater abstractions, and the eventual transport of water from one surface water body (SWB) to another. Thus, we exacerbate the water crisis by further contribution to the degradation of nature. Furthermore, we forget that there are interactions between ecosystem services - either synergistic or competitive, which determines the final impact of human activities on the state of nature and thus its ability to meet the demand for services.

In order to manage resources adequately - according to their supply, we need to establish the tools to map the ecosystems on which delivery of the resources depend, to assess the natural capital and to value the ecosystems themselves. The ECOSERV_PL project devoted a lot of attention to freshwater ecosystems: lakes and reservoirs, rivers and wetlands. Building upon European initiatives, e.g. MAES [2], we analysed the usefulness of the proposed indicators, taking into account the availability of data in Poland, the extent of water resource problems faced by citizens and local governments, and the possibilities of generating applicable information without the use of complicated mathematical models. The project resulted in the identification of indicators for more than a dozen ecosystem services, including water cycle regulation, mass movements, erosion, preservation of maternal habitats, carbon sequestration and climate regulation, at national, regional (catchment) and local levels. At the same time, we developed a methodology for analysing service interactions and illustrated the importance of understanding the value of freshwater ecosystems in development strategies and spatial planning.

Acknowledgments: This work was supported by EEA project „Ecosystem services of main types of ecosystems in Poland – applied approach".

References

[1] https://www.gov.pl/web/susza/najnowszy-raport-gus--polska-na-24-miejscu-w-unii-europejskiej-pod-wzgledem-odnawialnych-zasobow-wody-slodkiej

[2] Maes J, Teller A, Erhard M, Grizzetti B, Barredo JI, Paracchini ML, Condé S, Somma F, Orgiazzi A, Jones A, Zulian A, Vallecilo S, Petersen JE, Marquardt D, Kovacevic V, Abdul Malak D, Marin AI, Czúcz B, Mauri A, Loffler P, Bastrup-Birk A, Biala K, Christiansen T, Werner B., **2018**. *Mapping and Assessment of Ecosystems and their Services: An analytical framework for ecosystem condition*. Publications office of the European Union, Luxembourg.

Importance of floodplains in the Czech Republic in terms of ecosystem services provision compared to the surrounding landscape

Kateřina Krásná[1,2], Lenka Štěrbová[1], Marcela Prokopová[1], Vilém Pechanec[3], Jiří Jakubínský[1]

[1]*Department of Ecosystem Functional Analysis of the Landscape, Global Change Research Institute CAS, Bělidla 986/4a, Brno, Czech Republic*
[2]*Department of Geography, Masaryk University, Kotlářská 267/2, Brno, Czech Republic*
[3]*Department of Geoinformatics, Palacký University Olomouc, 17. listopadu 50, Olomouc, Czech Republic*

E-mail: krasna.k@czechglobe.cz

Floodplains can be considered as one of the most valuable habitats in terms of ecosystem services (ES) provision, especially if they are maintained in their natural state. The aim of this work is to analyze the quality of four relevant ES of floodplains in the Czech Republic. We focused on i) habitat provision (based on HVM [1][2]), which refers to habitat biodiversity and relative ecological quality of floodplain habitats, ii) habitats capacity to store carbon in biomass, iii) ability of floodplains to mitigate soil erosion and iv) to retain water.

Selected ES were quantified in five segments of floodplains in different landscapes typical for the Czech Republic. Ecological quality of floodplain habitats and biomass carbon storage were quantified based on detailed habitat mapping. The role of floodplains in soil erosion was studied mainly using soil loss equations. For the assessment of selected ES, indicators were proposed. We hypothesize that floodplain corridors are a more ecologically valuable component of landscape structure, while especially in agricultural and urban areas, preserved floodplains form the backbone of ecological stability and provide a greater number of ecosystem functions compared to their surroundings.

Our research has shown that the ability of floodplains to provide ES is highly dependent on anthropogenic influences, such as the presence of levees and increases in channel capacity, which lead to degradation of floodplains and changes in their functioning. For example, habitat provision and biodiversity are significantly negatively affected by land use changes that result in degradation or loss of floodplain and wetland habitats. In particular, the loss of alluvial forests represents a significant reduction in the ability of floodplain habitats to store carbon and retain water.

This work presents partial results of the project currently underway to develop a comprehensive methodological approach to determine the extent of floodplain disturbance under current conditions based on the identification and assessment of key floodplain ecosystem functions and services.

References

[1] J. Seják, P. Cudlín, V. Petříček, M. Prokopová, O. Cudlín, D. Holcová, K. Kaprová, J. Melichar, P. Škarková, K. Žákovská, P. Birklen, *Metodika hodnocení biotopů AOPK ČR 2018 (6. verze)*, Agentura ochrany přírody a krajiny ČR, Praha, 2018. (in Czech)
[2] J. Seják, J. Pokorný, K. Seeley, *Achieving Sustainable Valuations of Biotopes and Ecosystem Services*, **2018**, 10, 14 p.

Challenges and solutions for practical implementation of marine ecosystems services in the management of the Polish sea and coast

Joanna Piwowarczyk, Aleksandra Koroza, Paulina Pakszys, Tymon Zieliński

Institute of Oceanology, Polish Academy of Sciences, Powstańców Warszawy 55, Sopot, Poland

E-mail: piwowarczyk@iopan.pl

Ecosystem services are considered a useful tool to enhance the environmental management of marine and coastal areas. However, the practical implementation of this concept into managerial and planning practices is not an easy task. Our research explored challenges and possible solutions to streamlining this concept into marine spatial planning and environmental management of the Polish Marine Areas and their coast. Our approach combined a variety of social science methods, including document analysis, semi-structured interviews, and an interactive workshop with the professionals and scientists involved in marine governance. These methods were complemented by our own experiences arising from evaluating the most important ecosystem services provided by the habitats of the Southern Baltic. Our results suggest that there are eight significant groups of barriers that hinder the effective implementation of ecosystem services into planning and governance. The most important are: (i) limited knowledge (outside the scientific community) of the concept itself and its perceived vagueness, (ii) insufficient data and knowledge base, which is further hindered by the lack of adequate monitoring, and (iii) inadequate legal and administrative arrangements within marine management itself. While some of these obstacles seem relatively easy to overcome, for example, through the closer cooperation between 'science' and 'practice', others would require co-creation and co-development of long-term solutions. In our opinion, the development of a well-fitted monitoring program, one that would not only include environmental but also social and cultural data, is among the most important requirement for ecosystem services to become fully operational.

Marine ecosystem services through the lens of the local communities: what and why is valued. The insights from the Gulf of Gdańsk

Tymon Zieliński, Aleksandra Koroza, Paulina Pakszys, Joanna Piwowarczyk

Institute of Oceanology, Polish Academy of Sciences, Powstańców Warszawy 55, Sopot, Poland

E-mail: tymon@iopan.pl

Marine ecosystem services might provide an important tool to enhance societal support for the conservation of the marine environment. However, this approach will only be successful if the general public is aware of the links between the environment and the benefits they obtain. These links can be described in terms of ecosystem services. In this study, we investigated how the local citizens representing two communities around the Gulf of Gdańsk perceive their links with the sea they live by. We organized four interactive workshops: two for the urban community in the Tri-City (Gdansk-Sopot-Gdynia) area and two for the more rural Puck-Władysławowo region. In both cases, the benefits obtained from marine ecosystems were almost exclusively limited to cultural services, mainly tourism, recreation, and aesthetics. However, the representatives of the urban communities concentrated on their own recreational activities, while tourism as a form of economic activity prevailed in the narratives of the second group. Both groups underlined the importance of coastal landscapes for their everyday life and the positive impact of the sea on their own health. Representatives of the rural areas demonstrated a greater 'sense of place' and emphasized the importance of the sea for maintaining their social relations. Interestingly, both groups suggested that they were witnessing the creation of a new marine culture that – according to them – was rooted in active recreation, i.e., biking, walking, rollerblading, or swimming. The old culture – based on fishers and fisheries – was disappearing, although, perhaps not surprisingly, this process was assessed as much slower by the representatives of the Puck-Władysławowo region (where fishing continues to be important for local culture and identity). Although our results suggest that the local communities are aware of the benefits they derive from the sea, the regulating services are absent in their narratives. Since these services often sustain the delivery of other ecosystem services, we conclude that marine education efforts remain relatively unsuccessful in reaching other groups than perhaps schoolchildren. If the general public is not aware of the variety of services the sea provides, it would be difficult to build larger support for its proper conservation.

Marine ecosystem services and the most important habitats of the Polish Baltic Sea: what do we know and what are the data gaps?

Aleksandra Koroza, Joanna Piwowarczyk, Tymon Zieliński, Jan Marcin Węsławski

Institute of Oceanology, Polish Academy of Sciences, Powstańców Warszawy 55, Sopot, Poland

E-mail: akoroza@iopan.pl

Marine ecosystem services provide an important link between natural ecosystems and human well-being. They should be, therefore, implemented into managerial and conservation practices, and the ecosystems' capacity to deliver (selected) services should be assessed for any large investments in the marine and coastal realms. However, the scarcity of environmental data together with the complexity of ecosystem services and their indicators pose an important challenge for the identification, quantification, and evaluation of ecosystem services in a given area. Here, we report the results of our study, in which – based on the available literature and publicly accessible datasets – we assessed the most important services provided by three distinctive habitats of the Southern Baltic Sea: underwater meadows of *Zostera marina*, sandy beaches, and shallows, and stone reefs. For each habitat, we (i) identified the most important ecosystem services, (ii) designed specific indicators, and (iii) assigned values to these indicators for the selected areas to differentiate their importance for a given service. Our results show that despite large progress in investigating marine ecosystems in recent years, the most relevant indicators still cannot be calculated due to the lack of data. This is especially true in the case of cultural services, where intangible values are most important, but - at the moment – they are impossible to tackle. We demonstrate how qualitative assessment and generic indicators, even if not related directly to the health of marine ecosystems, can in the short term enhance using the ecosystem services concept, but this shortcut solution contradicts the concept's core tenets.

Effects Of Managing Nuisance Abundance Of Aquatic Plants On A Suite Of Ecosystem Services

Jan E. Vermaat[1], Kirstine Thiemer[1,2], Bart Immerzeel[1,7], Susanne C. Schneider[2,1], Keneilwe Sebola[3], Julie Coetzee[3], Antonella Petruzzella[4], Samuel N. Motitsoe[4], Mathieu Baldo[5], Benjamin Misteli[5], Gabrielle Thiébaut[5], Sabine Hilt[6], Jan Köhler[6], Sarah F. Harpenslager[6, 8]

[1]*Faculty of Environmental Sciences and Natural Resource Management, Norwegian University of Life Sciences, P.O. Box 5003, 1430 Ås, Norway*
[2]*Norwegian Institute for Water Research, Økernveien 94, 0579 Oslo, Norway;*
[3]*Centre for Biological Control (CBC), Department of Botany, Rhodes University, PO Box 94, Makhanda (Grahamstown) 6140, South Africa;*
[4]*Centre for Biological Control (CBC), Department of Zoology and Entomology, Rhodes University, PO Box 94, Makhanda (Grahamstown), 6140 South Africa;*
[5]*Université de Rennes, 263 Avenue du Général Leclerc, Campus Beaulieu, UMR 6553 CNRS ECOBIO, 35042 Rennes, France*
[6]*Dept. of Community and Ecosystem Ecology, Leibniz Institute of Freshwater Ecology and Inland Fisheries, Müggelseedamm 301, 12587, Berlin, Germany;*
[7]*Norwegian Institute for Nature Research, Sognsveien 68, 0855 Oslo;*
[8]*B-Ware Research Centre, Postbus 6558, 6503 GB, Nijmegen, The Netherlands*

e-mail: jan.vermaat@nmbu.no

Dense beds of aquatic plants are often perceived as nuisance and therefore mechanically removed, often at substantial cost. Such removal, however, may affect a range of ecosystem functions and consequently also the ecosystem services that benefit society. We studied five cases: River Otra (Norway), River Spree (Germany), Lake Kemnade (Germany), Lake Grand-Lieu (France), and Hartbeespoort Dam (South Africa). In all, nuisance aquatic plant growth is managed, but dominant species, geographic setting and major societal uses are different. We quantified 12 final ecosystem services as flows per area and year in biophysical and monetary terms. Quantified services were food and fodder production, commercial fisheries, hunting and gathering wild products, hydropower production, drinking and irrigation water production, flood prevention, carbon sequestration, active and passive recreation, as well as biodiversity conservation (non-use). These services were related to aquatic plant cover via intermediate functions, and the effects of three plant removal regimes were tested on the relative importance of the quantified ecosystem services and on the total sum of the monetary estimates (Total Economic Value, TEV). The three removal regimes were ‘maximum removal’, ‘current practice’, and ‘do nothing’. In all five systems, TEV was dominated by different forms of recreation. TEV was highest for Lake Kemnade, where visitor densities were highest. Also, in Lake Kemnade and Hartbeespoort Dam, TEV was most sensitive to the different management regimes, because a threshold in esthetic appreciation was passed in the ‘do nothing’ regime in the former, and because boating and angling were affected in the latter. In the other cases the different removal regimes had little effect on the estimated total economic value. Aquatic plant management strategies will benefit from taking into account the esthetic appreciation by different categories of recreative users before engaging in costly removal.

PARALLEL SESSION 3

SOCIO-CULTURAL SERVICES OF ECOSYSTEMS

On our way to equity – Providing ecosystem services for elderly people

Cristian I. Iojă[1], Diana A. Onose[1], Martina Artmann[2], Ana-Maria Popa[1]

[1]*Centre for Environmental Research and Impact Studies, University of Bucharest, N. Balcescu Blvd. No. 1Sector 1, 020041, Bucharest, Romania*
[2]*URBNANCE, Leibniz Institute of Ecological Urban and Regional Development, Weberplatz 1, 01217, Dresden, Germany*

E-mail: cristian.ioja@geo.unibuc.ro

Urbanization and ageing are two of the main challenges faced by modern society. In this context, United Nations advocates for the creation of sustainable human settlements which should be safe and inclusive, meanwhile the World Health Organization promotes aged-friendly cities. Nevertheless, ageing usually brings health problems and a decrease in independence which gradually translates in the growing number of persons needing some kind of care.

Care facilities for elderly people aim to maintain the physical and mental capacities of the elders and to stimulate their social life and important factors for their success are the presence and characteristics of green areas. The aim of the present research is to highlight what ecosystem services the green spaces have in care facilities for elderly people by investigating (1) if they are designed to encourage the interaction between the patients and green amenities, (2) which are the ecosystem services the elders enjoy in relation with green spaces. Our study is based on an extensive database containing the care facilities for elders in Romania, their characteristics and location. A survey directed to administrators was sent to all the identified care facilities with a response rate of 27%.

The results showed most care facilities have gardens but they are not especially designed for the needs of elderly people, lacking aged-adapted facilities. Even if the administrators are at least declaratively aware of the ecosystem services of green spaces provide for elders, many patients cannot enjoy them due to poor health or the effort and logistics implied by their use. The large range of ecosystem services, especially cultural, provided by green spaces in care facilities for elders makes them very valuable.

Regulations regarding green spaces in care facilities for elders should focus on both their surface and characteristics since they can significantly improve quality of life.

Contact with Nature in urban preschools in Poland – current state and perspectives

Iwona Zwierzchowska

Department of Integrated Geography, Adam Mickiewicz University, ul. B.Krygowskiego 10, 61-608 Poznań, Poland

E-mail: iwona.zwierzchowska@amu.edu.pl

Contact with nature provides a range of cultural ecosystem services and is recognized as beneficial for the health, well-being, and development of children (Fjørtoft, 2004; Luchs, Fikus, 2013; Flouri et al., 2014). However, despite this fact, the contemporary urban environment and lifestyle are not conducive to the opportunity for interacting with nature. Having in mind that children in ages 3-6 spend significant time in preschool, we aimed to recognize current and prospective opportunities for contact with nature in those institutions. Our research questions are:

1) What is the preschool management's attitude towards children's contact with nature?

2) What kind of environmental spaces and facilities are available for children's outdoor activities during their time in preschools?

3) What are the perspectives and needs for transforming preschools' outdoor spaces into nature-oriented playspaces or playgrounds?

We investigated the existing opportunities in providing children opportunities for interacting in nature during their stay in preschools. Our study recognized the nature of preschool gardens and natural elements available for children as well as the willingness to transform outdoor spaces towards nature-oriented spaces or nature-oriented playgrounds. Finally, we investigated preschools' needs for support in this transition direction.

The study was based on an online survey conducted between January and March 2020.The pilot survey was conducted in Poznań (Zwierzchowska, Lupa, 2021), and later distributed among preschools in other large Polish cities such as Gdańsk, Kraków, Łódź, Warszawa, Wrocław, Szczecin. In total, we collected 306 valid questionnaires. The gathered data were statistically analyzed.

The results showed to which extent preschools' outdoor areas are recognized as a natural play space and/or a natural playground and what are the most common natural elements available for children in preschool outdoor areas. The limited presence of diverse natural elements indicates space for improvements to improve cultural ecosystem services and provide children with more opportunities for interaction with nature.

We recognized the willingness to transform the outdoor area into a nature play space or natural playground and the necessary support for the transition of preschool gardens towards more nature-oriented such as financial support, consultancy support, support in designing and implementation of such gardens or procedural support (in obtaining permits and approvals of relevant authorities).

The results support directing future actions in any city that wants to ensure or improve cultural ecosystem services and contact with nature for children through Nature-based solutions such as nature-oriented playspaces or playgrounds.

References

[1] A. Luchs, M. Fikus, *Journal of Adventure Education & Outdoor Learning,* 2013, 13(3), 206–222.
[2] E. Flouri, E. Midouhas, H. Joshi, *Journal of Environmental Psychology*, 2014, 40, 179–186.
[3] I. Fjørtoft, *Children, Youth and Environments,* 2004, 14(2), 21–44.
[4] I. Zwierzchowska, P. Lupa, *Urban Forestry & Urban Greening,* 65, 127346.

