



**IALE 2022 European Landscape Ecology Congress**  
MAKING THE FUTURE, LEARNING FROM THE PAST

# **IALE 2022**

## **European Landscape Ecology Congress**

### **Book of Abstracts**

Editors

Jacek Wolski

Edyta Regulska

Andrzej Affek



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# Preface

## Dear Participants,

In July 11-15, 2022, the next European Landscape Ecology Congress will take place. The IALE 2022 Congress is IALE2021+1, originally scheduled in 2021 but postponed due to the COVID-19 pandemic. The IALE Congresses always have been opportunities to meet, discuss and interact with the wide and diverse field of landscape ecologists of all ages and research interests. But the Congresses are also moments to meet your colleagues, to become part of the landscape ecology community. Therefore, we wanted to organise a physical Congress, where we have opportunities to meet in real life with each other and the landscapes. When it looked as though there was a chance to meet safely, war broke out at our borders. The war that shocks the world and with each passing day increases the unimaginable suffering of Ukrainians and the destruction of their homeland. Considering the dangers of the Russian invasion, the uncertainty of tomorrow and the obvious need to help millions of refugees arriving in Poland, we regretfully decided to change the format of the Congress to an online meeting. Although we are aware that some advantages of face-to-face meetings cannot be fully maintained, we have done our best to make the online Congress interesting, interactive and valuable for everyone.

IALE 2022 European Landscape Ecology Congress aims to highlight landscape ecology as the transdisciplinary platform linking past, present and future. This approach is especially needed now when the world is facing global challenges such as climate crisis, biodiversity loss, environmental pollution, mass migration and urbanization. A holistic, landscape approach to the complex cultural-environmental systems – which is the essence of landscape ecology – provides the perfect framework for combining transdisciplinary tools and perspectives to better understand the diverse phenomena and processes around us and to predict and properly manage them. That is why we want to learn from past experience and knowledge to take responsibility for shaping sustainable landscapes and societies of the future.

We welcome both researchers and practitioners from all landscape-related disciplines, including environmental and social perspectives, to share their experience and interact within the broad, international community of all those interested in landscape related issues. We believe that landscape ecology – as the study of multifaceted interactions in geographical space – has the potential to integrate not only natural sciences and humanities but also researchers and policy-makers, which is the key to implement the Congress theme into practice.

Therefore, we invited three amazing speakers of different background and approaches to landscape who will share their insights from three different perspectives: landscape ecology, landscape planning and landscape architecture: **Andrzej Richling, Anna M. Hersperger, and Richard Weller.**

The general Congress theme – **making the future, learning from the past** – will be discussed through the four interconnected thematic groups covering the whole range of issues relevant for landscape ecology:

### **Past**

...Heritage, Reconstructing, Understanding, Drivers and actors of change, Transformations, Nature restoration, Mapping, Paleoecology, History, Memories, Legacies, Identity, Connectivity...

### **Learning**

...Communication/transferring knowledge, Coproduction of knowledge, Multi-/inter-/trans-disciplinarity, Dialogue, Education and awareness, Going to dialogue with landscape, Perception, Learning by doing, Monitoring, Multi-perspectivism, Evaluation of policies/measures...

## Future

...Modelling and scenarios, Transitions, Facing/meeting challenges, Aspirations, Expectations, Technology/new tools, Virtual, Artificial intelligence/big data, Social media, Landscape genetics, Solutions, Novel (eco)systems, Innovation, Regeneration, Sustainability, Resilience, Security, Measuring landscape...

## Making

...Practice, Policy, Design, Identity, Place making, Governance, Management (natural/heritage), Co-benefits, Stewardship, Protection, Conservation, Ecosystem services, Impact assessment, Impact and effect, Conflict solving, Mitigation, Well-being, Valuation, Implementation...

At IALE 2022, 28 symposia will be organised in six parallel sessions. We welcomed proposals from people with a background in science, policy and practice as well as from different landscape related disciplines in natural and social sciences. Symposia are organised in 10 thematic groups combining complementary symposia:

1. Learning from people
2. Learning from nature
3. Learning from data
4. Learning from past landscapes
5. Planning future landscapes
6. Policy making for European landscapes
7. Agricultural and productive landscapes
8. Urban and peri-urban landscapes
9. Regions in the spotlight
10. Education in landscape ecology

Next to the parallel sessions, Virtual Poster Gallery with more than 50 poster presentations accessible throughout the Congress will be an important way to present research.

The organisation of IALE 2022 will not be possible without the involvement and hard work of many people. We are very grateful to the 23 members of the Scientific Committee who helped us define the thematic scope of the Congress actively participated in the review of symposia proposals and made every effort to ensure that the topics of the symposia cover all aspects important for landscape ecology. We are also very grateful to almost 100 symposia organisers who submitted their proposals, reviewed more than 400 abstracts and prepared the timeline of their symposia.

Finally, we would like to thank all members of the local Organizing Committee and volunteers who spent many hours with us here in Warsaw, first preparing for the physical event in 2021, then for the physical event in 2022 (e.g., venue, excursions, registration, website, Book of Abstracts), and recently adapting everything in a rush into an online event (e.g. Whova web platform and video excursions). All this would not be possible without their hard work and full commitment over the past 3 years. We hope you will be satisfied with the end result and enjoy the Congress. Have a great week!



Andrzej Affek  
Congress Coordinator



Edyta Regulska  
Congress Secretary

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## Keynotes

### LANDSCAPE ECOLOGY IN POLAND – DEVELOPMENT AND PERSPECTIVES

Andrzej Richling

Polish Association for Landscape Ecology / University of Warsaw

The term landscape in its present meaning has been used in Poland since the second half of the 19th century, but the real blossoming of the landscape-orientated approach occurred only after the Second World War and was related to the development of applied natural research in the context of urban and spatial planning needs.

Poland actively participated in most events related to the development of landscape ecology. Polish representatives were present in the Slovakian town of Piešťany, where in 1982 the International Association of Landscape Ecology (IALE) was founded. In 1994, the first Polish landscape-ecology textbook was published. In 1988, the Landscape Ecology Club has been established in Poland within the framework of the Polish Geographical Society, and since 1993 the Polish Association for Landscape Ecology exists.

Fifty science conferences were held in Poland on the initiative of the aforementioned organisations. Seven of those conferences were of international character, and the debates were held in English. Of key importance were also their publishing activities. Since 1996, the publications have appeared as the “Problems of Landscape Ecology” series. In 2008, this series was transformed into a scientific journal. As of now, 53 issues were published, 27 of which were published after the series became a journal, and 8 issues were published in English. The Polish Association for Landscape Ecology organised 9 competitions for a master’s thesis in the field of landscape ecology, which were met with vivid interest.

In the past, landscape studies were much more laborious and usually concerned small fragments of the area. This situation changed with the spread of aerial and satellite imagery and the introduction of computer data processing. This technological revolution allowed the research to take into consideration large amount of data and create studies covering vast territories. It also enabled rapid development of dynamic approaches and it facilitated improvements in precision and reliability of research while simultaneously making it faster and easier.



## VISIONING OUR FUTURE LANDSCAPE: TRANSLATING SPATIAL PLANNING INTO SCENARIOMODELLING

Anna M. Hersperger

Swiss Federal Institute for Forest, Snow and Landscape Research

Strategic planning is widely regarded as an important policy measure to shape the future of our landscapes through integrated, collaborative practice at the regional level. Plans are crucial tools in this endeavor. Strategic spatial plans typically contain visions, strategies and policies related to the built environment, including transport, and to (semi) natural green areas, and contain a combination of development strategies and projects, with projects often providing the link to plan implementation. With regard to the green elements landscape ecology as an interdisciplinary science has great potential to inform strategic spatial planning. Landscape ecology concepts such as green infrastructures, multifunctionality, and landscape and ecosystem services play a key role here, as many of these concepts have an inherent spatial character. Whether in the form of texts or visualizations, these concepts present complex ideas and provide much needed vagueness. In doing so, they offer a way to safeguard against unwanted commitments in the context of great uncertainty and tension. However, for the implementation of plans, but also for scenario planning, which is becoming increasingly important, this vagueness poses a challenge. This talk presents recent research on landscape ecological concepts in planning and illustrates how vague planning intentions can be translated into scenario-based simulations.



## DESIGNING SYMBIOSIS

Richard Weller

McHarg Center for Urbanism and Ecology, University of Pennsylvania

This lecture argues that urbanization and conservation can no longer be conceptualized as diametrically opposed. Instead, in the context of the Anthropocene, urban development and the conservation landscape must become more symbiotic. This can only be achieved through intelligent design and planning. This argument will be made with reference to urban design case studies with an emphasis on rapidly growing cities in the world's biodiversity hotspots. Then, zooming out from an urban design scale, Weller will also present his concept of a World Park, a global initiative conceived to improve landscape connectivity and biological representation in the world's biodiversity hotspots.