Children's access to urban nature-based solutions in school settings: a comparative analysis in four European cities

Elsa Gallez[1,2], Corina P. Fraile-Mujica[1], Sylvie Gadeyne[2], Frank Canters[1], Francesc Baró[1,2]

[1]*Department of Geography, Vrije Universiteit Brussel (VUB), Campus Etterbeek, Building F Pleinlaan 2 - 1050 Brussels, Belgium*
[2]*Department of Sociology, Vrije Universiteit Brussel (VUB), Campus Etterbeek, Pleinlaan 5 - 1050 Brussels, Belgium*

E-mail: elsa.gallez@vub.be

Urban Nature-based Solutions (NbS) such as parks, rivers and street trees can deliver a wide range of regulating ecosystem services and provide physical and mental health benefits to children. However, children's exposure to urban nature is currently declining, especially among children living in disadvantaged neighbourhoods. One potential explanation for this decline is the uneven distribution of NbS within cities. Unequal access and exposure to NbS reinforces health and climate inequalities since underprivileged children are also the most vulnerable to urban environmental harms. As children spend a substantial amount of time on a daily basis in school settings, these areas can potentially play a prominent role in mitigating inequalities. Yet, studies adopting a school-based perspective when assessing children's access to NbS are still rare. Moreover, while the number of school greening initiatives is expanding in Europe, no cross-country comparative study has yet been published on this topic. Our research aims to identify the spatial patterns of school-related NbS and their relationships with schools' socio-economic background. More specifically, we explore to what extend these patterns and relationships vary across four large European cities currently implementing ambitious school greening programs (Brussels, Barcelona, Rotterdam and Paris) and over time (between 2006 and 2018). For this purpose, we used comparable green and blue land cover and tree canopy cover data from the European Copernicus Urban Atlas dataset, and schools' socio-economic characteristics based on local neighbourhood-level data. Through different geospatial and statistical analyses, our study reveals significant positive correlations between school-related green and blue space indicators and socio-economic variables (income and/or educational attainment) in Brussels and Rotterdam. The opposite trends are observed in Barcelona and Paris. Overall, the four cities show very distinct patterns of school-related socio-environmental inequalities and no substantial NbS gains during the period analysed, suggesting that greening initiatives in and around school settings are still to be upscaled at the city level.

Assessing the importance of landscape services by a combination of mapping and discrete choice experiment method

Piotr Krajewski[1], Katarzyna Zagórska[2], Marta Sylla[1], Iga Kołodyńska[1], Monika Lebiedzińska[1], Marek Furmankiewicz[1]

[1]*Institute of Spatial Management, Wroclaw University of Environamental and Life Sciences, C.K. Norwida 25, 50-375 Wroclaw, Poland*
[2]*Department of Microeconomics, University of Warsaw, Długa 44/50, 00-241 Warsaw, Poland*

E-mail: piotr.krajewski@upwr.edu.pl

In recent years, concept of ecosystem services has also become extremely popular. In this aspect, many theoretical and practical research have been done [1,2]. Much less papers concern landscape services or ecosystem services from landscape perspective. It is emphasized that there is a lack of systematization of the types of research in which the concept of ecosystem services and landscape services should be used. Bastian et al. [3] indicates that the term landscape services should be used for analyzes where the landscape units is main assessment area, for analyzes connected with human perception of aesthetic, cultural or sociological values of landscape, focused on anthropogenic effects such as land use or relationships between man and his cultural environment. Landscape services are strongly related to human perception of the landscape [4]. We can define landscape services as the social, health and economic benefits and goods provided to society and individuals by the surrounding landscape that enhance quality of life. Bastian et. al. [3] points out that there is the need to develop research methods for identifying and evaluating landscaping services and combining methods used in ecosystem services analysis with methods used in analysis of landscape history, memory, identity and visual values used by the cultural landscape research community. The concept of landscape services is based on the concept of ecosystem services, but takes into account a broader perspective related to the social dimension of the landscape and the perception of the spatial arrangement of the elements that make up the landscape, both natural and anthropogenic related to the provision of benefits for human quality of life [5]. In this aspect 6 groups and 14 subgroups describing landscape services were selected. To assess the importance of landscape services we prepared survey research for inhabitants representing 6 different research areas covering urban and rural, common and protected areas with tourist, industrial or agricultural use. We included municipalities classified as urban, rural and urban-rural. The selected areas were diverse in terms of topographic conditions, land cover and the location of nature conservation areas and industrial zones within their borders and divided on 117 landscape units representing 16 landscape types. In the survey, we used the CAPI method involving a combination of mapping daily and recreation activities and the discrete choice experiment method that includes selecting a combination of options for various types of investments that could potentially affect the availability of selected landscape services to residents in exchange for an increase in the value of the property tax paid once a year. We asked respondents how and in what kind of surroundings they spend their time outdoors doing daily, recreational, social and individual activities and how much it is worth to them to be able to perform outdoor activities dedicated to each group of landscape services or to increase accessibility to activities they already do.

References

[1] Stępniewska M., Lupa P., Mizgajski A, *Drivers of the ecosystem services approach in Poland and perception by practitioners*, Ecosystem Services, **2018,** vol. 33, Part A, 59-67.
[2] Solon J., Roo-ZIelińśka E., Affek A., Kowalska A., Kruczkowska B., Wolski J., Degórski M., Grabińska B., Kołaczkowska E., Regulska E., Zawiska I., Świadczenia ekosystemowe w krajobrazie młodoglacjalnym. Ocena potencjału i wykorzystania, Wyd. Akademickie SEDNO, Warszawa, 2017.
[3] Bastian O., Grunewald K., Syrbe R-U., Waltz U., Wende W., *Landscape services: the concept and its practical relevance*, *Landscape Ecology*, **2014,** vol 29 (9), 1463–1479.
[4] Keller R., Backhaus N., *Integrating landscape services into policy and practice – a case study from Switzerland*, Landscape Research, **2020**, vol. 45(1), 111-122.
[5] Vallés-Planells, M., Galiana F., Van Eetvelde V., *A classification of landscape services to support local landscape planning,* Ecology and Society, **2014,** vol. 19(1), 44.

Mapping cultural ecosystem services of the urban riverscape: what, where, when and why do residents benefit from the river?

Tomasz Grzyb

Faculty of Geography and Regional Studies, University of Warsaw, Krakowskie Przedmieście 30, Warsaw, Poland

E-mail: t.grzyb@uw.edu.pl

Urban green and blue spaces are robust providers of cultural ecosystem services (CES). Direct contact with nature may contribute to the well-being of city dwellers in multiple ways, including identities it builds, experiences it evokes, and capabilities it enhances. The perception of benefits can depend both on natural space features and visitors' attributes and preferences. The flow of CES related to the urban parks and forests have been widely studied; however, much less attention has been paid to urban riverscapes. This study aimed to fill this gap by assessing benefits associated with the recreational use of urban river, determining drivers of these benefits, and identifying bundles of benefits. A citywide PPGIS survey was conducted to map 12 benefits related to Vistula in Warsaw, Poland. Survey participants highly assessed urban riverscape benefits, with a general tendency of the highest scores to be clustered in the city core. The logistic regression analysis revealed that benefits vary in terms of drivers they are affected. Intellectual and emotional attachment to the riverscape is built through the long-term process of repetitive visits. Also, the devotion to nature is based on direct rather than visual experiences, and strongly associated with sports. On the other hand, on-water recreation underpins both emotional attachment to the river and social interactions. Three bundles of benefits have formed; survey participants interpret the riverscape as: (1) a homelike place, a space of intellectual join with nature; (2) a space of spending time actively and experiencing nature; (3) a space of social interactions. The results bring spatially explicit information on people's attitudes towards the urban river, and underscore the complexity of links between people and the riverscape. The knowledge of spatiotemporal patterns and drivers that affect CES of the urban riverscape may support the sustainable planning and management of nature-based recreation in cities.

Which trees are important and why? Comparison of ES supply and their perception by residents

Patrycja Przewoźna[1], Adam Inglot[2], Karolina Zięba-Kulawik[3,5], Paweł Hawryło[3], Krzysztof Mączka[4], Marcin Mielewczyk[4], Piotr Matczak[4], Piotr Wężyk[3]

[1]*Department of Geoinformation, Adam Mickiewicz University, ul. Bogumiła Krygowskiego 10, Poznań, Poland*
[2]*Department of Geodesy, Gdansk University of Technology, ul Gabriela Narutowicza 11/12, Gdańsk, Poland*
[3]*Department of Forest Resources Management, University of Agriculture, ul. 29 Listopada 46, Kraków, Poland*
[4]*Department for the Study of Social Dynamics, Adam Mickiewicz University, ul. Szamarzewskiego 89, Poznań, Poland*
[5]*Luxembourg Institute of Socio-Economic Research, 11 Porte des Sciences, Esch-sur-Alzette, Luxembourg*

E-mail: pwysocka@amu.edu.pl

Ecosystem Services (ESs) concept may have many important applications, one of which is more effective tree management [1], especially relevant in urban areas. Due to limited space, local decision-makers must make competing decisions about protecting, planting, and removing trees in these areas (related to both public and private spaces), often the subject of conflicts. Thus, a common shared understanding of ESs provided by trees is crucial for developing compromise solutions. Meanwhile, objectively the most valuable trees in the city are not necessarily the same as those that residents value most. The cascade model [2] indicates that people value those benefits they recognize as contributing to their well-being. Costanza et al. [3] argue that ESs should not be understood directly as benefits, but they also notice that although the concept is quite well-known, its practical applications are limited. Its applicability may be increased by a better understanding of the relationship between the provision of ES and its influence on human well-being [4]. The meaning of this relation may be particularly relevant in the case of trees. Their numbers are declining due to urbanization [5], although they do, after all, provide a great variety of ES to city residents [6]. This research proposes a methodological approach that enables valuation assessment of trees, including both ESs supply and the values residents attribute to trees regarding the benefits they appreciate. We address this challenge using multi-criteria analysis, fuzzy set theory, and Analytical Hierarchy Process. In this study, three data sources are proposed to identify valuable trees: (1) Airborne Laser Scanning (ALS LiDAR) point cloud enabling the location and biometric characteristics of trees and estimation with the i-Tree Eco model (USDA Forest Service) of some ESs they provide (air purification, sun protection, oxygen provision, and regulation of air humidity and soil moisture), (2) expert mapping providing information about other ESs related to those trees (such as providing animal habitat, food, or place of recreation) and (3) a survey with an interactive map (geo-questionnaire) for identification of trees valuable to residents in their daily lives. The proposed approach was used to identify the most valuable trees in Racibórz (Poland). The analysis included 17 ESs representing four classes of services: provisioning, regulating, habitat, and cultural ones (following [5]), considering their relative importance [1]. The applicability of obtained valuation maps was shown by comparison of trees located in protected and unprotected areas (with a division on public-private land) to verify whether management strategies related to their protection are sufficient.

Based on the proposed evaluation method, the most valuable tree-covered areas may be indicated regarding both ESs they provide and their influence on residents' well-being. Moreover, it can objectify tree protection strategies by localizing protected areas that residents underestimate when they are situated too far away from their residence or some barriers influence their accessibility. It also enables the localization of those tree-covered areas to be more valuable in residents' perception than it might seem by analyzing only the ES supply.

References

[1] P. Przewoźna, K. Mączka, M. Mielewczyk et. al., *Ambio* **2022**, *51(9)*, 2043-2057.
[2] M. Potschin, R. Hanines-Young, *Defining and Measuring Ecosystem Services,* in: *Routledge Handbook of Ecosystem Services,* Eds. M. Potschin, R. Hanines-Young, R. Fish, R. K. Turner, Routledge, **2016** London, 25-35.
[3] R. Costanza, R. de Groot, L. Braat., I. Kubiszewski. et. al. *Ecosystem Services* **2017**, *28*, 1-16
[4] C.Zhang, J.Li, Z. Zhou, *Ecological Indicators* **2022**, *137*, 108766.
[5] D.J. Nowak, E.J. Greenfield*, Urban Forestry and Urban Greening* **2020**, 49: 126638.
[6] J. Kronenberg *Urban Ecosystem Services,* in*:Sustainable Development Applications 3,* Eds., T. Bergier, J. Kronenberg, Sendzimira Foundation, **2012**, Kracow; pages: 13-30

Is it a frog or a whale? Environmental education in postglacial landscape, Poland

Katarzyna Szmigiel-Rawska, Sylwia Kulczyk, Marta Derek

Faculty of Geography and Regional Studies, University of Warsaw, Krakowskie Przedmieście 30, Warsaw, Poland

E-mail: k.szmigiel@uw.edu.pl

Educational values are recognized as cultural ecosystem sevices (CES), non-material benefits gained from nature. Knowing the natural environment is at the same time a prerequisite for its responsible and sustainable use. Environmental education (EE) is a complex process that involves both ecosystems and man-made facilities. It is a phenomenon situated on the crossroads between experience and knowledge, nonmaterial and material use of natural resources. EE can also be perceived as a path from the present to the future, as acquired knowledge and skills have the power to change people's perceptions, attitudes, and behaviors. ES research rarely accounts for this dynamism. Such studies are challenging, as both long-term research and close interdisciplinary cooperation are necessary.

In this paper, we focus on the case of the Masurian Center for Biodiversity and Nature Education 'Kumak', located in the Great Masurian Lakes, Poland. This modern research and educational centre focusses on small water bodies and aims to underline its importance as elements of the postglacial landscape.

Just before the official opening of the centre, we conducted the survey (n = 313) with inhabitants and visitors of the Mikołajki municipality, where it is located. We asked respondents what they value and what they know about the local nature. This local image has also been compared to the respondents' awareness of global climate change. We also verified locals' demand for environmental education and expectations about the new facility.

The results show that water, forests, and clean environment in general are highly important to the respondents, but the way of use of natural resources differs between locals and visitors. Visitors are more aware of global environmental threats and, surprisingly, better recognise local fauna and flora. Both groups declared their interest in visiting the educational centre once it is open.

We will repeat the same survey in the future to quantify the role of the centre as facilitator and distributor of ecological CES. The data already gathered will help to adjust the activities of the centre to public demand and recognised educational gaps.

PARALLEL SESSION 4

BIODIVERSITY AND ECOSYSTEM SERVICES

Mapping Biodiversity-related Ecosystem Services basing on monitoring multiple animal taxa

Viktoria Takacs[1], Aleksandra Langowska[1], Weronika Banaszak-Cibicka[1], Paweł Sienkiewicz[2], Janusz Kłoskowski[1], Stanislaw Świtek[3], Monika Fliszkiewicz[1], Karol Giejdasz[1], Piotr Tryjanowski[1]

[1]*Faculty of Veterinary Medicine and Animal Sciences, Poznan University of Life Sciences, Wojska Polskiego 71/c, Poznan, Poland*
[2]*Department of Agronomy, Faculty of Agriculture, Horticulture and Bioengineering, University, Full Address, Poznań, Poland*
[3]*Department of Enthomology, Faculty of Agriculture, Horticulture and Bioengineering, University, Full Address, Poznań, Poland*

E-mail: vikitakacs3@gmail.com

Ecosystem services and biodiversity are treated as closely related terms in political platforms as EU biodiversity strategy (Aichi biodiversity targets) or in Conservation of Biological Diversity forum. During the past years the numbers of publications containing both terms in titles, abstracts or keywords increased exponentially. However, most of these publications are related to policy, methodology or theoretical background. Evidence for ways of connecting ES and biodiversity is not complete. Some of the ecosystem services (e.g. pollination), have a well- established link to biological diversity, via ecosystem functioning, however in the cases of other services e.g. pest control, this is not so straight forward.

In this presentation I show a trial of ecosystem service mapping via biodiversity of multiple animal taxa (bees (*Apidae, Hymenoptera*), carabid beetle (*Carabidae, Coleoptera*), and birds.

We surveyed these taxa in 40 places near Poznan, Poland in Wielkopolski National Park and Mosina municipality. Sampling sites were 500 m buffer areas around randomly assigned points. All sampling sites were located on the same area, aiming at obtaining a database from multiple taxa. In case of birds point counts, of bees transect counts and in the case of carabids, pitfall traps were used.

There were 89 bird species (663 specimen), 77 bee species (1298 specimen) 70 carabid species (764 specimen) found on the area. Species and functional diversity indexes were calculated. Based on dependence on landcover parameters, this, we could map the probabilities of occurrences for the whole area. Moreover, we could see places where all taxa showed high diversity, or where the diversities show antagonistic values. Finally, we mapped some other – landcover based indicators of ecosystem services as landscape diversity, small woody features, and also showed places with possible good potential of ecosystem service provision. We investigated, how these indicators interplay, and how this knowledge can be extrapolated for predicting ecosystem service provision on the area.

During the mapping we experienced several difficulties concerning connection biodiversity and ecosystem services, those uncertainties might help in similar mapping studies and also, can give some guidelines for ES assessment exercises.

A Systematic Review on Mapping Ecosystem Services in Protected Areas

Marius Kalinauskas, Paulo Pereira

Environmental Management Research Laboratory, Mykolas Romeris university, Ateities st. 20, Vilnius, Lithuania

E-mail: m.kalinauskas@mruni.eu

Protected areas (PA) are key in supporting biodiversity conservation and supply of ecosystem services (ES) for human wellbeing. Therefore, it is crucial to conduct mapping-oriented ES studies that allow spatially identifying pressures to PAs. Although PAs are popular among ES researchers, there are fewer published works that focus on ES mapping. Also, there are no publications focused on overviewing the global state of art on ES mapping in PAs. Our work fills this gap in presenting the results of a systematic literature review on mapping ES in PAs. This work provides insights on current state of art of ES research advancements and shortcomings at temporal, spatial, and methodological dimensions. We apply "Prisma" method to refine the review sample in 10 years timeframe (2013-2023). 40 studies focused on ES mapping in PAs were selected (out of 3189). The results show that most ES mapping studies are localized in Europe and Asia. More than half of the studies (22/40) follow quantitative approach, with qualitative (8/40), and mixed method (10/40) being less applied. The methods vary in accuracy (objectiveness) and measurement metrics. ES supply analysis is dominating (32/40) in popularity, ES demand (4/40), ES flow (2/40), ES supply and demand (2/40) are studied less. Very few publications are focused on tradeoff analysis (3/40), future scenarios (1/40), and drivers of change (0/40). The systematic literature review revealed that ES mapping-oriented studies in PAs are still rather scarce. Such regions as North and South America, Africa, and Oceania are underrepresented. Scarcity of ES tradeoffs, future scenarios, or drivers of change studies create a gap for researchers to explore. It is crucial since ES that PAs provide are essential in achieving global (e.g., Sustainable Development Goals) and regional (EU Biodiversity Strategy for 2030) environmental targets. Systematic literature review on ES mapping in PAs allows identifying research gaps and contributes to monitoring the implementation of regional and global environmental agenda.

Acknowledgement: This project has received funding from the Research Council of Lithuania (LMTLT), agreement No. S-PD-22-64

Key forest ecosystem services in Poland – identification and assessment at various spatial levels

Adam Kaliszewski[1], Emilia Wysocka-Fijorek[2], Mariusz Ciesielski[2], Agnieszka Kamińska[2], Krzysztof Stereńczak[2], Piotr Gołos[1]

[1]*Department of Forest Resources Management, Forest Research Institute, Sękocin Stary, Braci Leśnej 3, 05-090 Raszyn, Poland*
[2] *Department of Geomatics, Forest Research Institute, Sękocin Stary, Braci Leśnej 3, 05-090 Raszyn, Poland*

E-mail: a.kaliszewski@ibles.waw.pl

The concept of forest ecosystem services, in contrast to the concept of forest functions, is a relatively new approach - primarily because of its ability to consider services at different scales, to determine the demand and supply for those services, and to identify the relationships among services (trade-offs, synergies, bundles). As such, it complements and expands opportunities to identify and exploit the potential of forest ecosystems under changing climate conditions and growing societal needs. The aim of the presentation is to present the results of the research conducted within the project ECOSERV-POL to identify and assess selected key forest ecosystem services in Poland at different spatial scales (national, regional and local). These services represent three categories of ecosystem services characterized by different indicators: provisioning services (including growing stock, potential honey and berry production), regulating services (including erosion risk mitigation, carbon storage, and relative pollination potential), and cultural services (including stands suitable for recreation, biodiversity index, and stands with recognized natural, spiritual, and religious values). The analysis was conducted for forests managed by the State Forests Holding, on multiple data sources, primarily data from the Forest Data Bank. The presentation also highlights the results of synergies and trade-offs between selected ecosystem services. The presentation concludes with recommendations for the use of the research results by practitioners and public authorities.

Potential of Polish Forests to Provide Ecosystem Services

Andrzej N. Affek, Ewa Kołaczkowska, Anna Kowalska, Edyta Regulska, Jacek Wolski, Jerzy Solon

Department of Geoecology, Institute of Geography and Spatial Organization, Polish Academy of Sciences, Twarda St. 51/55, 00-818, Warsaw, Poland

E-mail: a.affek@twarda.pan.pl

Forest ecosystem services (ES) comprise various provisioning, regulating and cultural services. Forests provide many benefits to people, such as timber, food and medicine, protection from flooding, noise and pollution, and improved health and well-being. Forest ecosystems differ in terms of their potential to provide ES, but it is unclear in what way and to what extent. Our aim was to 1) assess the potential of different types of forests in Poland to provide key ecosystem services, indicate: 2) ES hotspots 3) bundles of ES and 4) similarities among forest ecosystems in terms of their potential to provide ES, and 5) provide recommendations for sustainable forest management from the ES perspective.

We selected 17 key forest ES for the assessment, including *inter alia* timber, forest fruits, mushrooms, global and local climate regulation, air purification, pollination, habitat maintenance, and providing environmental setting for recreation, health recovery and education. We used data from the Polish Forest Data Bank, as well as satellite data, literature and expert assessments to calculate the proposed indicators. To show the diversity of forest ecosystems on a nationwide scale, the division into 36 forest habitat types was applied, and the forest region (Pol. *kraina przyrodniczo-leśna*) was adopted as the basic spatial mapping unit. The potential was estimated on the basis of the characteristics of state forests over 80 years old. The obtained indicator values were converted into a common 1-5 scale (from very low to very high potential) and summarized in a synthetic matrix. Furthermore, aggregated provisioning, regulating and cultural ES potentials of forest habitat types and all 8 forest regions were quantified. Limitations of inference related to the adopted methodological solutions and the nature of the source data were also indicated.

We showed that forests in Poland have the capacity to provide many important ES for people, and that their potential varies substantially depending on the forest habitat type and region. The highest overall potential is found in the forests of mountain regions (south of Poland), slightly lower in the northern regions, and the lowest in the central regions. Fresh, mountain forest type has a high potential to provide the largest number of key forest services (14 out of 17), which gives it the status of a multi-service hotspot. The key forest ES group into six bundles. These bundles include ES from different sections, and their coexistence results from the dependence on similar qualities of the forest ecosystem, such as soil moisture and fertility, species composition and spatial structure of vegetation.

This is the first such study in Poland, taking into account the diversity of the potential of several dozen types of forest ecosystems to provide a whole range of key ecosystem services. It responds to the need for mapping and assessment of forest ecosystem services on a nationwide scale. The developed solutions can be used as a reference point and a framework for standardized monitoring of the ES potential of forests. The obtained results and the recommendations formulated on their basis may contribute to a more sustainable management of forests and optimal use of their potential.

This research was funded by WWF.

Assessing the link of wild bee pollination service and landscape features in a systematic review

Sophie Meier

Leibniz-Institute of Ecological Urban and Regional Development, Weberplatz 1, Dresden, Germany

E-mail: s.meier@ioer.de

Most of the wild plant species and crop plants worldwide depend on insect pollination. In Germany, wild bees are one of the most important insect pollinators and their large variation in body size, shape and pollen specialization enables them to pollinate a large variety of plant species. Wild bees need well-structured landscapes that contain undisturbed refuge areas in form of, for example, stone walls, hedges, riparian strips, flower strips and forest edges. As part of the development towards an intensified agriculture, a considerable amount of such refuge areas disappeared in German. This induced a strong decline of insect pollinators. Consequently, the food security and the function of whole ecosystems could be at stake.

The link between landscape and wild bee occurrence is well-studied in various local field investigations, however, there is still a lack of information, if the links between wild bees and landscape or pollination service and landscape differ among different landscapes in Germany. A former study assessed potential pollination service of CORINE land cover ecosystem types via expert interviews for the European Union [1]. This approach provides a good starting point and could be combined with regional and objective measurements from field observations.

To validate and substantiate the expert-based approach, a meta-analysis is conducted to investigate the connection between landscape, wild bee diversity and pollination service to crops and wild plants by synthesizing results from field studies in German. Preliminary findings show that, while in Germany most of local field studies were conducted in agricultural ecosystems, only few studies measured the effect of forest, quarries, riparian strips, or roadsides. Latter were more in the focus in studies conducted in neighbor countries. This shows that research focusing on wild bee – landscape interaction in Germany is more often motivated by securing food production than by biodiversity conservation.

References

[1] G. Zulian, J. Maes, M.L. Paracchini, *Land 2013*, 2, 472-492.

Comparative Analysis of Geodiversity and Geosystem Services in Three Mountainous Protected Areas

Alicja Najwer[1], Cristina Viani[2], Rasool Bux Khoso[2], Marco Giardino[2], Michele Guerini[2] Sophie Justice[3], Zbigniew Zwoliński[1]

[1]*Department of Geoinformation, Adam Mickiewicz University in Poznań, B.Krygowskiego St. 10, Poznań, Poland*
[2]*Earth Sciences Department, University of Torino, Via Valperga Caluso 35, Torino, Italy*
[2]*Chablais UNESCO Global Geopark, SIAC, Thonon les Bains, France*

E-mail: alijas@amu.edu.pl

Geodiversity and geosystem services are two concepts related to environmental protection and sustainable development of any area. The joint consideration of these two concepts is relatively new and so far there is no developed methodological and methodic basis. Therefore, it is important to address these issues and look for solutions that will serve the environment and people of the current and future generations. The assessment of geodiversity and the indication of geosystem services in protected areas of various importance is the main goal of the presented paper.

Three protected areas in mountain regions were selected for this analysis. Namely: Chablais UNESCO Global Geopark (UGGp) in France, Sesia Val Grande UGGp in Italy, and Karkonosze National Park in Poland. The Chablais UGGp is situated between Lake Geneva and Mont Blanc. It encompasses more than 250 million years of geological history from the formation of the Alps to the recent glacial events that have carved out the landscape. The Sesia Val Grande UGGp is located at the north-east of the Piemonte Region, from the Monte Rosa massif to the Lake Maggiore. Its territory includes a spectacular section of the deep structure of the Alpine collisional belt as well as a record of past and present climate changes through glacial, periglacial, water- and gravity-related processes. The Karkonosze National Park is located within the Bohemian Massif in the Sudetes range, constituting a range of medium-sized mountains. The Polish part of the Karkonosze Mountains is built of granite, has a relatively dense river network and is intensively used for tourism.

Mapping and assessment of geodiversity and geosystem services were performed based on available data sources. Geodiversity maps were made, based on which geosystem services were identified in five categories. Among the most frequently appearing geosystem services in the studied areas, the following should be mentioned. The Chablais Geopark stands out in terms of both provisioning services due to a large number of lakes and a wealth of renowned mineral waters (Evian, Thonon) and cultural knowledge services, because of the quality of its geological record and the ease of its interpretation rendering the area of international significance for the understanding of the Alpine Orogeny and the development of tectonic thrust theories. The scientific relevance of the Sesia Val Grande geoheritage highlights the role of its geological matrix in influencing human culture. The Geopark's motto, "Where stone becomes culture" is a recognition of the importance of the abiotic ecosystem services offered by different lithologies, which foster not only the local stone cultural landscape, but also great architectural achievements. The Karkonosze National Park is characterized by the occurrence of granite groats as a geosite, peat bogs on the ridge surfaces of the main ridge which are an important element of biodiversity against the background of the entire park and rock formations that provide tourist services.

This research is partly supported by the National Science Centre (Narodowe Centrum Nauki) under Grant No. UMO-2018/29/B/ST10/00114).

Evaluating the Role of Semi-Natural Meadows and Highly Maintained Lawns in Promoting Air Quality and Mitigating Climate Changes

Piotr Archiciński[1], Adrian Hoppa[1], Potr Sikorski[1], Daria Sikorska[1], Arkadiusz Przybysz[2]

[1]*Institute of Environmental Engineering, Warsaw University of Life Sciences - SGGW, Nowoursynowska 161 Str., 02-787 Warsaw, Poland*
[2]*Institute of Horticultural Sciences, Warsaw University of Life Sciences - SGGW, Nowoursynowska 159 Str., 02-787 Warsaw, Poland*

E-mail: piotr_archicinski@sggw.edu.pl

Urban green spaces are critical for environmental quality and ecosystem service provisioning. This study quantitatively assesses the differential impacts of two common low vegetation urban green space management practices, highly maintained lawns and semi-natural meadows, on air quality and urban heat island mitigation. Using LIDAR and a spontaneity algorithm, we evaluated lawn mowing intensity across varied Warsaw urban green spaces and identified the respective vegetation structure and species composition. The study explores the potential of these two contrasting management practices in provisioning ecosystem services such as surface cooling, substrate moisture maintenance, and particulate matter removal. Highly maintained lawns, while aesthetically pleasing, showed limited potential for air quality improvement and urban heat island mitigation. These lawns, characterized by frequent mowing, watering, and the application of fertilizers and herbicides, demonstrated reduced carbon sequestration capabilities and limited shading effects, thus limiting their potential to mitigate urban heat island effects. Contrarily, semi-natural meadows, requiring minimal human intervention, exhibited a higher potential for air quality improvement and urban heat island effect mitigation. These diverse grasslands demonstrated enhanced carbon sequestration, improved soil structure and water infiltration due to their extensive root systems, and reduced stormwater runoff. Furthermore, these meadows displayed increased evapotranspiration and shading due to their vegetation density and diversity, aiding urban heat island effect mitigation. Their tall grasses and wildflowers also promoted biodiversity by attracting pollinators and other wildlife. These findings underscore the value of incorporating semi-natural meadows into urban green space design for improved air quality, reduced urban heat island effects, and enhanced ecological resilience. As such, they serve as vital information for urban planners, policymakers, and landscape designers in reimagining urban green spaces towards a more nature-based approach.

PARALLEL SESSION 5

ECOSYSTEM SERVICES IN URBAN AREAS

Linking Urban Ecosystem Services With Sustainability Transformations – From Shallow to Deep Leverage Points

Martina Artmann

Leibniz Institute of Ecological Urban and Regional Development (IOER), Weberplatz 1, 01217 Dresden, Germany

E-mail: m.artmann@ioer.de

Cities are confronted with negative impacts of an ever intensifying social-ecological crisis. Climate change, biodiversity loss or social segregation are a just few challenges harming a good life in cities and beyond. In fact, cities are part of the causes and solution for the crisis at the same time. The increasing human alienation from nature is widely discussed as a root cause of the current socio-ecological challenges. This phenomena is in particular found in cities. To foster sustainable human-nature relationships in cities, the concept of ecosystem services can provide meaningful methods and planning recommendations. However, in the light of the urgent need to foster a deep shift towards sustainability, the transformative capacity of the concept has so far not been adequately researched, in particular in the context of urban human-nature relationships.

In the light of this research gap and societal challenges, the aims of this conceptual talk are threefold. First, I will explore through the lens of ecosystem services how cities are confronted with external and internal human-nature disconnections. Second, I will reflect through the concept of leverage points how ecosystem service research can foster sustainability transformations, including system parameters, feedback, design, and intent. In particular the system intent, which addresses world views, goals, and paradigms of a system, is considered as a deep leverage point holding great potential to foster deep changes of a system. Therefore, I will explore in the third part of the presentation how future ecosystem service research can be developed further to transform from hierarchical human-nature relations towards urban human-nature partnerships. The positive vision of human-nature partnerships focuses on values such as compassion and care and recognizes nature as a living legal entity. Limiting human actions of making nonhuman nature increasingly visible, accessible, and controllable is then not considered as burden but as part of a good life for all living beings.

Mapping and Assessment of Urban Ecosystem Services in Poland

Andrzej N. Affek, Jacek Wolski, Bożena Degórska, Jerzy Solon, Anna Kowalska, Edyta Regulska, Marek Degórski

Department of Geoecology, Institute of Geography and Spatial Organization, Polish Academy of Sciences, Twarda St. 51/55, 00-818, Warsaw, Poland

E-mail: a.affek@twarda.pan.pl

The concept of ecosystem services (ES) can contribute to improving the quality of life in cities, but it has to be operationalized before being implemented in spatial planning. The study aim was to present methodological solutions to assess and map urban ES at different spatial scales, including methods for constructing and characterizing indicators.

Assessing and mapping ES is more complex than traditional mapping of ecosystems as it involves several interrelated issues. The most important include: 1) selection or construction of indicators that correctly describe the subject of measurement and the service itself, 2) selection of the appropriate spatial scale and the related mapping unit, 3) selection of source data enabling the calculation of indicator values. Each of these issues is briefly discussed and illustrated with examples covering three spatial scales (national, regional and local) and the three most common subjects of measurement: the potential of ecosystems to provide ES, ES flow and unmet demand.

An important element of ES assessment is the analysis of ES bundles and interactions between services, as well as the identification of areas with outstanding potential for providing multiple services, i.e. ES hotspots. We conducted an exemplary case study in Warsaw and analyzed the potential of 30 types of urban ecosystems to provide 7 regulating and cultural ES, critical for the well-being of urban residents: 1. carbon fixation in biomass, 2. erosion control, 3. slowing down the outflow of rainwater, 4. dust accumulation by vegetation, 5. urban heat island reduction, 6. creating conditions for 6. recreation and 7. education in nature. The similarity analysis (hierarchical cluster analysis) indicated that the considered ES group into two main bundles. Defining ES bundles allows for a substantial reduction in the number of indicators necessary to calculate overall ES potential. In turn, ecosystem types group into four clusters with distinctly different levels of ES potential. The general conclusion is that the ES potential of urban ecosystems increases with decreasing density of development and share of impervious areas, and increasing share of area covered with trees. We showed that urban forests and other green spaces, including spontaneously developing vegetation in the Vistula valley and on former agricultural lands, constitute ES hotspots in Warsaw.

Finally, we formulated recommendations regarding the process of assessing and mapping urban ecosystem services in Poland and indicated the benefits of including such assessment in spatial planning and city management.

The study is a contribution to the project: *Services provided by main types of ecosystems in Poland – an applied approach (ECOSERV-POL)*, financed by EEA Grants 2014-2021.

Cost-Benefit Analysis of Urban Nature-Based Solutions: A Systematic Review of Approaches, Scales and Outcomes

Alessia Chelli[1], Davide Geneletti[2], Luke Brander[3]

[1]*SUSTEEMS doctoral program, University of Trento, Via Inama 5, 38122, Trento, Italy*
[2]*Department of Civil, Environmental and Mechanical Engineering, University of Trento, Via Mesiano, 77, 38123 Trento, Italy*
[3]*Institute for Environmental Studies (IVM), Vrije Universiteit Amsterdam, the Netherlands*

E-mail: alessia.chelli@unitn.it

Urban nature-based solutions (NBS) are increasingly recognized as an effective strategy to support climate change adaptation in cities while improving social, environmental, and economic well-being. Cost-Benefit Analysis (CBA) is a commonly utilized method for evaluating the economic feasibility of NBS investments and supporting policymakers in comparing different investment alternatives. The application of CBA is not, however, straightforward as it requires the inclusion of a broad range of co-benefits including ecosystem services, which are distributed differently across space and time. Moreover, the monetization of these benefits may necessitate the use of sophisticated valuation techniques. The objective of this research is to examine the current state of CBA in the literature on urban NBS, through a systematic literature review.

The study aims to comprehensively compare the various approaches and components utilized in CBA studies, with a particular focus on investigating the spatial and temporal dynamics of NBS and their associated benefits. By examining the methodological choices employed in the reviewed studies, this research identify the implications of the different approaches, the potential knowledge gaps and provide recommendations for conducting CBA evaluation of urban NBS.

A Nature Park vs an Urban Park in Bucharest – a Comparative Assessment of Ecosystem Services

Lavinia C. Pîndaru, Gabriel O. Vânău, Mihăiță I. Niculae, Iulia V. Miu , Cristiana M. Pioarcă-Ciocănea , Raluca A. Slave

Department of Regional Geography and Environment, University of Bucharest, 90, Panduri Street, Sector 5, 050663, Bucharest, Romania

E-mail: lavinia.pindaru@s.unibuc.ro

This study aimed to compare the ecosystem services provided by nature parks and urban parks, two types of green spaces that serve distinct purposes. Ecosystem services refer to the benefits humans derive from nature, including provisioning services (e.g., food, water), regulating services (e.g., air quality, flood control), cultural services (e.g., recreation, education), and supporting services (e.g., soil formation, nutrient cycling). To conduct this comparative assessment, we selected one nature park - Vacaresti and one urban park – Tineretului of fairly similar size, located in the Bucharest, Romania. We used a combination of field surveys, remote sensing, and stakeholder interviews to assess the provisioning, regulating, cultural, and supporting services provided by each park. We also analyzed the spatial patterns of ecosystem services and their relationship with park characteristics, such as size, age, and management regime. Our results show that nature parks and urban parks provide different sets of ecosystem services, reflecting their different ecological and social contexts. Nature parks tended to provide more regulating and supporting services, such as carbon sequestration, biodiversity conservation, and soil formation, while urban parks provided more cultural services, such as recreation, social interaction, and aesthetic value. Provisioning services, such as food production and water supply, were limited in both types of parks.