# 1. Learning from people

## *Assessing intangible landscape values for landscape planning and design*

### **Symposium organisers**

*Irena Niedźwiecka-Filipiak* (Wrocław University of Environmental and Life Sciences), *Elżbieta Raszeja* (University of the Arts in Poznań), *Krzysztof Młynarczyk* (University of Warmia and Mazury in Olsztyn), *Maciej Kłopotowski* (Białystok University of Technology), *Agnieszka Ozimek* (Cracow University of Technology)

### **Summary**

One of the important objectives of landscape research is to observe phenomena and trends occurring in the landscape. These observations are the basis for its proper planning, design and management, as well as shaping landscape policies. The methods, tools, as well as assessment approaches depend on scientific disciplines that deal with these issues. It is still a somewhat underestimated, or simply challenging to assess, problem to combine land use and land cover measurements with human-scale view investigations, and to create coherent systems for assessing intangible landscape elements. This also raises the question of how to assess intangible, non-measurable landscape characteristics, including landscape views, in order to contribute to landscape planning and design adequately.

### **Description**

In landscape research, it is necessary to assess all the spatial components, including spatial and intangible characteristics, of landscapes. Different scientific disciplines create their specific methods, tools and measurement systems to measure and evaluate the landscape. This makes it possible to make founded decisions concerning landscape planning and design. The challenge here lies in measuring and assessing its intangible, non-measurable characteristics.

In landscape research, the landscape and its characteristics are measured in two main ways. The first concerns 'land use and land cover' measurements, where remote sensing and GIS software are of great importance. Landscape analysis and assessment take place in this respect on maps, in the quantitative, sometimes qualitative context concerning connectivity, continuity, and multifunctionality of e.g. greenery elements in the landscape. In the second trend, the research is carried out from a human perspective and belongs to the group of 'human-scale' studies, and photographs, films, visibility maps and graphs are used to measure and evaluate the landscape. The technological development has contributed to an increase in quantitative research, while qualitative research is most often based on various types of surveys conducted in different groups of respondents. The quantitative analysis also evolved thanks to the development of digital algorithms, including artificial intelligence, attempts are made to analyse photographic images automatically.

These two approaches to landscape assessments are important, also for the and planning and design of landscapes, including its assessment and effective placemaking. However, it is a challenge to define how to incorporate the visual and intangible values into landscape planning and design. The challenge lays in the fact that the conclusions of the analyses carried out, and perhaps above all the assessments carried out in the third dimension, can give an opportunity to protect the already existing valuable landscapes properly, but also to create new, valuable ones. Therefore, these assessments should be rather uniform, legible, giving the possibility of comparison and evaluation.

The following questions arise in this context:

- Is it possible to measure, evaluate, value landscape views, and if so in which way?
- How to create measuring systems for the evaluation of intangible landscape values?
- How to combine 'human-scale' measurements with 'land use and land cover' analyses?
- Which methods of measuring views can be used to make decisions with regard to new investments?
- How can the results of landscape measurements and assessments of intangible values be communicated so that its value is appreciated by non-professionals?
- How do historical aesthetic assessments of a landscape affect contemporary landscape design?
- What is the relationship between landscape value measurements and the creative intuition of a landscape architect?
- How to measure non-measurable landscape elements?
- How to assess the creation of new landscapes?

## UNDERSTANDING CHANGING LANDSCAPES: THE INTANGIBLE SIDE OF RURAL GENTRIFICATION ON A SWEDISH ISLAND

Hanna Elisabet Åberg

University of Bologna

**A**long the same lines of urban gentrification studies, research on rural gentrification has often focused on socio-economic aspects such as investment in capital, residential mobility, social upgrading, and displacement of people. Rapid socio-economic development does arguably affect its tangible surroundings, and this is not a negative shift per se, however, if not steered properly these processes result in changes to the locale's physical appearance and landscape. With a broader perspective comes a need to extend the focus beyond built environment and social shifts and to include the impacts on the landscape, both prior to and following settlement of gentrifiers. This paper aims to understand how changes in the landscape are perceived by inhabitants living in rural areas recognized for undergoing rapid development and being exposed to high flows of seasonal in-migration.

The findings and analysis presented in this paper are part of a larger research project on the island of Gotland, Sweden, which is assessing the processes of in-migration and landscape change within the local community. By looking at three areas, that are already recognised by public authorities as particularly exposed to a high rate of second-home ownership, increasing housing prices, and an evident increase of population age, a pattern to understand the motivations to move to and stay in these areas was explored. The findings presented are derived from three datasets, the first from a traditional data analysis based on traditional data sources such as census data and real estate prices that were collected for the entire island. The other two datasets are based on perception data gathered through one survey and workshops that were undertaken during 2021. The workshops were done while walking, asking participants to collect items they associated with the landscape and their relation to the place.

In this present study, the correlation between the socio-economic change in the specific areas was discussed in relation to the perception and aesthetic values of the landscape. The findings were varied depending on the site, where participants expressed different key values and aspirations of future landscape development. This local engagement can establish a foundation of awareness regarding future landscape development in the community, taking local perception into account in planning, managing, and monitoring the landscape.

## CULTURAL ECOSYSTEM SERVICES IN DETERMINING VALUABLE BIOCULTURAL LANDSCAPES

Zuzana Baránková · Jana Špulerová

Institute of Landscape Ecology, Slovak Academy of Sciences

The concept of biocultural diversity has been recognized to identify and study the cultural and ecological interconnection between humans and their environment. The growing interest of researchers in this topic has resulted in widely-based biocultural concept. Cultural ecosystem services (CES) can be a useful tool to identify bioculturally valuable landscapes.

Our research was based on a review of scientific articles with focus on biocultural topics, which were published between 1990 and 2021. To identify biocultural landscapes, the CES were divided into two categories to help examine connections between CES and biocultural landscapes.

We have distinguished two types of CES: differentiated CES (cultural heritage, spiritual and religious values, sense of place and traditional knowledge), and additional CES (aesthetic and inspirational perception, recreation and entertainment, ecotourism and educational and scientific). These two types of CES can guide us in identifying following landscape types:

- Natural heritage landscape – landscape with high biodiversity, valuable for recreation and tourism (e.g. national parks). Only additional CES can be identified in these landscapes.
- Biocultural landscape – landscape with low or high biodiversity value and with values of additional CES (e.g. golf courses, park loans).
- Biocultural heritage landscape – landscape with genius loci, or the sense of the past, inextricably connected to habitats with high biodiversity value (historical parks, urban historical gardens, water works, sacred places, traditional agrarian landscapes, etc.). Here at least one type of differentiated CES should be presented.

The term of biocultural diversity has spread beyond the field of ecology, and has also been used in a broader context in the ecological sciences when examining the urban environment. We thus identify bioculturally valuable landscape according to the following criteria: inclusion of at least one of the differentiate type of CES, while at the same time being related to landscape of high biodiversity value.

Biocultural heritage landscapes are rapidly vanishing; therefore there is a need to identify valuable biocultural landscapes across the world, and the CES can be a useful tool in their identification.



## INVESTIGATING THE LEVEL OF ATTACHMENT TO DIFFERENT URBAN PARKS: A CROSS-CULTURAL STUDY

Mahsa Bazarfshan<sup>1</sup> · Felix Kienast<sup>1</sup> · Reto Spielhofer<sup>2</sup> · Ulrike Wissen Hayek<sup>2</sup> · Adrienne Grêt-Regamey<sup>2</sup>

<sup>1</sup>Swiss Federal Institute for Forest, Snow and Landscape Research · <sup>2</sup>ETH Zürich

To improve mobile societies' quality of life and mental well-being, cultural differences in forming bonds with a place must be understood. This understanding involves studying the different attitudes towards public spaces, particularly green spaces, and assessing the meanings of how people perceive the environments. We therefore designed and conducted a controlled virtual reality experiment with people from different cultural backgrounds (Central European, Persian). We measured the Electrodermal activity in participants (n=120) by asking them first to answer a 3-minute stress inducer. Secondly, participants were immersed in the VR experience of two parks (Persian Garden, Historical Park in Switzerland) for 10-minutes, during which we measured skin conductance through Empatica E4 wristband. Participants were assigned to both urban parks and were asked to assess their place attachment at the end of each scene with a questionnaire. Using data from the interview and tonic signals, we compared the effect of urban parks on affection. We found that the degree of expressed place attachment to the different urban parks resulted in a significant impact on physiological responses. This study demonstrates the therapeutic effect of urban parks. It also provides evidence that place attachment is a major driver in how people experience urban green and emphasizes the role of urban green as mediator of culture in multicultural cities.