The Importance of Urban Trees in Nature Based-Solutions Conditions. The Case of Vilnius City Centre (Lithuania)

Yuliana Shuhani, Luis Valenca Pinto, Miguel Inácio , Manob Das, Paulo Pereira

Environmental Management Laboratory, Mykolas Romeris University, Ateities g. 20, LT-08303, Vilnius, Lithuania

E-mail: shuhani@mruni.eu

Urban development increases environmental degradation dramatically. To mitigate the impacts of urbanisation and, increase cities' resilience to pollution, natural hazards and enhance well-being, it is essential to establish nature-based solutions (NBS). Trees and their density are critical elements in NBS. This study aims to assess trees' impact and density on NBS conditions in Vilnius city center (Lithuania). Tree data were collected from multiple sources (open street map, land use from Copernicus) and vectorised in google earth online. NBS (e.g., parks, urban gardens, single street trees, forested areas, laws and grasslands were vectorised using google earth online and PlanetScope images (3 m resolution). Different remote sensing indexes were assessed, normalised difference vegetation index (NDVI), enhanced vegetation index (EVI), modified soil adjusted vegetation index (MSAVI2), and soil adjusted vegetation index (SAVI) to assess NBS condition. Three densities were estimated (Kernel Density) with a ratio of 100 m. Tree density, NDVI, EVI, MSAVI2 and SAVI were extracted to points (point extract tool). Tree points were used for data extraction. Data were processed in the QGIS version 3. A Spearmen correlation was applied to assess the correlation between tree density and the different indexes. Significant differences were considered at $p<0.05$. Statistical analyses were conducted using JASP 0.17.1. The results showed that the highest density of trees was located in the western part of the city. The correlation between tree density was significant in all the cases ($p<0.05$). Nevertheless, they were reduced. 0.384 for SAVI and MSAVI2, 0.381 for NDVI and 0.353 for EVI. Overall, the indexes considered had a similar correlation with tree density. Although the correlations were significant, they were not so high, showing that the NBS condition was low in some areas with tree density. This may be attributed to a high density of young trees with a lower NBS condition than older and larger trees. Further work in the field will be conducted to confirm this hypothesis and assess with better accuracy the different conditions of NBS in Vilnius.

The Attitude – Behavior Gap in Transport: Determinants of an Effective Choice Architecture for Sustainable Urban Mobility

Monika Paradowska

Institute of International Studies, Faculty of Social Sciences, University of Wrocław, Koszarowa Street 3, PL 51-149 Wrocław, Poland

E-mail: monika.paradowska@uwr.edu.pl

Many hard measures have been developed and tested in order to develop sustainable urban mobility and to reduce individual motorization, generating most of external costs of transport. Infrastructural, legal and regulatory tools, as well as financial incentives have been applied to encourage drivers to resign from their cars. These solutions are not very often combined with soft measures based on building pro-environmental and pro-social attitudes or promoting sustainable mobility. However, soft measures are expected to increase the effectiveness and acceptance of hard measures. Despite advanced scientific and practical achievements in this area and many recommendations for urban policies, Polish cities still face increasing challenges resulting from the dominance of individual motorization. Several different factors contribute to the poor propensity to switch to more sustainable transport modes. An important role is played by the "attitude-behavior" gap, understood as a discrepancy between the positive attitude of consumers towards certain behaviors and the simultaneous lack of such behaviors during consumer choices [1]. Previous studies conducted by the author show a low importance of care for the environment and the community when making transport choices, and hardly any impact of knowledge about sustainable transport and consumption. In addition, hard measures based on restrictions for drivers turn out to be the most effective. This may indicate a very low ecological awareness, which would be in contradiction with the findings of the Ministry of Climate and Environment [2], or the existence of an "attitude-behavior" gap. In both cases, the development of soft measures plays an important role in order to emphasize the benefits of sustainable transport choices. The main aim of the article is to determine to what extent various combinations of direct, visually supported information about private and external costs and benefits influence a shift from cars to more sustainable means of urban transport and thus reduce the "attitude-behavior" gap. The research is based on some elements of behavioral economics [3] (e.g. the framing effect and loss aversion), as well as on research on sustainable consumption and sustainable mobility. The following hypothesis was adopted: Car users rarely resign from their car if the perceived loss is stronger than the expected satisfaction from behaving under the possessed knowledge, pro-environmental and pro-social attitudes. The existing attitude – behavior gap is limited by hard measures supported by soft measures – information underlining first private benefits, and then environmental and social ones. The results showed that, in general, the use of soft measures led to more sustainable transport choices and thus reduced the attitude – behavior gap. Respondents' reactions, however, varied depending on the visual and information stimuli provided. The main conclusion suggests that soft measures should be developed and implemented to increase the effectiveness of hard measures, and to strengthen the public acceptance of the transformation towards (more) sustainable mobility in line with pro-environmental and pro-social attitudes.

References

[1] A. Burgiel, Luka między postawami a zachowaniami konsumentów i jej konsekwencje dla upowszechnienia zrównoważonej konsumpcji, in: Zrównoważona konsumpcja w polskich gospodarstwach domowych – postawy, zachowania, determinanty, Ed. S. Smyczek, Wydawnictwo Uniwersytetu Ekonomicznego w Katowicach, 2020, Katowice, 222-248.
[2] The Ministry of Climate and Environment, Badanie świadomości i zachowań ekologicznych mieszkańców Polski, 2020, Warszawa.
[3] R.H. Thaler, Zachowania Niepoprawne. Tworzenie Ekonomii Behawioralnej, Media Rodzina, Poznań, 2018.

Past, present and future of technologies from Industry 4.0 and Industry 5.0 in the Water-Energy-Food-Ecosystems Nexus: Guaranteeing ecosystems' integrity

Isabel J. Nobre, Paula Antunes, Paulo Condado

CENSE—Center for Environmental and Sustainability Research, Department of Environmental Sciences and Engineering, Campus de Caparica, NOVA School of Science and Technology, NOVA University Lisbon, 2829-516 Caparica, Portugal

E-mail: ij.nobre@campus.fct.unl.pt

In recent years, we have been seeing an increase in the use of detection and communication technologies to support ecosystem services research and management. For instance, wireless sensors have been facilitating constant monitoring of natural ecosystems with growing precision and accuracy. At the same time, machine learning can present a range of opportunities in ecosystem service research, offering rapid processing of big data and enabling significant advances in data description and predictive modeling. The benefits that Industry 4.0 and Industry 5.0 technologies can have to support the Water-Energy-Food-Ecosystems (WEFE) nexus security, and consequently on guaranteeing ecosystems' integrity, is clear. This way, and taking as a starting point a systematic literature review that assesses the benefits and harms of Industry 4.0 and Industry 5.0 technologies on the resources of the WEFE nexus, this work identifies which of these technologies address ecosystems' integrity and their capacity to deliver ecosystem services, as well as potential directions for the future application of these technologies to assure WEFE nexus security. To achieve this goal, we selected published papers that discuss the ecosystems' impact of technologies from Industry 4.0 and Industry 5.0, based on predefined inclusion and exclusion criteria. Accordingly, we used an established systematic literature review protocol to identify the main findings and evaluate the potential effects of these technologies on ecosystem services practices. The results of our systematic review provide valuable insights into the potential of Industry 4.0 and Industry 5.0 technologies in responding to the challenges of WEFE nexus security and sustainable development.

PARALLEL SESSION 6

MAPPING AND ASSESSMENT OF ECOSYSTEM SERVICES

Mapping and Assessment of Ecosystem Services at the Landscape Level

Damian Łowicki

Department of Integrated Geography, Adam Mickiewicz University, Poznan, ul. Wieniawskiego 1, 61-712 Poznan, Poland

E-mail: damek@amu.edu.pl

When assessing and mapping some ecosystem services (ES), it is necessary to consider the benefits not only from individual ecosystems but also from their distribution in space. This approach was developed based on landscape ecology and one of its paradigms, according to which the structure of the landscape determines its functions [1]. Services considered at the landscape level are, therefore, not the same as landscape services, which are cultural services related to the properties of ecosystems that enable aesthetic experiences, determine mental and physical health, and social and personal fulfillment. In the proposed approach, it is a method of assessing services, the subject of which may be any ecosystem and any services or their bundles. The essence of this approach is mapping the structure-process relationship, which facilitates the assessment of the impact of changes in land cover on ecosystem functions and services, which may have an effect on planning practice. Analyzing ecosystem services at the landscape level is particularly important in assessing regulating services. Two ES have the most significant potential to be used in the landscape approach: processing of biochemical or physical inputs to ecosystems (e.g., noise reduction) and regulation of physical, chemical, and biological conditions (e.g. pollination). This approach is especially important when the service carrier is mobile. This applies, for example, to the migration of pollutants between ecosystems [2,3] or the movement of pollinators between nesting and feeding sites [4]. In addition to regulating services, the landscape approach is important in mapping and assessment of cultural ES, especially the characteristics of living systems that enable aesthetic experiences. Relationships between different types of land cover, including cultural products, are important for landscape and tourist attractiveness. The presentation presents exemplary indicators, data sources, and their application to the assessment and mapping of ecosystem services at the national and local levels. The research is a part of the project “Services provided by main types of ecosystems in Poland - an applied approach” and received funding from Iceland, Liechtenstein and Norway within the EEA Financial Mechanism 2014-2021, and from the budget of Poland.

References

[1] R.T.T. Forman, M. Godron, *Landscape ecology*, John Wiley & Sons, New York, 1986.
[2] D. Łowicki, *Ecological Indicators* Landscape pattern as an indicator of urban air pollution of particulate matter in Poland **2019**, *97*, 17-24
[3] D. Łowicki, *Ecological Indicators* Prediction of flowing water pollution on the basis of landscape metrics as a tool supporting delimitation of Nitrate Vulnerable Zones **2012**, *23*, 27-33.
[4] D. Łowicki, K. Fagiewicz, *Ecosystem Services* A new model of pollination services potential using a landscape approach: a case study of post-mining area in Poland **2021,** *52*, 1-10.

Ecosystem service value changes in response to land use dynamics in Lithuania 1990-2018

Giedrius Dabasinskas, Gintare Sujetoviene

Department of Environmental Sciences, Vytautas Magnus University, Kaunas, Lithuania

E-mail: giedrius.dabasinskas@vdu.lt

Changes in land use/land cover (LULC) affect ecosystems and the services they provide. In this study, we assessed ecosystem value change (ESV) in response to LULC change in Lithuania from 1990 to 2018. Over the whole study period, cropland area decreased by about 150,000 ha, while grasslands and forests increased by about 112,000 ha and 24,400 ha, respectively. Land use intensity decreased from 261 in 1990 and 2006 to 259 in 2018 with the highest intensities were observed in urban areas and croplands. The total ESV in Lithuania was US$ 28.8 billion year-1 in 2018, which was lower compared to 1990 and 2006. Over the entire study period, the majority of the ESV was provided by croplands, followed by forests, grasslands, and wetlands. Wetlands accounted high share of the total ESV (about 5%), although they covered less than 1% of the total land area. Land use had a significant impact on ESV, with a total decrease of US$ 438 million year-1 over the entire study period 1990-2018. Between 1990 and 2018, the total ESV was mainly influenced by the decrease in provisioning (US$426 million year-1) and regulating (US$208 million year-1) services. Food and genetic resources were the main contributors to the overall decline in ESV. The reduction in cropland area was the major factor in the loss of ESV. The most significant increase in ESV was due to genetic diversity mainly driven by the increase in forest and grassland areas. However, the increase in the value of habitat (US$156 million year-1) and cultural (US$ 40 million year-1) services was not large enough to offset the reduction of the ESV. The change in ESV was observed on the area of 21.5% of the total land area of Lithuania. The highest elasticity values were concentrated in the urban municipalities, indicating a high change in ESV due to land use change in Lithuania. The results of this study provide a valuable insight into the potential of the sustainable management and regeneration of ecosystems.

Experimental evaluation of selected ecosystem services of agricultural soils in Slovenia

Ilona Rac[1], Helena Grčman[2], Anže Japelj[3]

[1]*Department of Animal Science, University of Ljubljana Biotechnical faculty, Jamnikarjeva 101, 1000 Ljubljana, Slovenia*
[2]*Department of Agronomy, University of Ljubljana Biotechnical faculty, Jamnikarjeva 101, 1000 Ljubljana, Slovenia*
[3]*Department for Forest and Landscape Planning and Monitoring, Slovenian Forestry Institute, Večna pot 2, 1000 Ljubljana, Slovenia*

E-mail: ilona.rac@bf.uni-lj.si

Soil is essential to the existence and development of society, as it enables agricultural production of food and raw materials, while also fulfilling many other human needs. Sustainable soil management is therefore key to wellbeing. In this project, we adopted, developed and used as an evaluation framework the concept of Soil Ecosystem Services (SES) as a logical extension of the concept of Ecosystem services (ES). Our aim was to show a possible approach to the evaluation of SES. We wanted to examine whether the economic evaluation of SES can meaningfully assess the value of soil and to what extent differences in soil properties affect the value of SES.

The analytical approach developed by the European Commission's working group for ES mapping and assessment MAES (Mapping and Assessment of Ecosystem Services) was adopted in the research. The sample parcels were selected based on a comprehensive GIS (Geographic Information System) analysis of the occurrence of pedosequences in combination with agricultural uses (soilscapes) in Slovenia to provide a representative sample of combinations of soil types and crops. Three SES were experimentally biophysically and economically evaluated. For the SES 'biomass production', we estimated the annual value of food production capacity based on the market price, while for the SES 'water retention and drought mitigation' and 'carbon sequestration' we used a cost-based approach. The results showed that assessing the value of soil solely based on agricultural production capacity does not realistically reflect its value, and they also pointed to the problem of using market prices for ES valuation. Results were influenced, more strongly than by soil properties, by values of the selected crops, the price of water and irrigation systems, and CO_2 emission allowances. Therefore, any results of such evaluations should be approached with caution and a firm grasp of the assumptions of the calculations.

Quantitative Approach for Assessing Khartoum State Vulnerability to Climate Change

Ahmed M. Alhuseen[1], Maria Kozova[2], Pavel Cudlin[1], Mahmoud Makki[3], Ismail E. Ismail[4], Abdellateef A. Ali[5]

[1]*Department of Ecosystem Functional Analysis of the Landscape, Global Change Research Institute, Academy of Sciences of the Czech Republic, Lipová 1789/9, 370 05 Ceské Budejovice, Czech Republic*
[2]*Faculty of Education, Catholic University in Ruzomberok, Hrabovska street 1, 03401 Ruzomberok, Slovakia*
[3]*Institute of Economics and Agricultural Policies, Agricultural Research Corporation Khartoum, Sudan*
[4]*Faculty of Education, University of Gadarif, P.O. Box 449 Al Gadarif State, Sudan*
[5]*Blue Nile University, Faculty of Education, Blue Nile State, Sudan*

E-mail: ahmedalhuseen@ yahoo.com

Khartoum State, the capital of Sudan fast is becoming a densely populated urban center and is anticipated to face the worst in terms of climate change impacts. Assessing the consequences of climate change on the urban sector considered to be a crucial step to adapt to them. This study aims mainly to quantitatively assess the vulnerability of Khartoum State to climate change, however, in this study, the term 'vulnerability' is considered as a function of exposure, sensitivity, and adaptive capacity. Therefore, the assessment of vulnerability carried out in this study has included the identification of these three incorporated elements. For the purpose of assessing the vulnerability of Khartoum State; local climate change exposure, sensitivity, and adaptive capacity have been determined based on experts' review and review of historical data from national government departments about climatic variability events that exhibited climate change impacts. Questionnaires have been distributed among a simple random sample of households to validate the secondary data. For the purpose of assessing the study area's sensitivity to climate change, a matrix has been used to identify who/what is at risk to the anticipated climate change impacts. The results showed that the quantified sensitivity and exposure rates of the study area to the risk of temperature increase, drought and sand/dust storms, and river and torrential floods reached 0.69 and 0.72 respectively of a total sum of 1. On the other hand, this study showed that the study area's adaptive capacity is found to be at a rate of 0.45.

The economic value of ecosystem services

Marek Giergiczny

Univeristy of Warsaw, Warszawa, Polska

E-mail: m.giergiczny@uw.edu.pl

Poland, with nearly 81% state-owned forests, has a unique forest ownership structure compared to other EU countries. A uniform ownership structure should favor a socially optimal forest management system. Indication of spatially optimal forest management, however, requires quantification of ecosystem services, preferably by the same measure. Ideally, this common measure for all goods and services is monetary valuation where possible using market prices, and where not possible based on social preferences. However, this approach requires valuing ecosystem services and determining the relationships between them. Ecosystem services are interrelated, e.g. maximizing the benefits of timber harvesting in many cases may mean reducing the benefits of other ecosystem services. Optimal management of natural resources requires knowledge of these relationships. The main purpose of this presentation is to show how to quantify and map a recreational service, which is a narrow slice of the broad category of cultural ecosystem services.

From ecosystem services to ecosystem accounting. The application of ecosystem accounting principles at the local scale

Marta Sylla

Institute of Spatial Management, Wrocław University of Environmental and Life Sciences, ul. Grunwaldzka 55, 50-357 Wrocław, Poland

E-mail: marta.sylla@upwr.edu.pl

The paper introduces the principles of the System of Environmental-Economic Accounting—Ecosystem Accounting (SEEA EA), which provides guidance to recognizing the contribution of ecosystem services (ES) to economy and human well-being. The spatial aspect is in the heart of each of the steps of the SEEA EA framework. The spatial perspective enriches the standard economic indicators that are used to describe the level of socio-economic development of the region or municipalities. This also poses a lot of challenges, especially in the integration part of the ecosystem accounting with economic activities. The aim of the work is to present the application of the conceptual framework of linking ecosystem services, benefits and economic sectors. The case study area represents five municipalities that are part of the Ślęża Landscape Park in Poland. We mapped four ecosystem services and attributed them to the benefiting sectors. The socio-economic character of the case study is determined by the set of indicators, while the economic sectors are classified according to ISIC v4. The analysis relates to the years 2012 and 2018. Thanks to the local character of our case study, we were able to spatially allocate the ecosystems and beneficiaries. We present in a spatially explicit way the contribution of selected ES to the local economy. We discuss the applicability of ecosystem accounting to spatial planning and local governance.

Applying The System of Environmental Economic Accounting-Ecosystem Accounting (SEEA-EA) Framework to Forest Ecosystems

Umberto Grande[1,2], Kevin Husein[1], Lorenza Nardella[2], Darius Kaminski[1], Elvira Buonocore[2], Pier Paolo Franzese[2], Agnieszka Piernik[1]

[1]*Department of Geobotany and Landscape Planning, Nicolaus Copernicus University, ul. Lwowska 1, 87-100, Toruń, Poland.*
[2]*International PhD Programme / UNESCO Chair "Environment, Resources and Sustainable Development", Department of Science and Technology, Parthenope University of Naples, Centro Direzionale Isola C4 (80143), Naples, Italy.*

E-mail: umbertogrande@doktorant.umk.pl

Air pollution is one of the main environmental problems at global scale. Pollutants released in the atmosphere by ever-increasing human activities are altering natural ecosystems while affecting human health. Poland shows the worst air quality among the European countries, mainly due to the use of coal for energy production. Polish policymakers are developing several strategies to mitigate air pollution, although the achievement of sustainability targets appears to be still hard. In this context, an important role is played by forest ecosystems covering about 30% of the national territory. Several studies recognized the important role of forests in providing relevant regulating ecosystem services, among which air quality amelioration. In this study, we explored the role of the Tuchola Forest (a Polish UNESCO-MAB Biosphere Reserve) in enhancing air quality and human well-being by removing atmospheric pollutants. In particular, the biophysical and monetary value of the forest ecosystem service of atmospheric pollutants removal was assessed by implementing the System of Environmental-Economic Accounting-Ecosystem Accounting (SEEA-EA) framework.

The extent and condition of the forest ecosystem as well as the efficiency in removing atmospheric pollutants was assessed using remote sensing data, among which the Corine Land Cover (CLC) database, the Leaf Area Index (LAI) product delivered by the Copernicus Global Land Service (CGLS), and pollutants concentration delivered by Copernicus Atmosphere Monitoring Service (CAMS).

Finally, the loss of ecosystem services due to the impact of a devastating hurricane hitting the study area in 2017 was also assessed. The results of the study will boost the scientific knowledge on forest ecosystem services while supporting policymakers to develop conservation strategies aimed at achieving sustainability goals.

POSTER SESSION

Conservation of Biodiversity and Ecosystem Services in the Cultural Landscapes of the Ancares-Courel Mountain Range, NW Spain

Ignacio J. Diaz-Maroto

Department of Agroforestry Engineering, University of Santiago de Compostela, Campus Terra s/n, E-27002 Lugo, Spain

E-mail: ignacio.diazmaroto@usc.es

Ancares-Courel is a transitional area from typical Atlantic to Mediterranean flora. It locates at the western end of the Cantabrian Mountains, and it is a zone of sloped land with elevations between 250-1,935 m. The climate is characterized by rainfall between 700-2,500 mm. The annual temperature regime is extreme with long winters in the highlands. Annual average temperatures range from 4.6 to 14.0 °C. The potential vegetation should occupy this region would be native broadleaf forests characterized by diverse *Quercus* species. The conservation of biodiversity in cultural landscapes is often greater than in the semi-natural landscapes, depending on the diversity generated by natural forces and anthropological actions. Traditional practices of land-use have shaped an agricultural-silvicultural-pastoral exploitation system adapted to highland environment. It is based on cereal crops, extensive grazing with orchard crops and fruit trees; all controlled by seasonal cycles and spatial patterns of human activities. This model has shaped the current cultural landscapes typified by exceptional biodiversity and wide-ranging ecosystem services. Agricultural lands are located at the bottom of the valleys and the villages on the sunny middle slopes. Orchards and fruit trees placed between houses and other farm construction surround the villages and give way to chestnut stands and rye fields. Scrubs dominate steep slopes where periodic burning is performed to regenerate pastures. The meadows are in the low-lying areas near to the rivers. On the shady slopes, far from the villages and where the humidity is higher, human pressure is low, being refuge from the best examples of primitive forests, mixed forests with abundance of different deciduous species. The environmental, cultural, and economic integration of agropastoral and forestry activities is vital to ensure cultural landscapes together its biodiversity and ecosystem services. Our goal is to study the evolution and historical background of these landscapes to establish conservation and recovery measures.

Wildland-Urban Interface Planning: Assessing the Use of Stakeholder-Informed Ecosystem Services Modelling in Transdisciplinary Approaches

Clara E. Mosso

Ecosystem Science and Sustainability, Colorado State University, 1231 Libbie Coy Wy, Fort Collins, CO., United States

E-mail: clara.mosso@colostate.edu

Wildland-urban interface (WUI) expansion is a pressing phenomenon around the World with impacts to ecological processes, wildfire risk, natural resources management, and social and demographic dynamics. Given its rapid evolution, its uncertainty, and the involvement of multiple stakeholders with conflicting values, the expansion of the WUI is considered a wicked problem. Science can advance in the development of strategies to address this issue through transdisciplinary approaches that embrace complexity. Transdisciplinarity is challenging, however, and easier said than done. The objectives of this study were: 1) to present the state of the art of WUI planning mechanisms and tools; 2) to identify the barriers and opportunities for the implementation of transdisciplinary approaches in WUI planning; and 3) to assess the feasibility of incorporating stakeholder-informed ecosystem services modelling in WUI planning as a strategy to promote transdisciplinarity and inform sustainable management approaches to WUI expansion. With the aim of comparing Southern and Northern hemisphere's social-ecological systems affected by WUI expansion, I used the province of Neuquén (Argentina) and the State of Colorado (US) as case studies. I conducted a normative and literature review for each site, which was complemented with semi-structured interviews and participatory mapping activities with key stakeholders. Then, I evaluated the use of InVEST models in WUI planning based on the availability of spatial ecological information for both systems and current WUI-related policies. Results suggest that collaboration between stakeholders, interjurisdictional coordination, and financial support are deficient aspects in WUI planning in both social-ecological systems, which results detrimental to the implementation of transdisciplinary approaches. On the other hand, both systems have reflexive WUI policies, which constitutes an opportunity for the introduction of transdisciplinary approaches, including stakeholder-informed ecosystem services modelling. This study provides insights to transform current interactions between researchers, communities, and policy practitioners into effective transdisciplinary approaches to address WUI expansion.

Temporality in mapping forest ecosystem services

Anita Poturalska[1], Katja Kangas[2] & Janne Alahuhta[1], Terhi Ala-Hulkko[1]

[1]*Geography Research Unit, Pentti Kaiteran katu 1, Oulu, Finland*
[2]*Natural Resources Institute Finland, Paavo Havaksen tie 3, Oulu, Finland*

E-mail: anita.poturalska@oulu.fi

Forests provide a wide range of ecosystem services for humankind. The provision of forest ecosystem services (FES) is dependent on the state of forest ecosystems, which is changing over time due to natural and anthropogenic reasons. Therefore, it is necessary to explore not only spatial, but also temporal patterns of FES provision in order to further understand the ecosystem service supply patterns. Yet, exploring the ecosystem services from a temporal perspective has not received as much attention as research on their spatial aspects (Rau et al., 2020).

Wood resources are an example of key FES that maintain our welfare. That is why we have chosen it as an example to map spatio-temporal patterns of FES provision. In this study, we used a Geographical Information System (GIS)-based space-time cube tools to analyze and map the temporal changes in wood supply in Europe. We used data on annual wood supply for period between 2008 and 2018 across European administrative regions. The supply data represents the capacity to provide a FES at a given location in a certain time (Burkhard et al., 2012), and were compiled from statistical databases.

The specific aims of the study are: 1) to test GIS-based space-time cube methodology for spatio-temporal ecosystem services mapping purposes; 2) to explore the changes in the distribution of forest ecosystem service supply values across the studied regions; 3) to get detailed information about the trends of forest ecosystem service provision across the research area within the study period.

Based on our findings significant changes in values of analyzed FES were detected across vast amount of European regions in the period studied. Our results demonstrate the potential usage of space-time cube methodology as a promising tool for mapping spatio-temporal patterns of FES and other ecosystem services provision.

References

[1] Burkhard, B., Kroll, F., Nedkov, S., & Müller, F. *Mapping ecosystem service supply, demand and budgets. Ecological indicators* 21 (2012): 17-29.
[2] Rau, A. L., Burkhardt, V., Dorninger, C., Hjort, C., Ibe, K., Keßler, L., Kristensen, J.A., McRobert, A., Sidemo-Holm, W., Zimmermann, H., Abson, D.J., von Wehrden, H., Ekroos, J. *Temporal patterns in ecosystem services research: A review and three recommendations. Ambio* 49.8 (2020): 1377-1393.

Assessment of the potential of mature forests in Poland using open source data to provide mushroom picking service

Ewa Kołaczkowska, Anna Kowalska, Edyta Regulska, Jacek Wolski, Jerzy Solon, Andrzej Affek

Department of Geoecology, Institute of Geography and Spatial Organization, Polish Academy of Sciences, Twarda St. 51/55, 00-818, Warsaw, Poland

E-mail: ekolaczk@twarda.pan.pl

The collection of forest mushrooms in Poland, as well as in other European countries, is a centuries-old tradition. Mushroom picking as a form of recreation and the use of mushrooms for food and medicinal purposes are particularly popular in Central, Eastern and South-Eastern Europe. The aim of the work was to assess the potential of forests to provide edible mushrooms and mushroom picking service based on their habitat and ecological properties. A complex indicator describing habitat and ecological conditions favorable for the occurrence of edible mycorrhizal fungi and the activity of mushroom pickers was developed. Individual forest compartments in the State Forests with a tree stand older than 80 years (i.e. with a mature stand) were characterized by the minimum value of six partial indicators (i.e. a factor limiting the potential), and then the average of these minima was calculated for forest site types in eight natural-forest regions (*Pol*. krainy przyrodniczo-leśne) and throughout Poland. The partial indices included: tree species with which fungi form mycorrhiza, soil subtype, habitat moisture, stand density and layering, and the average slope of the terrain determining the accessibility of forests for an average mushroom picker. Data on mycorrhizal relationships of selected fungi with tree species were obtained from mycological literature. Information on the species composition and structure of forest stands as well as habitat characteristics of forest compartments was obtained from the Forest Data Bank, while data on the slope of the terrain were obtained from the Digital Terrain Model with a resolution of 50 m.

The results show a large variation in the potential for mushrooming between habitat types and small regional differences. The limiting effect of habitat moisture and the share of tree species with which edible fungi form mycorrhizas are particularly noticeable.

This research was funded by WWF.

What is the importance of ecosystem services of private forests in Poland?

Emilia Wysocka-Fijorek, Piotr Gołos

Forest Research Institute, Poland

E-mail: e.wysocka-fijorek@ibles.waw.pl

Forest ecosystems, regardless of ownership or management type, are suppliers of many products and services, both market goods and public goods and services. The main difference in the provision of the latter by private forests, as opposed to public forests, is that owners must assume the obligations arising from their property rights, as reflected, among other things, in numerous programs to compensate forest owners, for example, for the costs of protecting biodiversity or for lost income due to the abandonment or curtailment of timber harvesting.

The objective of the study is to present the potential of different types of private forests to provide important ecosystem services, and to identify types of forest ecosystems with a distinct potential to provide services, as well as to show the relationships between forest ecosystem services.

The survey was conducted on a representative large, nationwide random sample of forest landowners who are farmers (1003 questionnaires). The computer-assisted personal interview (CAPI) method was used, with a standardised interview questionnaire containing 16 factual questions and a survey metric.

If private forestry is expected to engage in biodiversity, climate, water, and soil conservation on a large scale, it is necessary to know not only the expectations of owners, but also the level of their knowledge and awareness of nature, which is shaped by the value system of forest owners that governs the implementation of forest management. Knowledge on the above scale is necessary to implement the best solutions for multifunctional forest management, whose main objectives compete with each other to varying degrees. In addition, the objectives set in both the planning and implementation phases need to be increasingly modified, taking into account the increasing impact of extreme weather events in recent years that threaten the sustainability of forest ecosystems.

The importance of sequestration and storing CO_2 by forest ecosystems

Emilia Wysocka-Fijorek, Krzysztof Korzeniewski

Forest Research Institute, Poland

E-mail: e.wysocka-fijorek@ibles.waw.pl

From an environmental perspective, forests play a critical role in protecting water quantity and quality, supporting a rich biological diversity, maintaining soil productivity, and storing carbon. Carbon Forests focuses in particular on CO_2 absorbtion. With proper attention to leaving appropriate amounts of logging residue, forest management involving selected type of harvests can still build, or at least maintain, soil nutrient levels, organic matter, and microorganisms.

Carbon storage in forests and sequestration by forests (CICES 2.2.6.1) are regulatory services according to CICES version 5.1. Results are presented that were developed in the course of conducting a multi-faceted basic research including the study of carbon content in the individual components of the forest ecosystem (e.g., soil, understory, tree trunk, branches, leaves, dead wood). Field verification of the assumptions made was also carried out as part of the research conducted.

Appropriate harvest practices also minimize compaction and other physical changes to soil properties that might occur under clear-cut harvest (and in general, different land uses). What foresters do within the borders of designated carbon farms areas, foresters do additional efforts, additional practices of forest management recommended by numerous of scientists after years of pre-project field research.

Forest Recreational Services before and during the COVID19 pandemic – national analysis based on Yanosik data

Mariusz Ciesielski[1], Kamil Choromański[2], Karolina Taczanowska[3], Dariusz Gotlib[2]

[1]*Department of Geomatics, Forest Research Institute, Sękocin Stary, ul. Braci Leśnej 3, 05-090, Poland*
[2]*Faculty of Geodesy and Cartography, Warsaw University of Technology, Plac Politechniki 1, 00-661 Warsaw, Poland*
[3] *Institute of Landscape Development, Recreation and Conservation Planning, University of Natural Resources and Life Sciences, Gregor-Mendel-Straße 33, 1180, Vienna, Austria*

E-mail: m.ciesielski@ibles.waw.pl

Forest areas provide about 100 different ecosystem services. One of them is the possibility of recreation and rest in forest areas, which belongs to the group of cultural ecosystem services. The demand for this service depends on the location of forests. The increased demand for recreation in forests is especially observed in forest areas in large urban agglomerations. The importance of forest recreation was evident during the COVID -19 pandemic, when numerous restrictions were introduced that changed and disrupted people's habits. The forest and green spaces in general became the only places where people could spend their leisure time during some periods of the pandemic. The short-term ban on access to forests and green spaces introduced in Poland met with strong resistance in society.

Therefore, the following questions arise: 1) Did the pandemic and the restrictions affect the recreational use of forest areas? 2) Has the temporal distribution of activities changed on a daily, weekday, or monthly basis? 3) Did the intensity of forest use change? 4) What was the impact of the pandemic and restrictions on community mobility? 5) Where did visitors to the forest areas live?

We will present the answer to such questions using the processed and fully anonymized Yanosik portal database. This is a database that contains information about GPS routes recorded during travel by car. We compared this information with the location of forest parking across Poland and subjected it to geospatial analysis.

The research presented here is an example of the use of Big Data (over 40 TB dataset) in the analysis of cultural ecosystem services at the national level for 2019 (pre-pandemic year) to 2020 (pandemic year).

Social media-based analysis of cultural ecosystem services and heritage tourism in the Issyk-Kul region (Kyrgyzstan)

Tolgonai Bozzhigit kyzy, Andrzej Kostrzewski, Mikołaj Majewski

Adam Mickiewicz University, Faculty of Geographical and Geological Sciences (WNGiG), Institute of Geoecology and Geoinformation (IGIG), ul. B. Krygowskiego 10, 61-680 Poznan, Poland

E-mail: tolgonai.bozzhigit@amu.edu.pl

The notion of ecosystem services emerged during the latter part of the 20th century, and the adoption of this concept was largely influenced by the Millennium Ecosystem Assessment. Cultural ecosystem services (CES) include non-material values such as recreation, aesthetic enjoyment, education, historical places, religious sites and spiritual fulfilment. The advantages provided by these benefits enhance people's well-being and foster positive attitudes towards protected areas. However, measuring them, especially in large geographic areas, is challenging. One way to assess CES is through community surveys, but these can be expensive, lack uniformity, and have limited geographical coverage. Another option is to use social media data as an alternative to surveys..

The main objective of this study is to identify places where cultural ecosystem services are presented to tourists, and to specify categories of cultural ecosystem services. The first stage involves surveying local residents of the Issyk-Kul region. The aim of the surveys was to identify, with the help of local residents, places where tourists would be able to receive different types of cultural ecosystem services. The results of the surveys indicate some of the most interesting places for tourists according to local residents. In order to compare the results of the surveys, it was decided to analyze videos and photos on social media, where it is possible to get more data and opinions from other people than just local residents. In this study, photos on social media such as Flickr and videos on Youtube were used for analysis. The results of the two different survey methods help determine the categories of cultural ecosystem services and the most interesting places for geotourism in the southern part of the Issyk-Kul region.

The Issyk-Kul region is located in Kyrgyzstan and is one of the seven regions of the country. The southern part of the Issyk-Kul region includes areas south of Lake Issyk-Kul, which is one of the largest mountain lakes in the world. In the southern part of the region are the Tien Shan Mountains, which are part of the Central Asia mountain range. These mountains are a popular destination for tourists who come there for hiking, mountain biking and climbing. There are also many hot springs and resorts in the southern part of the Issyk-Kul region,. Issyk-Kul Oblast is a region that is known for its diverse ecosystems and cultural heritage. The region provides a range of abiotic cultural ecosystem services (ACES) which are crucial for the well-being of local communities and the sustainable development of the area.

The results of the research will be used to determine the most attractive places for tourists, also the results of the research will show what cultural services are characteristic of the area of the sourthern part of Lake Issyk-Kul.

Energetic based ecosystem services' valuation of southern Baltic Sea coastal lakes

Mikołaj Matela, Krystian Obolewski

Department of Hydrobiology, Kazimierz Wielki University, 10 Powstańców Wielkopolskich Av., Bydgoszcz, Poland

E-mail: matela@ukw.edu.pl

Baltic coastal lakes (BCLs) provide important ecosystem services (ES) to local communities. Coastal lakes are among the particularly valuable habitats included in the Natura 2000 Directive. These shallow, polymictic, eutrophic lakes are subject to high human-impact due to agriculture, tourism and recreation. In addition, ongoing climate change is likely to have significant adverse impacts on these less resilient lake ecosystems. In order to be able to develop an effective management plan (which would result in improving the ecological status of the lakes, as well as sustaining or improving the flow of services provided), it is necessary to assess the ES for BCLs and identify the factors shaping their flow. So far, no comprehensive assessment of the ES provided by the coastal lakes of the southern Baltic Sea has been developed. This thesis undertakes to fill this research gap using the emergy accounting method. The study focused on nine coastal lakes (Resko, Łebsko, Ptasi Raj, Liwia Łuża, Kopań, Gardno, Wicko, Dołgie, Sarbsko) classified into three types (brackish, transitional and freshwater) depending on hydrological connectivity with the sea. The results developed will allow for a better understanding of the ES provided by BCLs and the determinant of their flow related to lake type, catchment land cover type, ecological status. The results obtained will allow better monitoring of changes in the flow of the services provided in the future, as well as enabling improved decision-making by policymakers related to environmental management.