## HOW MANY VIEWS IN THE LANDSCAPE – A GIS FRAMEWORK FOR LANDSCAPE PARKS VISUAL RESOURCES ASSESSMENT

Szymon Chmielewski<sup>1</sup> · Malwina Michalik-Śnieżek<sup>1</sup> · Agnieszka Kułak<sup>2</sup> · Tadeusz Chmielewski<sup>1</sup>  
· Halina Lipińska<sup>1</sup>

<sup>1</sup>University of Life Sciences in Lublin · <sup>2</sup>Catholic University of Lublin

Landscape ecology deals with the structure, dynamics, functioning, and scaling of landscapes that bridge the gap between science and practice. Due to the multidisciplinary nature of landscape research, multiple methods are being used to characterize and quantify the landscapes; this study focuses on quantification task development. The study aims to set up a GIS-based framework of landscape visual resources quantification and mapping. The GIS visibility analysis is the most appreciated regarding landscape visual resources mapping; it has theoretical and practical explanations. Theoretically, the landscape can be regarded as “areas, as perceived by people” (Council of Europe, 2000). Consequently, this puts a privilege to GIS software because, since the beginning of its development, the viewshed algorithm computes the visible area. Adding a third dimension (3D) to the visibility analysis increases the analytical scope over landscape visual resources at the computing power expense. Nevertheless, the 2.5D approach, including tangential view methods, answers most landscape researchers' questions when working on a landscape protection plan.

The research method results from landscape protection plans practices (Szczebrzeszyński, Kazimierski & Nadwieprzański Landscape Parks in East Poland) that follows the landscape audit guidelines (Solon et al., 2014), and GDOŚ recommendations (Niedźwiecka-Filipiak et al., 2019). The geo-computations framework includes visual exposure index, vantage point location, scenic routes, view depth and skyline analysis, and landscape protection zone delimitation. The method is based on open source GIS software, and obtained results are the object of 2D visualization.

The results point that Szczebrzeszyński Landscape Park has the highest visual exposure index (19.1%), relatively numerous vantage points (45), and scenic routes sections (25 sections, 12.6 km total length). In Kazimierski Landscape Park, the exposure potential is slightly lower (10.2%) due to the significant share of forested areas (37%); it has fewer vantage points (17) but numerous scenic routes sections (27 sections, 26.3 km total length). In comparison, the Nadwieprzański Landscape Park visual resources are the lowest one (visual exposure index is 7.0%).

The abovementioned statistics are the starting point for further analysis of visual resources' spatial structure. The results depend on the GIS model input parameters, specifically, e.g. regarding the length and number of scenic routes. The resources quantification cannot be equated with visual landscape character and quality assessment; however, the GIS framework provides objective results that precisely localize and measure them. Its further development aims to include forest areas viewing exposure into the overall balance of visual resources, which are neglected since classified as covered landscapes.

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## IMPACTS OF WOODLAND PLANTING ON NATURE-BASED RECREATIONAL TOURISM IN UPLAND ENGLAND: A CASE STUDY

Sara Vangerschov Iversen

Aarhus University

Upland landscapes provide important ecosystem services (ES) to society. One cultural ES – nature-based recreational tourism (NBR) – is a growing industry in upland regions that provides an important revenue to areas where other industries are often in decline. NBR tourism is a service that relies partly on the aesthetic appearance of the landscape and changes in land management, such as increasing woodland cover, changes the appearance of the landscape and may therefore have a positive or negative impact on the economic value generated by NBR tourism. This study tested this query, by carrying out a survey of NBR tourists, using photo visualisation of different woodland scenarios, in a pastoral upland landscape in a UK National Park. This was conducted to estimate the economic value of NBR tourism under different woodland scenarios and participant's preferences. The findings presented in this paper suggest that NBR tourism generates a substantial income to the area and that the economic value would not decrease, if woodland cover were to increase up to 75%. The findings also make an important observation on how there is a difference between peoples' preference for woodland levels and the probability of return visits.

## PERCEPTION OF CHANGE IN RURAL LANDSCAPES ON SHAR PLANINA, NORTH MACEDONIA

Daniela Jovanovska<sup>1,2</sup> · Ruth Swetnam<sup>2</sup> · Fiona Tweed<sup>2</sup>

<sup>1</sup>University of Ss. Cyril and Methodius · <sup>2</sup>Staffordshire University

The interaction between humans and nature has nurtured the scenery of our surroundings. The rapid pace of recent land-use change alters this harmonious coexistence and leads to a change in appearance. Because individual preference for landscape aesthetics varies significantly, preservation and management of valued rural landscapes is challenging; especially in the Balkans with its complex environmental history and socio-cultural background. It is therefore vitally important to understand peoples' preferences with regards to landscape appearance.

In the process of assessing landscape visual quality, this research has (1) used GIS to derive a digital Visual Quality Index (VQI) for Shar Planina mountain range (830 km<sup>2</sup>); (2) validate this quantitative assessment with extensive fieldwork, and (3) substantiate the VQI through 230 interviews with Shar Planina residents from key cultural groups (Macedonian and Albanians).

Looking to assess, mitigate and manage the effects of landscape change, this study aims to examine the role of familiarity, functionality and socio-cultural background of local inhabitants in their perceptions and preferences of rural scenery and associated preferences of change.

The results show that local rural residents had higher preferences for presented change scenarios depicting the appearance of landscape scenery under restored traditional management and lower preference for the opposite scenarios depicting abandonment. Perceptions differed depending on the socio-cultural profile of the respondents and were largely influenced by landscape functionality, but also by the 'landscape of reference' and familiarity to the view.

North Macedonia is experiencing significant changes and challenges. With its focus on landscape change, this research addresses the tangible background of peoples' landscape appreciation and will ensure that these important voices are heard in defining management goals for the protection and sustainable development of this region.

## INTEGRATED ANALYSIS OF SOCIAL-ECOLOGICAL FUNCTIONS OF URBAN GREEN SPACES IN TRADITIONAL VILLAGE OF PENGLIPURAN, BALI, INDONESIA

Sadahisa Kato<sup>1</sup> · Kosuke Hishiyama<sup>2</sup> · Anak Agung Ketut Darmadi<sup>3</sup>

<sup>1</sup>Tottori University of Environmental Studies · <sup>2</sup>Senshu University · <sup>3</sup>University of Udayana

**G**reen spaces provide a variety of ecosystem services. However, methods to evaluate both ecological and socioeconomic benefits of urban green spaces in a truly integrated manner are not well established. This study aims to fill in this gap by applying various methods to gain a whole picture of a myriad of benefits provided by traditional green spaces in Bali, Indonesia. Focusing on telajakan, a type of traditional green space, located between the frontal wall of a Balinese housing compound and a ditch/pedestrian path in a roadside, the study utilizes and explores various methods such as telajakan vegetation survey and measurement, household socioeconomic survey, and in-depth homeowner interviews in order to arrive at a more comprehensive conclusion on the changes of telajakan plantings, uses of telajakan space, and socioeconomic drivers that inflict these changes. By conducting telajakan vegetation survey and measurement, and homeowner interviews, we have already found that: (1) diversity of planted species is decreasing but there is room for maintaining functional diversity by planting indigenous species with multiple functions; (2) aesthetic, economic, and religious functions are strongly favored plant functions by homeowners; and (3) semi-public nature of telajakan is being lost but new meaning is given to telajakan's functions and a new form of social interaction is observed in two different villages in northern Denpasar, Bali. In Penglipuran traditional village, we have added household socioeconomic questionnaire to the methods and are currently analyzing the additional data. We hope to find an interaction between the vegetation survey results and the sociocultural and economic data to arrive at a conclusion that will better describe the socioeconomic drivers that affect homeowners' behaviors and the kinds of plants planted in telajakan and the way they manage it. The results of the study will add further insights into the difficult question of conserving local culture and tradition in the rapidly changing social-ecological systems.

## ECO-AESTHETICS, SOCIAL ACCEPTANCE AND ENVIRONMENTAL CONCERNS OF THE CURRENT LANDSCAPE PRACTICES IN GLOBAL SOUTH CITIES

Merham Keleg<sup>1</sup> · Lora Nicolaou<sup>2</sup> · Georgia Butina Watson<sup>3</sup>

<sup>1</sup>Ain Shams University · <sup>2</sup>Frederick University · <sup>3</sup>Oxford Brookes University

A great deal of research is stressing the different values of nature through multiple perspectives, as the world is facing rapid urbanization, with almost 60% of the population expected to be living in urban areas by 2050. This means that more people will be disconnected from nature which puts more emphasis on the importance of nature as an urban amenity as it would be soon the only type of nature that people encounter. The current pandemic has added a new facet of the value of urban nature. The lockdown debates have made it clearer that urban nature in the form of green open spaces and in close proximity to all residents is not a luxury anymore.

Learning about nature-people interactions within cities paves the way for healthier and more socially responsive and eco-friendly cities. Urban nature encounter is already scarce in some contexts, especially in metropolitan and high dense cities, which requires more effort for getting the most out of the provided to attain the diverse values of nature. Additionally the morphology of green spaces within most of the Eastern Mediterranean, despite internationalization and similar development practices, is different than the European cities in numerous ways. So, the Eastern Mediterranean culture and cities' morphologies are not familiar with the green frameworks which characterize most European cities and the long connection to the identity of European cities and communities. As in some cases, only very lately we see the first attempts for the establishment of urban parks which borrow western models without much consideration of local culture and identity, climatic conditions, water shortages, etc., exacerbating the disconnection between nature identity and the local identity of communities with more highlight on western culture aesthetics.

There is also lack of integration of the diverse visions of nature as per the different stakeholders; communities, executive bodies, urban ecologists, landscape architects, etc., and so the green spaces do not reflect the true identity (natural and cultural) of communities and cities.

The presentation will be based on case studies from Cairo, Egypt and Nicosia, Cyprus as cases from the Eastern Mediterranean. The case studies will show the different local communities' perspectives of 'urban nature'.

## APPLICATION OF LANDSCAPE CAPACITY ASSESSMENT TO VERIFY SPATIAL DEVELOPMENT PLANS OF PROTECTED LANDSCAPES

Piotr Krajewski

Wrocław University of Environmental and Life Sciences

The spatial development potential of communities in Poland is determined in a document called a study of conditions and directions of spatial development. Unfortunately, the current legislation does not take into account the need to analyse the changes that will occur in the landscape as a result of the implementation of spatial development plans. No tools are used in this area to objectively identify the most sensitive landscapes that should be protected. Therefore, the main goal of the research was to develop the method for assessing landscape capacity defined as ability of the landscape for absorption of changes in spatial structure without losing its visual quality. This method is based on the assessment of landscape features such as topography, height of buildings and vegetation, composition of buildings and vegetation and visibility from viewpoints and main roads. These are the criteria recognized as the most affective for ability to hide land use changes in the landscape. In this context, a change of land function in a place surrounded by tall buildings and dense greenery will be much less perceptible by residents than a change of land use in an open landscape. Identifying the most and least visually capacious landscapes is important for planning landscape changes during the preparation of spatial planning documents. The application of this method is presented on the example of a case study of one of the villages in the Ślężański Landscape Park located in south-western Poland.

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## GUIDELINES FOR DEVELOPING AN IN-SITU EXPERT VISUAL QUALITY ASSESSMENT ON AGRICULTURAL LANDSCAPES

Ana Medeiros · Cláudia Fernandes · João F. Gonçalves · Paulo Farinha-Marques

University of Porto

Visual landscape assessment is nowadays crucial in landscape planning. However, scenic beauty remains difficult to assess as the wide range and complexity of expert assessment frameworks available can hinder the task. This paper gathers some basic guidelines for the elaboration of a visual quality study carried out by experts and focuses on in situ assessments of agricultural landscapes.

A rapid systematic search of the literature was performed on Scopus and ISI Web of Science, using the snowballing method to search for other pertinent seminal papers on the issue. The search words include visual quality, scenic, beauty and landscape assessment or evaluation. A total of 900 records were retrieved and 354 were considered for further reading after applying exclusion criteria.

It was found that seven main assessment decisions should be considered:

1. what is the goal of the evaluation – the first step in developing a visual assessment is to understand the assessment context: education (inform population), application (planning) or litigation (more interested in the process itself or methodology);
2. who will evaluate – if the assessment context is community planning, broader participation of residents in the dialogue is preferable and the user should be a key actor from the start. If the context is litigation, then it is advisable to use a diverse group of experts;
3. how to select the landscape – the landscape selection depends on the goal, for instance, impact assessment, or designation of protected areas. Several other issues mentioned are related to boundary selection and how to adapt the extent and number of areas to the size of the territory studied;
4. what framework should be adopted – three general approaches are usually considered: expert approach (ecological and formal aesthetics models), psychophysical approach (psychophysical and surrogate component models), and public preference approach (public preference models. The most widely applied practical frameworks for analysing visual qualities by experts are discussed;
5. which criteria and indicators to select – this decision is also crucial and should follow a sequence of filters: have a clear theoretical base, be transferable, quantifiable, mappable, available, and relevant;
6. how to choose the viewpoints and vistas;
7. how to analyse the data – various landscape sampling methods and instructions for taking panoramic photos are presented, as well as the appropriate survey methods.

The evaluation of visual quality is a complex exercise, with many different goals. Despite the diversity of approaches and frameworks for expert visual quality evaluation, this paper summarises the main guidelines to consider when developing a new study on agricultural landscapes. Following clear guidelines can simplify the task of creating visual assessments, empower new researchers into this type of assessments and boost the standardization of knowledge in this scientific area.



## CLASSIFICATION AND ASSESSMENT OF CULTURAL ECOSYSTEM SERVICES DISTRIBUTION CHANNELS (CESDC) FOR LANDSCAPE PLANNING AND TOURISM DEVELOPMENT. CASE STUDY: KAZIMIERZ LANDSCAPE PARK (POLAND)

Malwina Michalik-Śnieżek<sup>1</sup> · Grzegorz Gajek<sup>2</sup> · Barbara Sowińska-Świerkosz<sup>1</sup> · Halina Lipińska<sup>1</sup>

<sup>1</sup>University of Life Sciences in Lublin · <sup>2</sup>Maria Curie-Skłodowska University

Cultural ecosystem services (CES) are non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences. They are of particular importance in relation to areas valuable from the point of view of landscape resources used for tourism promotion. Such areas are landscape parks, which in Poland are promoted by regional governments as places of exceptional natural, cultural and scenic values. The state of landscape resources depends on the will to preserve and protect them, which in turn is often the result of calculating the costs to be incurred and the profits that they can bring. The visualization of potential profits from tourist traffic is particularly important for taking protective measures. These profits may be tangible and intangible, but determining their potential value is possible only by analyzing the distribution channels of CES.

The aim of this study is to identify CESDC, their classification and assessment for the purposes of landscape planning and shaping local tourist traffic, taking into account the principles of sustainable development. For the indication and classification of CESDC, a modified definition of the distribution channel by Stanton (1984) was adopted, understood as “objects, groups of objects or organizational units that participate in the flow of services from the service provider to the service recipient” as well as the CES classification by The Common International Classification of Ecosystem Services (CICES). For each CES class occurring in the research area, the distribution channels for the assigned benefits were determined and classified. Distribution channels were assessed through the prism of the 4P marketing model (product, price, promotion, place) in relation to the type of benefit, willingness to pay, the number and type of promotional activities and the place of obtaining the service.

The test results showed a large variation of the CESDC in the testing area, containing natural and anthropogenic objects as well as human activities. They also demonstrated a high concentration of CESDC in areas of high tourist traffic. The use of well-functioning CESDC models in relation to similar benefits provided in other areas may constitute the basis for landscape planning and protection, taking into account the needs of the development of tourism on the principles of sustainable development.

Stanton W.J. (1984). *Fundamentals of Marketing*. McGraw-Hill Companies.

## COMPREHENSIVE TOOLS FOR URBAN GREEN SPACES ASSESSMENT: A REVIEW OF MEASURING SYSTEMS

Ieva Misiune

Vilnius University

**M**ore than a half of the world's population already lives in urban areas and it is projected that by 2050, it will reach 68%. As the trend continues, sustainable development ever more depends on the successful management of urban territories. Researchers analyze not only the environmental problems caused by urbanization, but also emphasize the so called 'nature deficit' phenomenon, when people are too separated from the natural world and this separation affects human-nature relationships. Urban green spaces (UGS) become highly important and contribute not only to solving environmental problems, but as a source for recreation of urban dwellers. Important question remains how we could develop a UGS that contains both – high ecological value and visit attractiveness? This requires both – assess all the spatial physical components of the UGS and include an intangible, still highly valuable characteristics of urban landscapes.

The main idea of this presentation is to introduce results of a systematic quantitative literature review of a multi-criterial UGS assessment tools and methods. This review will allow to develop a theoretical model for qualitative assessment of public UGS, which would include various indicators allowing to assess tangible and intangible values that UGS provides in urban landscape. On the basis of the literature analysis, groups of key indicators will be identified and the theoretical structure of the assessment model will be developed. Key findings regarding the possible multi-criterial assessment model covering different aspects, including non-measurable landscape elements, will be presented and discussed.