Grant support: 008/RID/2018/19/Minister of Education and Science under the name "Regional Initiative of Excellence" in 2019 – 2022.

The urban ecosystem and human well-being in cities

Katarzyna Pukowiec-Kurda

Department of Natural Sciences, University of Silecia, Będzińska Street 60, Sosnowiec, Poland

E-mail: katarzyna.pukowiec@us.edu.pl

Urban greenspaces perform many functions: ecological, tourist, aesthetic or health (Rahmonov et al., 2020). In the modern world, based on consumption, the health function is the most important (Jay & Schraml, 2009). In addition, with the current high degree of urbanization, which is by United Nation more than 50% worldwide, urban greenspaces as substitutes for nature in the city are important elements of the urban structure. For city dwellers, they are places to meet, relax, escape from the heat, a place for sports, tranquility, walking. In addition, they regulate temperature, purificate air or raise humidity (Egerer et al., 2021; Nitschke et al., 2017). Thus, they provide basic ecosystem services to city residents (Foley et al., 2005).

Ecosystem services in cities have been extensively studied, however, works on the abundance of ecosystem services in cities are rare. Therefore, the purpose of this work is to develop a new methodology, to assess the intensity of ecosystem services in cities. The work proposes a new index that can be used in sustainable city planning. The method is based on several steps: identification of urban greenspaces, identification of ecosystem services according to the CICES classification (MEA, 2005), assessment of the intensity of ecosystem services and mapping of the intensity. The final result of the work is a map of the intensity of ecosystem services in cities.

Studies have shown that urban parks provide more ecosystem services in cities than forests. The results indicate that the ideal situation in a city is the presence of different types of ecosystems, because only they guarantee the provision of all sections of ecosystem services. Cultural section are the most represented in the city and are provided by artificially created urban parks (Pukowiec-Kurda, 2022). The proposed indicator can be used in the city's spatial planning and improved in the future with additional research aspects.

References

[1] O. Rahmonov, K. Pukowiec-Kurda, J. Banaszek, K. Brom, *Environmental Protection and Natural Resources* **2020**, *30*, 8-17.
[2] M. Jay, U. Schraml, *Urban Forestry and Urban Greening* **2009**, *8*, 283-294.
[3] M. Egerer, D. Haase, T. McRhearson, N. Frantzeskaki, E. Andersson, H. Nagendra, A. Ossola, *Urban Sustainability* **2021**, *1*, 22.
[4] C.R. Nitschke, S. Nichols, K. Allen, C. Dobbs, S.J. Livesley, P.J. Baker, Y. Lynch, *Landscape and Urban Planning* **2017**, *167*, 275-287.
[5] J.A. Foley, R. DeFries, G.P. Asner, C. Barford, G. Bonan, S.R. Carpenter, F.S. Chapin, M.T. Coe, G.C. Daily, H.K. Gibbs, J.H. Helkowski, T. Holloway, *Science* **2005**, *309*, 570-574.
[6] MEA (Millennium Ecosystem Assessment), *Ecosystems and Human Well-being: Synthesis*. Island Press, Washington, DC, 2005.
[7] K. Pukowiec-Kurda, *Ecological Indicators* **2022**, *144*, 109532

Integrated coefficient of ecosystem services of urban vegetation

Eva Pauditšová[1], Zita Izakovičová[2], Tamara Reháčková[3]

[1]*Institute of Management, Slovak University of Technology, Bratislava, Slovakia*
[2]*Institute of Landscape Ecology, Slovak Academy os Sciences, Bratislava, Slovakia*
[3]*ATR s.r.o., Bratislava, Slovakia*

E-mail: eva.pauditsova@stuba.sk

Urban vegetation represents an essential role in the health and comfort of the urban environment. The quality of urban vegetation is the key indicator for assessment of the benefits of ecosystem services. In planning processes the greenery coefficient is used by default as one of the important regulatory tools. The preferred parameters for calculating the greenery coefficient is the area, type and quality of greenery. On the other hand, current planning process needs new, integrated approach to calculate of coefficient of greenery. The contribution is focused on the calculation of the integrated coefficient of greenery which represents the needs of fulfilling ecosystem services and includes current requirements for the functions of greenery in the residential environment. The integrated coefficient includes ecological, environmental, social and climatic (adaptation) ecosystem benefits. The integrated coefficient is verified in an urban environment, in Bratislava (Slovakia). The output of the study is the proposal of a scale of values of the integrated coefficient of greenery for individual types of green areas in settlements and the method of using the given coefficient in planning and decision-making processes.

Assessment of the potential of selected landscapes of Poland to provide landscape services

Monika Lebiedzińska, Marta Sylla, Iga Kołodyńska, Piotr Krajewski, Marek Furmankiewicz

Institute of Spatial Management, Wroclaw University of Environmental and Life Sciences, Grunwaldzka 55, 50-357 Wroclaw, Poland;

E-mail: marta.sylla@upwr.edu.pl

While the term ecosystem services has gained considerable attention in the scientific forum, the landscape services seem to be less investigated. We identified three different approaches in the scientific literature to defining landscape services and we applied the landscape service classification by Vallés-Planells, Galiana, & Van Eetvelde, 2014. We surveyed 38 Polish landscape researchers about their expert scoring of the potential of selected 16 landscape types (according to national landscape typology) to offer services of : (1) providing space for daily activities such as living, working and commuting, (2) regulating the spatial structure by landscape's diversity and compositional richness of the natural and/or cultural elements as well as buffering disturbing use, (3) improving physical and mental health, (4) , providing (passive and active) enjoyment of observing nature and/or active outdoor leisure activities, (5) providing opportunities for personal fulfilment such as improving knowledge, spiritual fulfilment, inspiration for art and culture, (6) providing opportunities for social fulfilment while social gatherings, community integration, providing place identity, sense of belonging. The results of the expert-based assessment of the potential of the landscape services. Combined with the ecosystem service matrix, the landscape service potential metrics provide a supporting tool for the landscape decision making process. The landscape service potential assessment could be used as a basis for further service use analyses.

References

[1] Vallés-Planells, M., Galiana, F., & Van Eetvelde, V. (2014). A classification of landscape services to support local landscape planning. *Ecology and Society*, *19*(1). https://doi.org/10.5751/ES-06251-190144

Relationship between forest ecosystem services and social preferences for willingness to pay by young people in selected European cities

Beata Fornal-Pieniak[1], Agnieszka Mandziuk[2], Dagmara Stangierska[3], Katarzyna Widera[4] Maria Bihunova[5], Pedro Miguel Ramos Arsenio[6], Emila Janeczko[7]

[1]*Department of Environmental Protection and Dendrology, Institute of Horticultural Sciences, Warsaw Uni-versity of Life Sciences-SGGW, Nowoursynowska St., 166, 02-787 Warsaw, Poland*
[2]*Department of Forest Management Planning, Dendrometry and Forest Economics, Institute of Forest Science, Warsaw University of Live Sciences-SGGW, Nowoursynowska St., 166, 02-787 Warsaw, Poland*
[3]*Department of Pomology and Horticulture Economics, Institute of Horticultural Sciences, Warsaw Uni-versity of Life Sciences-SGGW, Nowoursynowska St., 166, 02-787 Warsaw, Poland*
[4]*Department of Economics, Finance, Regional and International Research, Faculty of Economics and Management, Opole University of Technology, Prószkowska 76, 45-758 Opole, Poland*
[5]*Institute of Landscape Architecture, Slovak University of Agriculture, Tulipánová 7 949 01 Nitra Slovakia*
[6]*LEAF—Linking Landscape, Environment, Agriculture and Food Research Center, Associated LaboratoryTERRA, Instituto Superior de Agronomia, Universidade de Lisboa, Tapada da Ajuda, 1349-017 Lisboa, Portugal*
[7]*Department of Forest Utilization, Institute of Forest Sciences, Warsaw University of Life Sciences—SGGW, Nowoursynowska 159, 02-776 Warsaw, Poland*

E-mail: beata_fornal_pieniak@sggw.edu.pl

At the beginning of the 21st century, some studies focused on the social function of the forests (which includes recreational activities, nature tourism activities and source for health and well-being) later the term ecosystem services arise, where is presented social preferences to WTP by the people [1, 2]. The purpose of the study was to determine the determinants influencing the propensity for types of forest ecosystem financing as a derivative of the preference local forests depending on their benefits and services (biodiversity, climate regulation, soil conservation, water regulation, social and economic benefits, visual (aesthetic) values) and the country of residence of the respondents. Study objects were represented by four types of forest ecosystem: single-stratum, single species forest (monoculture) without shrub layer with poor undergrowth, single-stratum, multi-species forest without shrub layer with quite well development of undergrowth, multi-stratum, multispecies forest with shrub layer and rich undergrowth, multi-stratum, multi-species forest with rich shrub layer and rich undergrowth as well as recreational infrastructure. A survey was carried out to determine public preferences for recreation in local forest complexes around three major European cities, Lisbon (Portugal), Warsaw (Poland) and Nitra (Slovakia). Social preferences concerned the willingness to pay (WTP) for the maintenance and protection of the forest areas, depending on their appearance and degree of development. Data were processed using statistical analysis (Friedman's ANOVA and logistic regression). The research results indicate that there is a relationship between the level of preference for the different types of forest ecosystem and the respondents' readiness to finance them hypothetically. Depending on the country, the tendency to protect urban forests results from different motives. In the case of Portugal, the WTP was more influenced by the fact that these areas exist and respondents can visit them at any time, while in Poland and Slovakia WTP is mostly driven by the appearance of the forest related to the range of ecosystem services. These forests have also a cultural heritage value for tourists, which should be protected and preserved for future generations.

References

[1] L. Tyrväinen, H. Väänänen. The Economic Value of Urban Forest Amenities: An Application of the Contingent Valuation Method. Landsc. Urban Plan. **1998**, 43, 105–118, doi:10.1016/s0169-2046(98)00103-0.
[2] T. Zhang, W. Zhang, W. H. Meng, Z. Zhang.. Analyzing Visitors' Preferences and Evaluation of Satisfaction Based on Different Attributes, with Forest Trails in the Akasawa National Recreational Forest, Central Japan. Forests **2019**, 10, 431, doi:10.3390/f10050431.

Microplastics in lakes and their effect on pelagic ecosystem

Magdalena Bowszys

Department Tourism, Recreation and Ecology, University of Warmia and Mazury, Oczapowskiego 5, Olsztyn, Poland

E-mail: mbowszys@uwm.edu.pl

Microplastics are widely distributed in aquatic environments. Contamination in freshwater ecosystems is a new and growing problem. Lakes are particularly vulnerable to contamination because of their close proximity to emission sources. The aim of the study is to review the current state of knowledge on microplastic pollution in lake waters and to indicate their potential effect on ecosystem. All the major physical zones of lakes and their associated fauna can be exposed to microplastics. The results present the fate of microplastics in the water column and the influence they have on biota and lake food webs. In lake pelagic zones, they can be ingested intentionally or accidentally by primary consumers or secondary consumers and transferred via the food web to higher trophic levels. Therefore microplastics can pose potential threats to wide range of species inhabiting lakes, and finally to humans. Microplastics may also be regarded as a factor destabilizing ecosystem services.

Evaluating the Role of Urban Green Spaces in Enhancing Air Quality: A Comparative Study in Poland

Adrian Hoppa[1], Piotr Sikorski[1], Daria Sikorska[1], Piotr. Archiciński[1], Arkadiusz Przybysz[2], Marta Melon[1]

[1]*Institute of Environmental Engineering, Warsaw University of Life Sciences - SGGW, Nowoursynowska 159 Str., 02-787 Warsaw, Poland*
[2]*Institute of Horticultural Sciences, Warsaw University of Life Sciences - SGGW, Nowoursynowska 159 Str., 02-787 Warsaw, Poland*

E-mail: adrian_hoppa@sggw.edu.pl

The escalating problem of air pollution, predominantly aggravated by industrialization and population growth, is a global concern with significant ramifications for human health and the broader ecosystem. This is particularly pronounced in Poland, where tackling air pollution poses a unique challenge. Our study embraces the Ecosystem Services (ES) framework by examining the role of urban vegetation, specifically trees, in mitigating this critical issue.

Our research pivots on the premise that trees, as essential components of urban ecosystems, provide valuable services, one of which is air purification. In particular, we focus on their ability to intercept and sequester particulate matter ($PM_{2.5}$ and PM_{10}), regarded as key contributors to air pollution-related health risks. We conducted field research in two distinct Polish urban ecosystems - Warsaw and Łódź, assessing their effectiveness in air quality regulation along daily commuting routes to schools. For both cities, we measured PM concentrations and the Leaf Area Index (LAI), a proxy for tree coverage, along selected pathways. This approach allowed us to explore the correlation between tree coverage and PM concentrations, reflecting the air-purifying ES provided by urban trees.

Our preliminary findings present a nuanced picture. In Warsaw, we observed localized PM accumulation at the boundaries of tree-covered areas, with slight decreases in zones exhibiting high LAI values, suggesting a marginal, statistically insignificant role of trees in winter air purification. Conversely, our research in Łódź, a post-industrial city, conducted during the summer, revealed a somewhat positive correlation between tree coverage and lower suspended dust concentrations.

Our study underscores the variable and complex nature of the ecosystem services rendered by urban trees, pointing towards the need for further research. Understanding these dynamics can contribute to more effective planning and management of urban green spaces, ultimately leveraging their potential in mitigating air pollution, and promoting human and ecological health.

Regulating Ecosystem Services: The Role Of Urban Forests In The Removal Of Particulate Matter In The Bydgoszcz-Toruń Area (Poland)

Fabiana Figurati[1], Lorenza Nardella[1], Umberto Grande[1,2], Dariusz Kamiński[2], Elvira Buonocore[1], Agnieszka Piernik[2], Pier Paolo Franzese[1]

[1]*International PhD Programme / UNESCO Chair "Environment, Resources and Sustainable Development", Department of Science and Technology, Parthenope University of Naples, Centro Direzionale Isola C4 (80143), Naples, Italy*
[2]*Department of Geobotany and Landscape Planning, Nicolaus Copernicus University, ul. Lwowska 1, 87-100, Toruń, Poland*

E-mail: fabiana.figurati001@studenti.uniparthenope.it

Air quality amelioration represents one of the biggest challenges that the European Union is facing nowadays, and Particulate Matter (PM) specifically is regarded as one of the most hazardous pollutants, especially in urban areas. Through the provision of different ecosystem services, Urban Green Infrastructures (UGIs) are capable of improving air quality in cities. In particular, urban vegetation contributes to the abatement of PM_{10} concentrations via deposition mechanisms involving the leaf surface. In the present study, we aimed to assess and map the ecosystem service of PM_{10} removal generated by the urban forests of the Bydgoszcz-Toruń area (Poland). The assessment was performed in both biophysical and monetary terms. The role of the functional diversity of the vegetation was also explored. A spatially explicit modelling approach integrating high-resolution, remotely-sensed Leaf Area Index (LAI), Green Cover, and PM_{10} concentrations was used.

Pollution maps were generated performing spatial interpolation. All elaborations and modelling steps were performed on a seasonal basis in a GIS environment. Finally, maps of mean seasonal removal efficiency (kg/ha) and total removal (Mg) were generated. The monetary valuation of the PM_{10} removal ecosystem service was then performed using the externality value of PM_{10} pollution as estimated by the EEA for EU countries.

While in spring and summer the deciduous broadleaves showed a higher removal efficiency, the total removal was higher for the conifers due to a larger land cover and their ability to remove PM_{10} throughout the year.

In conclusion, this work highlights that the biophysical and economic assessment of ecosystem services can help policymakers in developing urban planning strategies aimed at ensuring the implementation of UGI in urban contexts.

Understanding Urban Residents' Interaction with Nature: A Comprehensive Study in Warsaw

Marta Melon[1], Piotr Sikorski[1], Piotr Archiciński[1], Edyta Łaszkiewicz[2], Adrian Hoppa[1], Daria Sikorska[1]

[1]*Institute of Environmental Engineering, Warsaw University of Life Sciences – SGGW, Nowoursynowska 159, 02-776 Warsaw, Poland*
[2]*University of Lodz, Social-Ecological, Systems Analysis Lab, Faculty of Economics and Sociology, Rewolucji 1905 r. 39, 90-214 Łódź, Poland*

E-mail: marta_melon@sggw.edu.pl

Urban landscapes are often interspersed with green spaces which play a pivotal role in contributing to the overall well-being of residents. As such, these areas warrant careful consideration in urban planning and design initiatives. However, the criteria guiding selection of these areas for nature-based recreation remain underexplored. This study aims to shed light on this topic, by investigating the urbanites' engagement with nature within Warsaw city.

We conducted an exhaustive study, scrutinizing various objective indicators of naturalness, including the presence of rare plant species, lichens, amphibians, and birds, to assess their impact on the selection of green spaces. Our aim was not only to ascertain the factors influencing the choice of these locations but also to identify the preferred type of green space for fostering contact with nature.

Our results demonstrated a limited correlation between the perceived naturalness of an area and its actual naturalness. Interestingly, we found that urban residents predominantly engage with nature in under-resourced parks, challenging the conventional belief that richer natural areas provide superior opportunities for recreation. This observation calls for a fresh perspective in urban planning, recognizing the untapped potential of these under-resourced green spaces.

These findings provide critical insights for future urban planning strategies, advocating for the conservation and development of diverse green spaces that cater to the specific preferences and needs of urban residents. The study underscores the importance of embracing a nuanced understanding of nature engagement in urban spaces, with an aim to promote public health and improve the quality of urban life.

First Inquiry Into Cultural Ecosystem Services of UNESCO Karst Biosphere Reserve, Slovenia

Nina Lončarević, Martin Senič, Oddgeir Andersen[2], Stine Rybråten[2] , Renata Rozman[3], Martina Lužnik[1]

[1]*Department for biodiversity, University of Primorska, Glagoljaška 8, 6000 Koper, Slovenia*
[2]*Norwegian institute for nature research, Vormstuvegen 40, 2624 Lillehammer, Norway*
[3]*Park Škocjan Caves, Slovenia, Škocjan 2, 6215 Divača, Slovenia*

E-mail: nina.loncarevic@famnit.upr.si

Cultural ecosystem services (CES) are defined as "The nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences" by the Millennium ecosystem assessment. Literature agrees on the importance of assessing CES, parallel to provisioning and regulatory ecosystem services, to fully capture the benefits and values humans obtain from nature. However, research shows CES are largely neglected, particularly intangible ones. Some reasons are difficulty to assess them quantitatively and evaluate monetarily. This implies they are rarely embraced by managers of natural and urban areas, forsaking inclusion of people, their sense of place, spiritual connection, cultural heritage values etc., tied to the area. Our research takes place in UNESCO Karst Biosphere Reserve, Slovenia, and encompasses four municipalities, Divača, within which is Škocjan Caves Regional Park, Pivka, Hrpelje-Kozina and Ilirska Bistrica. CES were assessed in Škocjan Caves Regional Park as having the highest value, compared to provisioning and regulatory ecosystem services [1]. Within this study, we focus on the whole Biosphere Reserve area, and with the aim to enhance its participatory management plan, we included assessment of intangible cultural ecosystem services. We used the method of narrative analysis and conducted thirty in-depth interviews. The interviews were of approximately one-to-one-and-a-half-hour duration, and were divided into sections: spatial, place/heritage, identity, work/activities, spiritual, artistic, inter-generational, educational, non-market values and threats. We constructed the interview guide relying on the framework provided by Gould et al. [2], adjusting the questions to the local cultural context. The interviews were conducted with local inhabitants of the Biosphere reserve, whose work, free time, or both were tied to nature. We determined the sample using stratified quota sampling, relying on an extensive stakeholder list previously prepared. Interviews are still ongoing, and we are expecting early results in July.