Previous meta-analysis has shown that since 1990, only 15 multidimensional urban green space quality assessment tools have been developed and published in international scientific literature. The tools are very different both in volume and its complexity. The study showed that these tools do not have enough indicators and do not evaluate all properties of the green spaces. Thus, greater comprehensiveness and more inclusive indicators might be critical in assessing UGS and their role for urban landscapes. This discussion could also contribute to a better understanding of how social assessment could be combined with ecological and 'land use and land cover' analyses. Furthermore, a comprehensive tool could become a good support for better planning and management, as well as for better landscape policies.

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## THE ROLE OF LANDSCAPE DISTINGUISHING MARKS AND VISUAL ANALYSES IN THE PLANNING AND DESIGN OF NEW BUILDING INVESTMENTS IN AREAS OF HIGH LANDSCAPE VALUES

Irena Niedźwiecka-Filipiak · Jerzy Potyrała · Paweł Filipiak

Wrocław University of Environmental and Life Sciences

Rural areas account for a considerable part of the world's territory. They are carriers of traditions and regional specificity, which calls for the responsibility of appropriate management of their development with respect to the landscape. Some of the rural areas are protected in order to ensure such measures, but there are also many unprotected sites that have their own landscape values and qualities. For this reason various forms of tourism are developing within them, which in turn leads to the development of the region and gives an opportunity to its inhabitants to generate income, but in many cases it also causes enormous urbanization pressure, sometimes comparable to that occurring around large cities. The question that arises is how to proceed and whether it is possible, when investing in new facilities in areas attractive to tourists, to develop the space in a way that will not degrade its landscape values.

The aim of the research was to determine the procedure/rules of conduct, which would ensure the possibility of introducing a new investment in an area of high landscape attractiveness. The research area was the site associated with a large ski resort Czarna Góra in Poland. The area is located partly within and partly adjacent to the Śnieżnik Landscape Park, and is visited by tourists throughout the year, with particular intensity in winter. The research was conducted in three stages. The first one consisted in defining landscape distinguishing marks of the studied area, as well as attractive view sequences and viewpoints within them. The goal was to determine places for locating potential investments that would not obstruct the view of these features. During the second stage, the forms and volumes of feasible building investments were determined on the basis of architectural features, while the third stage consisted in verifying on the numerical model of the area and on photographs how they are visible from the previously specified viewpoints and sequences.

The procedure/rules of conduct established by the authors proved to be correct. It allowed for taking into account a wide range of landscape distinguishing marks and at the same time it enabled looking at them from the point of view of new investments. Additionally, visual analyses helped to select the location and forms, volume and scale of newly introduced objects. The presented method can be replicated in any area characterized by high landscape values.

## LANDSCAPE DESIGN OF ZONES WITH LARGE-SCALE STRUCTURES LOCATED IN PERI-URBAN AREAS USING SECTORAL ANALYSIS OF LANDSCAPE INTERIOR (SALI): CASE STUDY OF WROCLAW, POLAND

Irena Niedźwiecka-Filipiak · Justyna Rubaszek · Anna Podolska · Janusz Gubański

Wrocław University of Environmental and Life Sciences

**P**eri-urban zones of large cities are convenient for the location of large-area investments of various functions. These are production facilities of industrial plants, hypermarkets, warehouses, and in recent years huge logistic-transshipment zones including multi-hectare halls/ facilities with large communication areas for transport vehicles. These developments lack greenery, and if there is any, it is introduced haphazardly and is limited to low greenery or small, single trees. This results in the fragmentation of green and open areas, which contributes to the loss of biodiversity, and causes visual degradation of the landscape. Similar processes have been observed around Wrocław, and they are particularly intense near its borders. The problem arises in places that are located in the planned GI system, including the Wrocław Functional Area (GIWFA), the first (inner) ring of which is located precisely in the urban fringe of Wrocław. For this reason, it is important to prevent the emergence of vast structures that cause fragmentation of open spaces, as well as to introduce solutions aimed at strengthening connections between the already existing elements of green infrastructure.

The aim of the study was to determine the possibilities of developing the areas occupied by large-surface facilities in a manner conducive to minimizing their impact on the natural environment and landscape. The research was conducted on the example of a complex of large-area facilities located in the inner ring of the designed GIWFA system. Sectoral Analysis of Landscape Interior (SALI) method was used for this purpose. Theoretical models of solutions by using only low greenery (lawns), low and high greenery (lawns and trees) and high greenery (trees) in the analyzed area were developed and compared with the current state. The research was carried out in two aspects: on a plan as a land cover analysis, and from the perspective of a moving person in terms of the percentage of greenery in each view.

The conducted analyses established that for the same area of greenery on the plans/maps in all models there are differences in the amount of greenery in the view. As a result, models with high greenery were found to be predominant over the others. They allow, while maintaining the largest usable space around the object, to best integrate it into the landscape and try to restore or maintain the continuity of natural systems. The developed models and visualizations can be used for the cooperation with investors and representatives of local authorities.

## THE CHANGES OF LANDSCAPE ECOLOGICAL AND THE EFFECTS ON CULTURAL ECOSYSTEM SERVICES IN RURAL AREA

Onkamon Nilanon · Danai Thaitakoo

Chulalongkorn University

**R**ural life depends on the dynamics of the landscape and ecosystem services (ES) it provides. Humans use these services not only for their basic needs but also for their culture. The changes of landscape degrade ES abilities, including cultural ecosystem services (CES), and deteriorate human well-beings. This study focuses on identifying the relationship between ES and culture and how a changing landscape will impact them.

Tracking down on the landscape and people interactions by collecting data from interviewing the local people, we found a development that can describe the relationship between ecosystem services and culture. Then, identify ES for each element and use stepwise analysis to link them with culture. We found that people in rural areas manage resources by transforming landscapes and using social relationships to regulate them, which turns into a culture. Moreover, we also found spiritual beliefs that protect people's lives and help protect the landscapes. The steps of CES we found are the hidden structure of rural communities. Urbanization has changed the landscape by transforming the forest into agricultural lands and natural streams into paved channels, which cause the degradation of ES and also CES. The stepwise analysis of ecosystem services clearly shows how the change in landscape will cause the loss of community economic, social, and their linkage to the natural world.

Relationships of landscape and ES should be addressed in rural development and planning. Especially for rural communities, CES reflects how people adapt and live with the landscape. With the steps of CES development, we can identify landscape elements and processes that should be conserved to maintain ES for local well-being. The development of rural areas must consider this hidden structure to mitigate the impact of changes on rural communities.

## '7S' DIGITAL VIEW COMPONENT PARAMETERISATION METHOD AS A LANDSCAPE ASSESSMENT AND PLANNING TOOL

Agnieszka Ozimek

Cracow University of Technology

The phenomenon of landscape degradation, both open and urbanised, has been intensifying in recent years, on the one hand in the face of the spatial planning crisis, and on the other one – as a result of intense pressure from developers. It is primarily due to decisions taken at the micro-scale, which translates into the macro-scale. It is therefore necessary to develop measurable, objective indicators that can be used to characterise landscapes of high aesthetic value and that can then support the arguments of experts who make decisions on the protection and shaping of landscapes. The results of quantitative studies are usually accepted unquestioningly, as they use objective numerical values.

In recent years, many countries have been striving to establish landscape assessment systems. These procedures mainly use maps and three-dimensional terrain models. Unfortunately, little consideration is given to eye-level views and, if this happens, numerical indicators are rarely used in these appraisals.

This paper aims to present the '7S' Method (Shade, Shape, Surface area, Size, Share, Silhouette/Skyline, Structure) of computer-assisted parameterisation of the view components. It uses measurements of the colour, shape, surface area and height of objects included in the view, as well as their percentage share in the view, interference with the skyline and the whole image structure. To carry out the calculations, the author's application was programmed in a MATLAB environment and an image processing toolbox were used.

The method has been applied in several tasks: choosing of the object colour, comparison between the degree of different views attractiveness and the extent of change in the view in the case of introducing a new investment, as well as the effects of implementing various design variants. It was also used in indicating the dominant object, inventorying the components of the view and selecting the best scenario of its transformation. The obtained results encourage the application of the new method in situations where the expert's intuition is not sufficient (e.g. when choosing between project variants that differ only slightly from each other).

The developed method aims at assisting the expert in inventorying the visual resources of the landscape, as well as in making decisions regarding acceptable transformations of its physiognomy. The results of the analysis, being a set of numerical parameters, should be supplemented with broader knowledge, extending beyond the visual values of the site, and with the other factors, such as the profitability of a given investment. The described method fills a crucial research gap, as quantitative analyses have been hitherto rarely included in view studies, although this is how observers usually perceive the landscape.