References

[1] Actum, d.o.o., *World Wide Fund for Nature*, 2011
[2] R. K. Gould, S. C. Klain, N. M. Ardoin, T. Satterfield, U. Woodside, N. Hannahs, … & K. M. Chan, *Conservation Biology*, 2015, 29(2), 575-586.

Angler In Urban Space – Opportunities And Threats To The Quality Of Ecosystem Services

Emil Andrzej Karpiński

Department of Tourism, Recreation and Ecology, University of Warmia and Mazury in Olsztyn, Oczapowskiego St. 5, 10-719 Olsztyn, Poland

E-Mail: emil.karpinski@uwm.edu.pl

Due to increasing urbanization, the quality of ecosystem services provided in cities is an important issue for the future. Recreational fishing is one of the most popular forms of outdoor recreation worldwide and a major ecosystem service provided by freshwater ecosystems. Urban expansion and socio-economic changes drive anglers to pursue their hobby within urban areas more frequently. Therefore, it is worth finding out how they potentially affect the environment.

In a survey study among 570 anglers, conducted in 2021, participants were asked whether their most frequented fishing spot was in urban areas. It has become dividing line between urban and rural anglers.

Urban anglers were a minority of the surveyed population (25.8%). They were younger, had lower earnings and were more likely to be from urban areas compared to the general population. In terms of involvement in fishing, they were less experienced but more avid. On the other hand, their expenditures were significantly lower than rural anglers. Their preferred means of transportation were more diverse and environmentally friendly (more walking, biking and commuter transportation). The distances traveled to the most frequently visited fishing grounds were also significantly lower than for rural anglers. In contrast, they did not differ in term of releasing or keeping the fish they caught. They were also more likely to be isolated when fishing and were less likely to choose to fish in the company of friends or family.

Urban anglers, due to their characteristics, can potentially generate more pressure on resources and a smaller source of offseting income. On the other hand, their means of transportation and lower mobility indicate lower expenditures and less pollution, which, however, could be nullified by their high level of activity. This one, in turn, suggests that they have potential as observers and trendsetters of environmental change.

Blue-green City Design – How to Fit Cultural and Regulating Ecosystem Services Into Small Urban Lot

Renata Włodarczyk-Marciniak[1], Kinga Krauze[1], Agnieszka Bednarek[1,2], Małgorzata Łapińska[1,2], Aleksandra Trzcińska[3]

[1]*European Regional Centre for Ecohydrology of the Polish Academy of Sciences, 3 Tylna Str., 90-364 Łódź, Poland*
[1,2]*UNESCO Chair on Ecohydrology and Applied Ecology, University of Lodz, Faculty of Biology and Environmental Protection, 12/16 Banacha Str., 90-237 Łódź, Poland*
[3]*Łódź City Office, Bureau of Revitalisation and Housing, 171 Piotrkowska, 90-477 Łódź, Poland*

E-mail: r.wlodarczyk@erce.unesco.lodz.pl

Densely built-up city centres, are particularly vulnerable to climate change and require adaptation and mitigation measures, important not only for the functioning of the environment but also for the health of residents. Properly planned and integrated into the urban fabric, multifunctional blue-green infrastructure (BGI) can reduce negative effects of urbanization, while achieving numerous social and environmental benefits.

One of the main objectives of the euPOLIS project (Integrated NBS Urban Planning Methodology for Enhancing the Health and Well-Being of Citizens: The euPOLIS Approach, H2020) is to co-design spaces with different stakeholders in a participatory model and introduce Nature based Solutions (NbS) that respond to the region's challenges. One of the cities where the project's activities are concentrated is Łódź - post-industrial city in Poland, suffering the environmental, social and economic problems. The demo site comprises a small, narrow square in the city centre that could be an enclave for local residents and biodiversity, but is currently a pedestrianized space, not conducive to spending extended periods of time or communing with nature.

To transform this space into one that is more conducive to local residents, we applied a number of methods prior to design. We focused on gaining knowledge from residents about the square could look like based on their behaviour and surveys and workshops results. But we also assessed conditions based on data and our own observations for the main issues of public health and well-being, environment, urban development, social and economic conditions. The main outcome of the work is to show the process of shaping space with different stakeholders and to identify solutions acceptable to residents, policy makers, researchers and planners that support both regulating and cultural services.

Ecosystem services in urban space on the example of Olsztyn lakes

Andrzej Skrzypczak, Klaudia Jastrzębska, Karol Korsheinrich

Institute of Engineering and Environmental Protection, Faculty of Geoengineering, University of Warmia & Mazury in Olsztyn, Oczapowskiego 5 St., 10-719 Olsztyn, Poland

E-mail: sandacz@uwm.edu.pl

Ecosystem services are one of the factors forming the tourism potential and attractiveness of the Warmia and Mazury region. They determine human well-being and are a connecting link between the tangible and intangible values of nature and their subjective multidimensional perception by users of geographic space. Aquatic ecosystem services in urbanized space are of particular importance. Within the administrative boundaries of the city of Olsztyn there are eleven lakes with an area of more than 5 hectares. Their total area exceeds 720 ha. The purpose of the present study was to identify the needs of Olsztyn residents relating to the ecosystem services of Olsztyn lakes in cultural, social and natural aspects. The subject of the study was also the degree of satisfaction and expectations related to the possibility of fulfillment of these needs. The survey was conducted in the fall of 2022 using a diagnostic survey method. A Web-Assisted Interviews (WAI) survey questionnaire with a semantic five-point Likert scale was used. On the basis of 124 questionnaires, the variation of respondents' needs and satisfaction levels were analyzed taking into account the gender factor and the frequency of use of ecosystem services. The most expected ecosystem benefits of a universal nature turned out to be aesthetic and scenic values, i.e. the beauty of wildlife, natural landscapes, the presence of forests in the surroundings, the presence of diverse flora and fauna, as well as silence and lack of noise. At the same time, the lakes with the most developed recreational infrastructure were the most popular.

Cultural ecosystem services of biosphere reserve on the example from Slovakia

Jana Špulerová[1], Veronika Piscová

[1]*Institue of Landscape Ecology, Slovak Academy of Sciences, Stefanikova 3, Bratislava 81499, Slovakia*
[2]*Institue of Landscape Ecology, Slovak Academy of Sciences, Branch Nitra, Akad 2, Nitra 94901, Slovakia*

E-mail: jana.spulerova@savba.sk

Biosphere reserves are designated areas that aim to conserve biodiversity, promote sustainable development, facilitate scientific research and education and support adaptation to climate changes. In Slovakia, there are currently four biosphere reserves: Polana, Slovak Karst, Tatra, and East Carpathians. The purpose of this contribution is to highlight the significance of biosphere reserves in Slovakia for provision of cultural ecosystem services including research and education goals. The poster presents results of the review summarizing the current state of knowledge of biosphere reserves (BRs) in Slovakia and assessment of research activities undertaken there and how they contribute to the mission and fulfillment of the goals of the designation process to the World Network of BRs. The 121 studies were characterized by research subject, BR function examined, and contribution to the development of which particular aspect of BR. Most of the studies focused on biodiversity protection, management of BR, land use changes, and scenario modeling. The strengths of BR in Slovakia are a long history and continuity of research, close cooperation with some scientists and institutions, case studies of BR included in international projects, existing examples of participatory studies, and a wide range of research topics. An important contribution to research is that provided by existing long-term monitoring sites.

The concept of Bioshere reserve with the various zones, offer outstanding opportunities for creating learning locations and learning landscapes for learning sustainability and for the introduction of new learning methods for many groups of players every day. Learning for sustainability presupposes that in future the employees in the biosphere reserves will see their job as including making the biosphere reserve into a ”learning landscape“, developing new learning methods and designing learning processes. As educational places, not only schools, kindergartens or specially established educational facilities are suitable, but also the territory of the biosphere reserve itself. The term ”learning sustainability“ also makes it clear that new forms, learning locations and fields of action are required. Partial results presents the promotion of education in the Tatra Biosphere Reserve as a basis for a sustainable society and the diffusion of principles of sustainable development into all forms of education (formal, non formal and informal) and in all educational systems.

This research was supported by Project APVV-20-0108 Implementation of Agenda 2030 through biosphere reserves.

PARALLEL SESSION 7

ECOSYSTEM SERVICES IN URBAN AREAS

MApping and Forecasting Ecosystem Services in URban areas in Lithuania (MAFESUR)

Paulo Pereira, Katažyna Bogdzevič, Manob Das, Miguel Inacio

Environmental Management Laboratory, Mykolas Romeris University, Vilnius, Lithuania

E-mail: pereiraub@gmail.com

Urbanization is a global phenomenon that negatively impacts ecosystems and services. Land use and climate change are among the drivers of change in urban areas. Land use change imposes different environmental pressures such as water and soil pollution, imperviousness, erosion, greenhouse gas emission and biodiversity loss. Climate change is responsible for the increased frequency of extreme temperature and rainfall episodes, responsible for heat waves and flooding episodes. Cities are highly vulnerable to extreme events because of urban fabric characteristics (e.g., soil sealing, dark materials, concrete, compacted areas, and lack of green spaces). All these aspects (e.g., land use changes and the impact of extreme events) have detrimental impacts on Ecosystem Services (ES), especially in a global environmental context. Therefore, it is vital to assess the impacts of future land and climate change impacts on urban areas. MApping and Forecasting Ecosystem Services in URban (MAFESUR) aims to map and assess this in the functional areas of tree most important urban areas in Lithuania, Vilnius (4246.61 km^2), Kaunas (1620.671 km^2) and Klaipeda (88.60 km^2). Three different land-used scenarios will be assessed. Business as usual, urbanization and sustainable urban development adapted to the municipal scale and considering the specificities of each city (e.g., national and municipal plans). Dinamica EGO 7.0 will be used to project future land use changes under different climate scenarios. After developing the land use scenarios, 2 regulating and 2 provisioning ES for 2050 will be forecasted. In this presentation, we will show the first results of this project.

Acknowledgements: The work is supported by the project MApping and Forecasting Ecosystem Services in URban areas (MAFESUR), funded by the Lithuanian Research Council (Contract: Nr. P-MIP-23-426)

Local climate regulation in cities as ecosystem service: Proposal of an indicator for Germany as part of the national ecosystem accounting

Ralf-Uwe Syrbe[1], Sophie Meier[1], Michelle Moyzes[2], Karsten Grunewald[1]

[1]*Research Area Landscape, Ecosystems and Biodiversity, Leibniz Institute of Ecological Urban and Regional Development, Weberplatz 1, D-01217 Dresden, Germany*
[2]*Stab, Energiedienst Holding AG, Schönenbergerstr. 10, D-79618 Rheinfelden, Germany*

E-mail: r.syrbe@ioer.de

In densely built-up cities quarters, urban green spaces provide an important contribution to maintaining urban quality of life and human health. Phenomena such as heat stress can be reduced as means of local climatic balancing. In order to make the according ecosystem service climate regulation of urban green infrastructure measurable and thus specifically controllable, a country-wide applicable indicator has been developed.

For the indicator "urban climate regulation", both the supply of climate regulating services by urban green spaces and the demand for them by the residents are recorded. Based on regularly available nationwide geo-data, a specific cooling capacity value is determined for the most important urban surface types, using tree canopy and land cover, and taking into account area sizes and location characteristics.

Overall, 76% of the population in the 165 German cities studied can benefit from high or very high cooling capacities in their close living environment. In 37 cities, even more than 85% are provided with good or very good cooling capacity by green infrastructure. The proposed indicator enables a comparison between the cooling capacity of individual land types, city districts as well as entire urban areas and can consequently be a professional planning and decision-making basis for resilient urban development. The planning of nature-based solutions is favored because win-win situations can be identified as well as efficient measures in terms of the number of people affected.

The Leibniz Institute of Ecological Urban and Regional Development (IOER) is providing geo-data and contributing them to a national research data platform (NFDI) in which spatial data and assessment information on land use, land cover, landscape quality, and ecosystems are provided and monitored. For this purpose, ecosystems with their extent, characteristics, and services are assessed quantitatively and cartographically. The contributions are presented here using the example of urban climate regulation service.

The impact of urban green infrastructure on the thermal conditions. Case study of the northern Wielkopolska (Poland)

Piotr Lupa

[1]*Department of Integrated Geography, Faculty of Human Geography and Planning, Adam Mickiewicz University, Poznań, Krygowskiego 10, 61-680 Poznań, Poland*

E-mail: piotr.lupa@amu.edu.pl

Urban Green Infrastructure (UGI) provides multiple regulating ecosystem services. Its significant influence on the air temperature distribution in the city and the water cycle regulation is essential for adapting cities to climate change and ensuring a high quality of life for residents.

The study aims to quantify the GI role in temperature regulation in the 31 cities and towns in the northern part of the Wielkopolska Region, Poland. At the same time, an attempt was made to evaluate the urban climate policies by analyzing the UGI-related contents in environmental protection programs and low-carbon economy plans.

Using the Landsat 8 multispectral satellite image and GIS processing, NDVI (normalized difference vegetation index) and surface temperature within selected cities and their buffer zones were quantified. Obtained results were used to indirectly assess the role of UGI in regulating the air temperature, considered an ecosystem service. The results obtained were compared to the provisions of the mentioned municipal documents.

The research confirmed the significant and spatially diversified influence of GI on the reduction of surface temperature in cities. Under the same atmospheric conditions, the differences in the mean temperature between cities with different GI shares exceeded even 5 °C. However, such a crucial role of GI needs to be more stressed in the climate policies of cities, where investments in grey infrastructure are much more common, and the links between grey, blue, and green infrastructure are often ignored.

Influence Of Peri-Urban Green Spaces On The Local Thermal Environment: A Case From An Urban Agglomeration (India)

Manob Das[1,2], Arijit Das[1], Miguel Inácio[2], Paulo Pereira[2]

[1]*Department of Geography; University of Gour Banga; Malda, West Bengal, India.*
[2]*Environmental Management Laboratory; Mykolas Romeris University; Vilnius, Lithuania*

Email: dasmanon631@gmail.com

Cities are experiencing several issues related to urban heat island(UHI) effect and heat waves. The green spaces significantly mitigate UHI effect and enhance urban resilience to climate change. This study aims to assess the influence of peri-urban green space on the local thermal environment in English Bazar Urban Agglomeration (EBUA), Eastern India. The thermal performance of a peri-urban green space was assessed by field observations and its impact on the cooling effect. The field observations were carried out across a transect route with a clear sky on five summer days. The results showed that the green space area was significantly cooler than the surrounding area at different hours. The temperature from the boundary increases with increasing distance, gradually showing that green space has a strong cooling effect on the surrounding environment. The temperature from the green space to the outside increased by about 0.30˚C per meter. The landscape features (e.g., vegetation cover, impervious surface) had an important impact on the thermal environment, i.e. temperature decreases with increasing vegetation cover and increases with increasing impervious surfaces. The study findings can benefit thermal environmental management through green space planning and design to maximize the ecological benefits in urban areas.

Ecosystem services on a neighborhood scale, the Malmö, Sweden showcase

Agata Cieszewska[1], Renata Giedych[1], Gabriela Maksymiuk[1], Piotr Wałdykowski[1], Adamczyk-Jabłońska Joanna[1], Kuchcik Magdalena[2], Pusłowska-Tyszewska Dorota[3], Klimaszewski Krzysztof[4],

[1]*Department of Landsvape Architecture, Warsaw University of Life Sciences, Nowoursynowska 166, 02-787 Warsaw, Poland*
[2]*Institute of Geography and Spatial Organization, Polish Academy of Sciences, Twarda 51/5, 00-818 Warsaw, Poland*
[3]*Faculty of Building Services, Hydro and Environmental Engineering, Warsaw University of Technology, Nowowiejska 20, 00-653 Warsaw, Poland*
[4]*Faculty of Animal Science, Warsaw University of Life Sciences, Nowoursynowska 166, 02-787 Warsaw, Poland*

E-mail: agata_cieszewska@sggw.edu.pl

Ecosystem services (ES) are standardized in the list included in CICES, a narrower group are those implemented in cities, while very rarely are urban ecosystem services identified at the local scale like neighborhoods. The CoAdapt project's research analyzed ecosystem services occurring in housing estates already well adapted to climate change in Malmö. Two of Malmö's neighborhoods were considered for ES analyses: the newly designed Vastrahammen and the old Augustenborg estate retrofitted with NbS - in the residential and public parts (the school and its immediate neighborhood). Field observations using a unified form were carried out by a group of scientists representing various disciplines, including natural aspects (climatologist, hydrologist, environmental planner) and spatial ones (urban planner, landscape architect). The ES list was compiled on the basis of literature research supplemented by a workshop method conducted among the survey participants. As a result of the analysis, among the 35 ES analyzed, as many as 23 occurred frequently (indicated 8 to 10 times) in the settlement, and a bit less in the school areas (18 ES). Only less than 5, and in the settlements even less than 3 ES were not indicated at all in the field observations, indicating a fairly good selection of ES specific to the neighborhood areas. Among the ESs least frequently identified were: protection of the gene pool, fire protection, and providing spiritual (and symbolic) experiences, and in the case of school areas also energy supply (e.g. biomass, wind, solar and water energy) and wild plants used for nutrition. Analysis of the indications of specialists shows a fairly high degree of agreement in identifying the ES. The biggest differences are indicated by the assessments of a hydrologist and an urbanist, with greater differences noted in the schoolyard areas than in the settlement areas.

Relationships between natural and built green space features and the provision of cultural ecosystem services in two German cities

Christin Busch[1], Kathrin Specht[1], Luis Inostroza[2,3], Harald Zepp[4]

[1]*ILS Research gGmbH, Brüderweg 22–24, 44135 Dortmund, Germany*
[2]*Mendel University in Brno, Faculty of Regional Development and International Studies, Zemědělská 1665/1 Brno, 613 00, Czech Republic*
[3]*Universidad Autónoma de Chile, 641 Pedro De Valdivia, Santiago, Región Metropolitana, 7750000, Chile*
[4]*Institute of Geography, The Ruhr-University Bochum, Universitätsstraße 150, 44801 Bochum, Germany*

E-mail: christin.busch@ils-forschung.de

Against the background of increasing urbanization processes, careful management of the provision of cultural ecosystem services (CES) through urban green spaces (UGS) is a key aspect of sustainable urban planning. However, the perception of UGS and thus the provision of CES depend heavily on socio-cultural preferences. These preferences are crucial for making the benefits of UGS perceptible for the urban population. An important aspect of CES in the urban context is that the predominantly human-made, built environment in cities makes the true contribution of the natural environment to the well-being of people in these areas elusive, prompting careful consideration of preferences for UGS features as sources for CES supply. A full understanding of the co-production of CES and the interactions between built and natural capital that encourages people to visit UGS is still lacking.

Therefore, the aim of this study was to investigate the relationships between the provision of CES and features of UGS, both natural and built. Based on 15,452 Google Maps reviews, the textual proximity relationships of mentions of CES preferences (based on the CICES classification) and UGS features were examined for a total of 362 UGS in the cities of Bochum and Gelsenkirchen (Germany). The relationships and bundles were assessed using multidimensional scaling and displayed through a network visualization method.

The results showed strong relationships between CICES classes active or immersive interactions (CICES 3.1.1.1), passive or observing interactions (CICES 3.1.1.2) and aesthetic experiences (CICES 3.1.2.4) with each other as well as with the natural and built features of UGS. The classes culture or heritage (CICES 3.1.2.3) and education and training (CICES 3.1.2.2) were also very close to each other and formed a common cluster. The results provided important insights into the design of UGS and the associated provision of CES.

Assessment of the efficiency of ecosystem functions of the landscape on the example of the town of Černovice, Czech Republic

Ondřej Cudlín[1], Jan Purkyt[1], Vilém Pechanec[2], Radka A. Dante[1,3], Jan Brožek[3], Lenka Štěrbová[1], Marcela Prokopová[1], Renata Včeláková[1], Jiří Jakubínský[1], Pavel Cudlín[1]

[1]*Global Change Research Institute of the Czech Academy of Sciences, Lipová 9, CZ-370 05 České Budějovice, Czech Republic*
[2]*Department of Geoinformatics, Faculty of Science, Palacký University Olomouc, 17. listopadu 50, CZ-771 46 Olomouc, Czech Republic*
[3]*Department of Applied Ecology, Faculty of Agriculture and Technology, University of South Bohemia in České Budějovice, Studentská 1668, CZ-370 05 České Budějovice, Czech Republic*

E-mail: cudlin.o@czechglobe.cz

In Central Europe, increasing anthropogenic pressures, i.e. population density, intensification of agriculture, urban sprawl or depletion of soil fertility, combined with climate change, are the main causes of land degradation and decreasing in ecological stability of the landscape. The main objective of our contribution is to determine the impact of these factors on the biodiversity and ecosystem functioning, especially on primary production, evapotranspiration, water and nutrient retention in the study area. We mapped natural and non-natural habitats, determined the risk of loss of habitat naturalness and identified land degradation, including assessment of water quality and performance level of selected ecosystem functions.

As a basis for evaluating the ecosystem function performance, habitat mapping was conducted using the Habitat Valuation Method (HVM), classifying habitats according to their plant composition and naturalness and assessing their habitat provision value based on expert valuation of eight ecological criteria.

The risk of biodiversity and habitat loss was determined using the CZ-GLOBIO model. The model was modified using the MSA index based on habitat naturalness according to the HVM method. The Environmentally Sensitive Area Index (ESAI), based on a combination of drivers of man-made pressure and unfavorable natural conditions (climate quality, soil quality and vegetation quality), was used to determine the extent of land degradation in the studied area. Long-term monitoring of selected surface water quality parameters was conducted to identify the main causes of water resources degradation. The result is an assessment of the efficiency, risk and potential of ecosystem functions, expressed by changes in annual average biophysical values, demonstrated by the example of Černovice town. This methodological approach can be immediately applied in various environmental studies for any administrative or natural unit, after providing spatial data with corresponding information accuracy for any location in the Czech Republic.

PARALLEL SESSION 8

ECOSYSTEM SERVICES IN MANAGEMENT PRACTICE

Understanding ecosystem services in agroecosystems (AES) – critical assessment of data availability and usability for land-use decisions in Poland

Robert Borek[1], Paweł Radzikowski[2], Bożena Smreczak[3], Anna Jędrejek[1], Małgorzata Kozak[1]

[1]*Department of Bioeconomy and Systems Analysis, Institute of Soil Science and Plant Cultivation-State Research Institute (IUNG-PIB), 24-100 Puławy, Poland;*
[2]*Department of Systems and Economics of Crop Production, Institute of Soil Science and Plant Cultivation-State Research Institute (IUNG-PIB), 24-100 Puławy, Poland;*
[3]*Department of Soil Science Erosion and Land Conservation, Institute of Soil Science and Plant Cultivation-State Research Institute (IUNG-PIB), 24-100 Puławy, Poland;*

E-mail: rborek@iung.pulawy.pl

Understanding of ecosystem services (ES) and benefits resulting from them is relatively poor in Polish society. Agricultural ecosystems is special case, oriented into production intensification but at the same time yield stability is at stake due to increased use of soil resources and climate change. We have identified ES provided by agroecosystems of Poland and proposed 118 indicators to enable assessment of individual services values. Next, we assessed the data availability for individual indicators and performed analysis of their usefulness for decision-makers and practitioners. Finally, we identified synergies and tradeoffs between them and proposed potential use of available information for sustainable multifunctional planning of agricultural areas in Poland. Because complex and resource-intense nature of social-ecological system prevent practical use of ES in policy, we propose better tailoring ES assessments to problems at the very beginning of the assessment process based on designing problem-oriented ES assessments, which focus on the information demand by decision makers.

Ecosystem Services Linked to Sustainable Forest Management (SFM) of Temperate Oak Forests

Ignacio J. Diaz-Maroto

Department of Agroforestry Engineering, University of Santiago de Compostela, Campus Terra s/n, E-27002 Lugo, Spain

E-mail: ignacio.diazmaroto@usc.es

The deciduous forest is found in the mid-latitude regions of both hemispheres. The climate is peculiar because there is a winter season and rainfall for almost year-round. The vegetation is composed primarily of broad-leaved trees that shed all their leaves in winter. In the current state of climate change, the resilience of these ecosystems is facilitating their expansion due to the gradual increase in temperature and the precipitation maintenance. However, there are important nuances, such as the decrease in snow precipitation and the shorter duration of the cold season. Oak trees are the main species of many of these forests playing an important role for biodiversity conservation and people livelihoods, as well as to maintain ecosystem services. Nevertheless, oak forests are under pressure from global warming, land-use change, fragmentation, pests and diseases, and progressive replacement by more shade tolerant tree species. Despite widespread anthropological activity, still oak maturate forests can be found in different regions of Europe, Asia, and America. Significant changes have taken place in them over the past 150 to 200 years as industrialized countries have shifted from an economy based on firewood and charcoal to fossil fuels. And more disturbance is likely to occur in temperate forests, as agriculture and nature conservation policies provide different incentives for land-use change. Our research aims to assess the ecosystem services regarding forest management applied, both past and present, always looking for sustainable rural development. In this context, forest management sustainability depends on the maintenance of traditional activities: extensive agropastoral exploitation and rational management of forests. To guarantee the sustainability of these activities, measures such as shelterwood –mature trees left standing to provide shelter in which saplings can grow–, and prescribed burning to create open habitats, improvement of forest access, increment of public awareness, and environmental actions need to be adopted.

Challenging the dominant view on forest ecosystem services? Citizen forest management initiatives in Poland

Krzysztof Niedziałkowski

Institute of Philosophy and Sociology, Polish Academy of Sciences, Nowy Świat 72, 00-330 Warszawa, Poland

E-mail: kniedzialkowski@ifispan.edu.pl

Forest governance in Poland is characterised by the dominance of public forest ownership and hierarchical, top-down policy-making focused on provisioning ecosystem services. These governance arrangements, characteristic of post-socialist countries, have traditionally been challenged by environmental NGOs, advocating stronger protection of old-growths. Recently, institutional stability of the forest policy field has been increasingly influenced by numerous citizen initiatives responding to technocratic local forest management decisions. These civic initiatives, so far not analysed scientifically, vary in terms of the issues addressed, actions employed, and the local actors involved. In the paper we use a data base of 274 such initiatives to explore their manifestation, actors involved, main postulates, and the responses of forest managers. Based on this, using a combination of quantitative and qualitative methods, we explored whether these initiatives pose challenges to the traditional forest management and, if so, what kind. We imply that the growth of bottom-up initiatives indicates a growing diversity of beliefs and values regarding forests and the increasing determination of local people to impact local environmental decisions, despite limited participation options. Furthermore, informed by the institutional theory, we argue that the growth of local initiatives, particularly during and after Covid-19 pandemics, suggests the eroding legitimacy of dominant rules and discourses. This process is particularly visible in sub-urban forests, which are increasingly seen by urban populations as providing mainly non-provisioning services: recreation areas where timber harvesting should be stopped. We also identify a networking trend among the initiatives that unifies their discursive background, enhances their influence, and creates an additional political pressure at the national level. Recognising this, public forest management administration has undertaken mitigation measures. Consequently, the new initiatives have already influenced forest governance in Poland to some extent, although their impact is still to be assessed based on how new institutions will be implemented.

Ecosystem services and public involvement in urban development planning of Slovak cities

Peter Moravík, Peter Mederly, Simeon Vaňo

Department of Ecology and Environmental Science, Constantine the Philosopher University in Nitra, Tr. A. Hlinku 1, 94901, Nitra, Slovakia

E-mail: peter.moravik@ukf.sk

The urban environment is currently exposed to several challenges associated with accelerating urbanization trends, global climate change, and other environmental and socio-economic factors [1]. However, the prevailing practices of planning, management and utilisation of the landscape still need to respond to these challenges adequately - for instance, current spatial planning approaches mainly emphasize social and economic needs and contexts [2]. A promising approach to overcome the mentioned challenges may be incorporating ecosystem (landscape) services and citizen participation procedures into spatial planning processes. In the Slovak Republic, favourable conditions for such a process have been built over the previous three decades [3], however inappropriate changes in legislation currently threaten them.

With an emphasis on the direct or indirect use of ecosystem (landscape) services and participatory planning techniques, the given contribution attempts to present an overview of spatial planning approaches in the context of Slovak cities. The study's findings are based on a thorough investigation of a variety of information sources, including official municipal information, documents on urban and strategic planning, and national legislation, as well as their subsequent analysis and interpretation. The result is an assessment of the situation as it stands in Slovakia and a comparison with that in other countries e.g. [4,5], which should serve as the foundation for creating an appropriate procedure for integrating the idea of ecosystem services and citizen participation processes into spatial planning procedures.

References

[1] Z. Izakovičová, P. Mederly, F. Petrovič: Long-Term Land Use Changes Driven by Urbanisation and Their Environmental Effects (Example of Trnava City, Slovakia). *Sustainability*. **2017**, *volume 9*, issue 9: 1553.

[2] S. Vaňo, A. Stahl Olafsson, P. Mederly: Advancing urban green infrastructure through participatory integrated planning: A case from Slovakia. *Urban Forestry and Urban Greening*. **2021**, *volume 58:* 126957.

[3] P. Bezák, P. Mederly, Z. Izakovičová, J. Špulerová, Ch. Schleyer: Divergence and conflicts in landscape planning across spatial scales in Slovakia: opportunity for an ecosystem services-based approach? *International Journal of Biodiversity Science, Ecosystem Services & Management*. **2017,** *volume 13*, issue 2: 119-135.

[4] J. Schneider, H. Kubíčková: The state of the art of use of the concept of ecosystem services within spatial plans in the Czech Republic. *Sustainability.* **2020**, *volume 12*, issue 21, 9000.

[5] K. Grunewald, O. Bastian, J. Louda et al.: Lessons learned from implementing the ecosystem services concept in urban planning. *Ecosystem Services*, **2021**, *volume 49*, 101273.

The Influence of Local Decision Makers' Perception of ES Provided by Community Gardens on Their Attitudes towards Community Gardening

Lenka Dubová, Jan Macháč, Marek Hekrle

Institute for Economic and Environmental Policy, Faculty of Social and Economic Studies, J.E. Purkyne University in Usti nad Labem, Pasteurova 3544/1, 400 96, Usti nad Labem, Czech Republic

E-mail: dubova@ieep.cz

Community gardens (CGs), as a type of urban agriculture and urban greenery, have a potential to provide urban dwellers and city representatives with a wide range of ecosystem services (ES) that support ecosystem, human health and local communities. In the Czechia and other Central European countries, the majority of CGs are created through a bottom-up process. Nevertheless, local decision makers or spatial planners can influence the development of CG in their area. Thus, in this contribution the overall research question is: How the local decision makers' perception of ES provided by CGs influence their attitudes towards community gardening in Czech cities? The main method of data collection was a semi-structured interview. Analysis of the transcribed interviews involved open coding and subsequent interpretation and conceptualisation.

The results show that among the most frequently mentioned benefits of CGs by Czech city representatives are cultural ES in the form of social benefits. Production ES in the form of crop cultivation is perceived by the representatives as a means of providing the social benefits mentioned above. The results of the analysis suggest that representatives who perceive only a small range of ES provided are also less willing to actively support the creation of CGs. By contrast, in the majority of cases where the city is aware of the wide range of ES provided, it is already actively supporting CGs or looking for ways to support them. The low importance and in some cases scepticism of the production function is reflected across all types of cities. This may also be due to comparisons with allotment gardens, which are historically very widespread in the country. Thus, the results suggest that it is appropriate to use examples of good practice to promote the establishment of CG in cities and to proclaim the wide range of benefits that CGs in the form of ES provide.

Model Proposal for Planning and Management of Ecosystem Services at Urban-Rural Interface: Eyupsultan Green Transformation Guide

Serim Dinc[1], Inci Olgun[2], Kumru Cilgin[2]

[1]*Department of Urban and Regional Planning, Istanbul Technical University, Taskisla, 34437, Istanbul, Turkey*
[2]*Department of Urban and Regional Planning, Mimar Sinan Fine Arts University, Findikli, 34427, Istanbul, Turkey*

E-mail: srmdinc@gmail.com

Urban ecosystem services (UESs) rarely compete with more profitable land uses due to the pressure of urbanization. However, the climate crisis has demonstrated the critical role of ESs for cities and communities. Design and planning decisions that will preserve/rehabilitate UESs must focus on adaptive spatial strategies for sustainable resilient cities. At this point, it shouldn't be forgotten that UESs are related to interactions between societies. Accordingly, site-specific approaches should be carefully considered for a model that will evaluate the harmony of urban/rural space. In this study, Eyupsultan, which is one of the transition regions between the rural and urban areas of Istanbul, is the case study. Although Eyupsultan is distinguished on a metropolitan scale with its ESs diversity, these areas are under threat from mining activities and large urban projects. In particular, the loss of provisioning services such as food, and climate regulating services such as forest, watershed and urban green areas raises concerns for the future of 20million-populated-Istanbul. The aim of the study is to develop a spatial model for the management of ESs in Eyupsultan. The study consists of 4 steps:(1) Spatial analyses to understand the local identity; (2)Tracing the change in natural and rural areas with land use analyses of 1992, 2005, 2020; (3)Identification of character areas for natural areas based on analyses; (4)"Eyupsultan Green Transformation Guide", which includes strategies and actions specific to character areas. GIS was used as a tool. ESs components have been considered on the maps as units that are both ecologically prominent and should be prioritized for management. The method and findings of this study constitute a first example for the districts of Istanbul with similar rural identity and rural-urban transition characteristics. It also provides a unique tool for the practical use of the concept of UESs in the spatial planning system.

Ecosystem services in restoration priority assessment for planning and management of postmining land

Katarzyna Fagiewicz

Department of Integrated Geography Adam Mickiewicz University, Krygowskiego 10, 61-680 Poznań, Poland

E-mail: kfag@amu.edu.pl

Awareness of the need for environmental repair is growing, resulting in a global escalation of ecological restoration and related efforts. The United Nations has established 2021-2030 as the Decade of Ecosystem Restoration. Convention on Biological Diversity (2016) calls for the "restoration of degraded natural and semi-natural ecosystems, as a contribution to reversing the loss of biodiversity, recovering connectivity, improving ecosystem resilience, enhancing the provision of ecosystem services, mitigating and adapting to the effects of climate change.

A particular challenge for restoration activity is post-mining areas that require the reconstruction of degraded ecosystems. The main principle is to plan ecosystem restoration in such a way as to enable future land use following local needs and expectations[1]. The ES approach was conceived to communicate and facilitate understanding of the human-environment relationship [2] raising awareness of humans' benefits from ecosystems. In the context of post-mining areas, it is worth using ES for greater involvement of stakeholders in discussions on the restoration and use of post-mining land. This makes it possible to move from the general goal of reclamation of post-mining areas to focusing reclamation on strengthening or restoring ecosystem services lost due to exploitation in order to use post-mining areas per the expectations of local communities, administration, or local policy challenges. The presented paper proposes a method of operationalising these assumptions for practice from the perspective of 1. changes in ecosystem services related to the opencast mining of lignite, 2. changes in ecosystem services along with the progress of reclamation works, 3. the use of post-mining ecosystem services as support for local climate policy, The first step is to identify the critical ecosystem services that can be obtained from the reclamation of degraded land. A set of indicators was then proposed for reclamation assessment, planning, and monitoring. It was assumed that the indicators should have a simple and thus friendly mathematical algorithm, not constituting a barrier for the user, and should be based on available data. Such indicators are certainly not sufficient to value benefits. However, they are a valuable tool for informing stakeholders about restoration results and comparing them depending on the adopted scenarios, expectations, or priority challenges. Using the Ecosystem Service approach for assessing the restoration priority of postmining areas supports decision-making and management of restored areas.

References

[1] Sánchez L.E, Silva-Sánchez S.S, Neri A.C.. *Guide for mine closure planning*. Brasília: IBRAM – Brazilian Mining Association, 2014

[2] Fish R, Saratsi E, Reed M, Keune H., *Stakeholder participation in ecosystem service decision-making*, in: *Routledge handbook of ecosystem services*. Routledge, 2016, London; p. 256–270.