## DIGITAL VIEW ANALYSIS FROM THE TOP OF THE ŁYSICA HILL WITH IDENTIFICATION OF REGIONAL LANDSCAPE SPECIFICITY OF THE STUDY AREA USING NEW DATA STRUCTURES

Agnieszka Ozimek<sup>1</sup> · Irena Niedźwiecka-Filipiak<sup>2</sup> · Paweł Ozimek<sup>1</sup> · Paweł Filipiak<sup>2</sup> · Piotr Łabędź<sup>1</sup> · Jerzy Orlof<sup>1</sup>

<sup>1</sup>Cracow University of Technology · <sup>2</sup>Wrocław University of Environmental and Life Sciences

**V**isual landscape research is an important part of landscape analysis. It is especially important in the case of introducing new investments in a protected landscape, which has not only natural but also historical values. This article aims to show how the location of a viewing tower in a strictly protected area will affect the landscape values. The study was conducted on the example of the Łysica mountain located in the Świętokrzyskie National Park in Poland.

In 2018, the Association of Polish Landscape Architects (SPAK) was commissioned by the General Directorate of the Environment to develop Recommendations for conducting landscape analyses to designate landscape protection zones. In 2021, the method was used to analyse the view from the top of Łysica hill and to determine the regional landscape specificity of the study area.

The research included the following stages:

- preliminary studies related to the area of analysis;
- acquisition of digital data;
- local inspection – field verification of data and discernment of landscape characteristics;
- identification of landscape distinguishing marks – assigning them weights;
- analysis of view links between representatives of landscape distinguishing marks;
- development of terrain model and its coverage;
- analysis of active exposure from the observation tower depending on its height;
- analysis of passive exposure of the tower from viewpoints;
- synthesis of results and conclusions.

An important task was to determine the regional specificity of the site and to delineate the boundaries of Landscape-functional Units (LaFU) and their valorisation. They were identified as distinguishing marks of the cultural landscape: spatial layout of villages, homesteads, traditional wooden and brick buildings, cellars, sacral buildings, manors, greenery, surface waters. The degree of accumulation of representatives of distinguishing marks was used for distinctive categorisation of the surrounding 80 villages.

A digital model of the terrain and parts of its coverage was developed, and then the range of visibility from the planned tourist and educational tower on Łysica was analysed depending on its height. Simulations of active exposure from the tower were also performed, using point cloud data. The visibility of functional and landscape complexes of the highest value was examined. Passive exposure of the tower from viewpoints was assessed, ranking them according to distance. Point clouds were also used for these simulations.

The analyses carried out proved that an object with a height of about 27 m will be the most advantageous solution. It will be visible from 3 vantage points that lie between 2 and 4.5 km away and in these views, it will be intrusive. In views from 12 points 4.5-8 km away the tower will be noticeable but the nature of its visual impact will be negligible.

## PARTICIPATORY MAPPING OF DEMAND FOR ECOSYSTEM SERVICES IN AGRICULTURAL LANDSCAPES

Annette Piorr · Mostafa Shaaban · Sonoko Bellingrath-Kimura · Carmen Schwartz

Leibniz Centre for Agricultural Landscape Research

**A**gricultural land use systems have been optimized for producing provisioning ecosystem services (ES) in the past few decades, often at the expense of regulating and cultural services. Research has focused mainly on the supply side of ES and related trade-offs, but the demand side for regulatory services remains largely neglected. Better informed decisions in land use and landscape design require knowledge on spatial and intangible values of the landscape. Integrating the demand side reveals valuable, spatially explicit, and non-measurable stakeholder knowledge.

Our research aims to evaluate the usefulness of participatory geographic information system (PGIS) methods for demand assessments in larger rural and agrarian contexts by identifying spatially explicit demand patterns for ES, thereby enlarging the body of participatory approaches to ES-based land use management. Accordingly, we map, assess, and statistically and spatially analyze different demands for five ES by different stakeholder groups in agricultural landscapes in three case studies. The results are presented in a stakeholder workshop and prerequisites for collaborative ES management are discussed.

Our results show that poor correlation exists between stakeholder groups and demands for ES; however, arable land constitutes the highest share of the mapped area of demands for the five ES. These results have been validated by both the survey and the stakeholder workshop. Our study concludes that PGIS represents a useful tool to link demand assessments and landscape management systematically, especially for decision support systems. The search for measurements of the evaluation of intangible landscape values can benefit from the use of tools that allow a mix of quantitative and qualitative data collection, such as PGIS.



## PERCEPTION – IDENTIFICATION – INTERPRETATION. INTEGRATED LANDSCAPE ASSESSMENT FOR PLANNING AND DESIGN AT THE LOCAL LEVEL

Elżbieta Raszeja

Association of Polish Landscape Architects / University of the Arts in Poznań

**M**ultifaceted landscape research and its integrated assessment provide necessary support for decision-making processes at various levels of spatial planning and management. In the practice of planning and designing on a local scale, research is usually limited to the registration of landscape elements, description of its structure using measurable parameters and indicators and evaluation according to a set value score. The effect of such an approach, however, is the reduction of the multidimensionality of the landscape, and often even confusing and ambiguous conclusions. In addition to identifying the forms, it is also necessary to interpret their content and to take into account the historical perspective to understand the processes that shaped the landscape. This allows the degree of durability and legibility of the traces of the past to be assessed, as well as the scale and dynamics of contemporary transformations. It is also necessary to take into account the perception of the landscape by its recipients and users, conditioned and modified by their attitudes, values and preferences, as well as knowledge, experiences and life practices.

The aim of the article is to present an original model of landscape identity research and to indicate its usefulness for planning and designing at the local level. The research model sets out a pattern of conduct in the process of learning and understanding a landscape (perception – identification – interpretation) and is based on the analysis of the components of its identity (Biography – Structure – Image). The model can be used for research conducted on a local scale (individual villages, complexes of villages, small towns, districts of large cities). The next stage of the research procedure is operationalization, i.e. equipping the model with appropriate research procedures and tools, adapted to the purpose and scope of the research.

The BSI model was tested on many examples as part of the author's research and didactic work. In 2019, studies of the rural landscape were carried out in the area of selected units located in Wielkopolska, designated as part of the currently prepared landscape audit. The criterion for selecting research areas was their diversity in terms of: genetic types of settlement, physiographic features, cultural specificity, dynamics of historical development, pace and directions of contemporary transformations. The current landscape structure was analyzed, the degree of preservation and legibility of historical spatial arrangements was assessed, and contemporary deformations and threats were identified. The visual value and landscape exposure were also assessed. The summary of the conducted research was the formulation of guidelines for the development and protection of landscape in individual units.

## COMBINING SUBJECTIVE AND OBJECTIVE DATA TO EXPLORE DEMAND AND SUPPLY OF SOCIAL FUNCTIONS IN URBAN GREEN SPACES

Elizabeth Schrammeijer · Ziga Malek · Peter Verburg

Vrije Universiteit Amsterdam

Opportunities for physical activity, mental restoration and cooling are just some examples of the essential social-cultural functions provided by urban green spaces (UGS). However, ecosystem service analyses of UGS rarely, or poorly, integrate social functions. Especially assessments of mismatches and trade-offs incorporating multiple social functions is a major challenge.

In this study we build on Public Participatory GIS (PPGIS) to assess social functions and their spatial distribution in the City of Amsterdam, the Netherlands. Subjective responses are combined with objective data on spatial characteristics using advanced statistical and machine learning techniques to quantify and map the demand and supply of social functions. We consider UGS as providing specific functional niches for urban residents, depending on residents needs at the moment of use and on the specific characteristics, or functional traits, of the green space.

We demonstrate clear differences in demand between user groups for the functions relaxing, cooling, social interaction and walking routes. Mismatches between demand intensity and supply of a number of social functions are also mapped. Especially the function of relaxing appears to be highly mismatched in some areas and may be traded off against social interaction. Another mismatch between supply and demand for cooling is shown likely to be exacerbated by more than 25% in some neighbourhoods by 2030 with current plans for residential development.

Our findings reinforce the idea that residents need functional green space close by so that they can easily visit or pass through green space to benefit from the required function. We also point out that quieter functions are in danger of being displaced in densely populated areas. Therefore green spaces highly suitable for quieter functions is essential in urban densification plans and only focussing on multi-functionality is unlikely to ensure that the demands of all residents are met.

We demonstrate a method that can improve understanding of social functions as well as related mismatches and trade-offs. Such knowledge is especially important in the context of sustainable urban densification and realising liveable cities.

## FLOWERING MEADOWS FOR PEOPLE, BEES AND BIODIVERSITY

Beatrice Schüpbach<sup>1</sup> · Soeren Weiß<sup>2</sup> · Oliver Frör<sup>2</sup>

<sup>1</sup>Agroscope · <sup>2</sup>University of Koblenz-Landau

The EU-Common Agricultural Policy (CAP) promotes the introduction of woody and grassy semi-natural habitats (SNH) in agricultural landscapes in order to foster biodiversity. Grassy and woody SNH however, can also provide cultural eco-system services. The knowledge why and how grassy and woody SNH provide cultural ecosystem services as e.g. the visual quality of the landscape can help to design grassy and woody SNH to foster biodiversity.

For this purpose, we conducted an online survey showing pictures of combinations of different crops and grassy or woody SNH to participants in six European countries. The survey followed the design of a choice experiment including six to eight choice cards. Depending on the crop, pictures of combinations in three to four seasonal stages were shown. Participants selected the most preferred combination in each card. In order to find the reasons for selecting a picture, we determined five attributes describing combinations regarding order, the availability of green colour, colours from flowers, leaves or fruits, open soil, and dry vegetation that characterize the pictures.

In a first step, data from Hungary and Switzerland were analysed using latent class models and including the attributes described above. The results revealed three groups of participants in Hungary and two groups in Switzerland differing in their preferences for green vegetation, ordered vegetation and the presence of open soil (Switzerland). Nevertheless, all groups in both countries strongly preferred colourful flowers in crops or meadows (Schüpbach et al., 2021). Though in all classes of both countries colours were preferred, the origin of the colour differed between the two countries: in Hungary, only crops (rapeseed and sunflowers) provided colours, while in Switzerland besides rapeseed also grassy SHN flowering in early and late summer were a source of colours.

This difference suggests two things. First, flowers are not only important for pollinators and biodiversity, but also for human beings. Providing more flowers for a longer period is not only good for biodiversity and pollinators but also makes landscapes attractive, if they are colourful. Second, the availability of flowers in grassy SNH may depend on the country and its botany. A further important reason may be the system of direct payment in the respective country. In Switzerland the botanical quality of grassy SNH is rewarded but not in Hungary and in the EU CAP.

The ongoing analysis of the remaining four countries based on revised attributes will complete the findings about relevant aspects explaining preferences for grassy and woody SNH.

Schüpbach B. et al. (2021). *What determines preferences for semi-natural habitats in agrarian landscapes? A choice-modelling approach across two countries using attributes characterising vegetation*. *Landsc. Urban Plan.*, 206: 103954.

## HOW GREEN SPACES NEED TO CHANGE TO ADDRESS THE PUBLIC POST-COVID EXPECTATIONS

Daria Sikorska<sup>1</sup> · Joanna Bukowska<sup>1</sup> · Edyta Łaszkiwicz<sup>2</sup> · Piotr Sikorski<sup>1</sup>

<sup>1</sup>Warsaw University of Life Sciences · <sup>2</sup>University of Lodz

The COVID-19 transformed the lives of urban dwellers worldwide, including the visits and usage of urban green spaces (UGS). We investigated the preferences towards the alterations in UGS which should take place to ensure healthy and safe recreation. We based the study on a preference survey held in Warsaw. The respondents assessed different types of landscapes characterized by varying share of features, such as built-up structures or number of visitors present. We assessed the overall attitude towards COVID-19 and preferences for UGS adaptations. There was a clear respondents' need for more vegetation, both wild and cultivated, and more places for spending time in UGS. People perceived various types of UGS comparably, being significantly less likely to spend type in urban landscapes compared to parks or natural forests. The respondents declared that vegetation density and share of vegetation were most important for them and claimed to little consider whether the path was crowded or not. However, when scoring the photomontages they chose locations without other users with the possibility of freely straying off the track. Any repressive actions by distancing people spatially in UGS, isolating seniors or introducing entry limits did not meet social approval.

## SENSE OF PLACE IN RIVER LANDSCAPE MANAGEMENT – A PROGRESSIVE PERSPECTIVE

Iga Kołodzyńska<sup>1</sup> · Sarah Gottwald<sup>2</sup> · Jasmin Otto<sup>2</sup> · Wiktoria Morawska<sup>3</sup> · Agnieszka Jakóbiak<sup>1</sup>

<sup>1</sup>Wrocław University of Environmental and Life Sciences · <sup>2</sup>Leuphana University Lüneburg · <sup>3</sup>University of Wrocław

Rivers are social-ecological systems that offer various benefits for people's livelihoods, yet often they create natural and administrative boundaries, especially in national border contexts. Despite the need and requirements for cross-border cooperation for sustainable river development, formal landscape planning instruments are limited within the national border. In contrast, and specifically within the European Union, borders do not represent a limit for people's mobility, instead people are constantly on the move, and thus shaping and perceiving the landscape and its changes. Simultaneously, there are new forms of corporal as well as virtual mobility supported by the Internet of Things. These trends in people's mobility call for new governance approaches in sustainable river management, where people can act as environmental stewards overcoming administrative boundaries. Environmental stewardship has shown to be closely linked to sense of place theory, i.e. the meanings and attachments people attribute to a place. Progressive understanding of sense of place accounts for a dynamic lifestyle, assuming mobility as the natural human condition. However, empirical studies are still scarce, that consider people's everyday life environments, view both approaches (essentialist and progressive) as complementary, and account for the different types of mobility, such as physical or digital.

Therefore, we aim at exploring the influence of mobility on sense of place and in consequence environmental stewardship in the context of cross-border regions, because people in contrast to national planning instruments can transcend borders and thus support sustainable river management.

As a first approach towards this aim, a literature review will be guided by the questions: (1) which methods have been applied to investigate the relation of sense of place and mobilities? (2) which types of mobilities have been considered? (3) how has sense of place been conceptualized and operationalized? and (4) how was it linked to stewardship or management approaches?

We apply a systematic literature review using PRISMA method, we search for peer reviewed articles at Scopus taking a pragmatic view including a variety of scholars. Expected results provide an overview of the current scientific debates on the nexus of sense of place and mobilities in the context of landscape management and methodological opportunities. This research is embedded with the Move'n'Sense research project which uses the results as a starting point to empirically investigate sense of place in a study region to finally develop environmental stewardship nudges for integrated river landscape management.

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## FEELINGS ABOUT QUARRIES: MEASURING THE SENSE OF PLACE IN A LIMESTONE LANDSCAPE

Kamila Svobodova

University of Göttingen

Understanding people's motivation to visit a place and to return there, in particular the social, economic, and psychological motivations behind their decisions, is important to succeed in environmental policy and decision-making. To engage the question of why people respond well to some places and not to others, the literature must progress beyond normative constraints and include all types of factors that contribute to the sense of place. Re-consideration of the notion that only certain places are worthy of attachments is key in the progress.

Small-scale mining and quarrying producing industrial minerals, such as natural stone, gravel, and limestone, contribute significantly to livelihoods at all scales. Quarries are common features of urban and rural landscapes. These industrialized elements may possess unique cultural values and meanings to people living nearby. After mining activity ceases, quarries may create natural habitats of unique flora and fauna, venues for leisure activities, and provide community benefits such as education, inspiration, social bonding, and other cultural ecosystem services.

The aim of this study is to explore individuals' sense of place in relation to operating and abandoned quarries near Prague, Czech Republic. Placed in a popular limestone region of Czech Karst, the study demonstrates how people's sense of place in relation to the quarries is formed, localized, and affected by people's demographics, knowledge of the area, and their perception of mining. In this approach, the sense of place is understood as a concept fully shaped by individuals' perceptions and expressions of the place. The sense of place is conceptualized as a bundle of (1) people's feelings about the place, (2) their activities related to the place, and (3) place characteristics as perceived by people.

Paper questionnaires from 400 visitors of eight quarries in Czech Karst were collected directly in the field. The Mann-Whitney U test and the Kruskal-Wallis test were performed to identify statistically significant differences between visitors' demographics, experience and perceptions (IV) and determinants of the sense of place (DV). The Hierarchical Cluster Analysis followed to determine clusters of the sense of place determinants and how they differ between the quarries.

The analyses revealed the structure of the sense of place bundles and showed, among others, that while people's perception of mining affected how they felt about the quarries, their knowledge of the area affected their activities and perceived place characteristics. This study contributes to a more nuanced conceptualization of the sense of place in industrialized landscapes and provides the research and policy community with a better understanding of the people's drivers behind their place-related choices. People's sense of place and their feelings about places are key variables at a local scale but are largely underestimated in environmental decision-making.

## MAPPING LANDSCAPE VISUAL QUALITY IN THE BASQUE COUNTRY OF NORTH-WEST SPAIN

Ruth Swetnam<sup>1</sup> · Irati Dorronsoro Aguirrezabal<sup>2</sup> · Ane Garay Aginagalde<sup>2</sup>

<sup>1</sup>Staffordshire University · <sup>2</sup>University of the Basque Country

The Basque Country is an autonomous region on the Atlantic coast of Spain with a unique culture and language (Euskara). Its maritime location gives it a distinct climate which is wetter and cooler than the wider Iberian Peninsula. Consequently, the area has a distinct land use character with rugged, forested mountains incised by tight valleys which are densely settled. During the socio-political turmoil following the Second World War, Basque culture was challenged, with the language suppressed in favour of Spanish. Cultural identity matters, often determining the nature of land use practice which in turn determines how places look. These landscape views give Basque communities a strong sense of 'place' which is culturally distinct. Therefore, attempts to map this cultural ecosystem service should reflect the landscape preferences of Basque residents.

Our approach combined GIS mapping with public survey and builds upon previous work mapping landscape aesthetics in Wales, Iceland and North Macedonia. Landscape parameters which (1) captured visually distinct and quantifiable components of the view and (2) are known to evoke generally positive or negative responses were incorporated. Fieldwork tested and adapted these visual indicators to the Basque landscape to establish a Visual Quality Index (VQI) which was mapped for the Basque region at 2 km<sup>2</sup> to produce a consistent measure of landscape aesthetic quality for 2045 sites. Public validation of the method and the resulting VQI map was sought through a photographic preference survey (PPS) of 535 Basque nationals. The PPS confirmed the choice of visual parameters and demonstrated a significant link between Basque peoples' landscape ratings and the mapped VQI. Landscape components that were valued included: limestone peaks, mountain pastures, rocky coasts and vernacular farm buildings. Large roads, quarries and apartment blocks were disliked; whilst some measures of modernity (high speed railways, wind turbines, sports facilities) received mixed responses. The survey cohort was demographically varied but gave consistent landscape responses, with few significant variations due to age, gender or residence.

Empirical mapping of landscape aesthetics at regional scale remains technically complex and contentious. Caveats concerning data availability, parameter choice and scale must be considered; it is key to acknowledge that such measures will inevitably be partial. However, there is still value in capturing cultural ecosystem services through systematic and synoptic mapping. Such outputs are useful for planners and modellers; as land use alters, so too will landscape appearance and this concerns local residents and visitors. With adaptation, the VQI presented here is transferable to other locations. To do so, requires careful consideration of local landscape context, by those with deep familiarity with it. Fieldwork remains important and validation through public consultation is key.

## CORRELATION BETWEEN PLACE ATTACHMENT AND REGIONAL SIGNIFICANCE OF CES IN PERI-URBAN AREAS: A PPGIS CASE STUDY IN BUDAPEST METROPOLITAN REGION

István Valánszki<sup>1</sup> · Lone Sørenkvist Kristensen<sup>2</sup> · Sándor Jombach<sup>1</sup> · Márta Ladányi<sup>1</sup> · Krisztina Filepné Kovács<sup>1</sup> · Zsombor Boromisza<sup>1</sup>

<sup>1</sup>Hungarian University of Agriculture and Life Sciences · <sup>2</sup>University of Copenhagen

**N**egative effects of rapid urbanization process are recognizable in peri-urban areas. These include degradation of ecosystem services, as well as demographic and socioeconomic changes. Several researchers highlight that more attention should be paid to peri-urban ecosystem services in order to elaborate the most effective resource management and policies to decrease the negative demographic and land use impacts. Among these ecosystem services related research, the cultural ecosystem services (CES) are the most neglected types. The evaluation of cultural services is still difficult, mainly because of the intangible nature of CES and because their relative importance varies along urban-rural geographical dimension. In order to deal efficiently with the socio-cultural conflicts in peri-urban areas, we need a deeper understanding of the relationships between the CES and local social background. In this way, the aim of our study was to increase the understanding on the locals' place attachment and on the relationships between CES and local societies. We did so by analysing the spatial regularities, patterns based on the locals' acknowledgement on CES in a diverse peri-urban area.

During our research, we applied a special method for community-based assessment and involvement of local communities. The so called ppGIS method (Public Participation GIS) combines community-based mapping with GIS techniques. We took a Hungarian micro-region from Budapest Metropolitan Region as a suitable peri-urban example. The study area, called Vác micro-region, contains 18 settlements. Five cultural services were defined: aesthetic, recreational and therapeutic, spiritual, cultural and historic, educational values. During the survey a total of 184 maps were collected, after the data was digitized. The analyses were performed partly by GIS methods (using QGIS software) and partly by statistical analyses.

Our results showed, that the regional significance is the highest in the micro-regional centre (Vác), and we also found, that a few (or only one) outstanding values of a settlement could influence significantly the level of regional significance. The smaller settlements around the regional centre are the least well-known from cultural perception point of view, while the villages located in the middle of the study region are better known. Analysing the place attachment, we could conclude, that citizens of settlements located around the regional centre have the strongest, while villages situated in the middle of the study area have the weakest place attachment. Finally, we found, that in many settlements, if the regional significance is high, the place attachment is low, and vice versa. Our results can help for planners and decision makers to understand better the social processes in peri-urban areas, and the relationships between locals and cultural values, heritage of these settlements.



## LANDSCAPES AND IDENTITIES IN TRANSFORMATION: CONSTRUCTION OF THE PROJECT FROM THE SOCIAL ASSESSMENT OF THE LANDSCAPE. THE CASE OF PICHILEMU, A COASTAL CITY OF CENTRAL CHILE

Paola Velasquez · Alexis Vasquez · Emanuel Giannotti · Victor Alegria

Universidad de Chile

In the last forty years, drastic changes have taken place in the Chilean coastal cities' image and spatial configuration, highlighting the appearance of fragmented and disconnected urban landscapes resulting from accelerated urbanization processes associated with tourism, agricultural exploitation, and infrastructure. These dynamics have surpassed institutional and regulatory frameworks and have collided with ecological processes and critical ecosystems. We propose a broad and permanent citizen participation process to establish the community's active and responsible role in installing sustainable territorial planning.

Qualitative-participatory methodologies seek to understand the landscape phenomena from the perspective of those who cross through them, play a leading role, or experience them, making their views part of the research and planning process.

All the activities were systematized and incorporated into the project's geographic information system and presented as a discussion starting point in each workshop:

1. Construction of a shared diagnosis: describing the image of Pichilemu, defining the city's soul, how the community imagines it twenty years from now; spatialization of opportunities, needs, and threats; specify significant elements of the landscape's identity, natural spaces, green areas, and viewpoints; assessment of environmental assets (ecological diversity, recreational and landscape, cultural heritage); past, present, and future practices associated with environmental assets; perception of changes associated with environmental assets, the landscape, and the city's image; ethnography and visual study of the landscape process in rural territories and communities.
2. Elaboration of a consensual proposal: validation of diagnosis; development of scenarios and visions of the future; definition of objectives and strategic projects of the Green Infrastructure Plan; the collaborative project design process for strategic projects.
3. Creating a positive environment for a plan's implementation: involvement of the community and representatives of different areas of territorial management; the community's legitimization and ownership of the plan.

There is evidence of a high estimation of the natural elements, strongly associated with a local identity, and a high aesthetic appreciation of the landscape that structures the vision of the territory's future. Secondly, the community has expressed a great interest in participating in constructing their territory and has demonstrated the capacity to engage in a long-term participation process. Methodologically, it is fundamental to adapt the participatory actions to the specific realities of the territory and its communities.

This process achieves an actual engagement of the local community considering a wide diversity of actors, which allows the project to become a space for collaborative development and participatory democracy and strengthens the sense of belonging and community, based on the idea of establishing a common good sustained over time.

## USING SOCIAL MEDIA PHOTOGRAPHS DEEP LEARNING TO ASSESS CULTURAL ECOSYSTEM SERVICES OF URBAN GREEN SPACES FOR HIGH-DENSITY URBAN MANAGEMENT: CASE FROM THE CENTRAL BEIJING

Haiyun Xu<sup>1</sup> · Mujie Ren<sup>2</sup> · Guohan Zhao<sup>3</sup>

<sup>1</sup>Beijing University of Civil Engineering & Architecture · <sup>2</sup>The University of Sydney · <sup>3</sup>Aalborg University

Cultural ecosystem services (CES), such as aesthetic and recreational enjoyment, play a virial role in the contribution of landscape to human well-being. Assessing local CES had policy implications for urban green space resource allocation. However, it is challenging to quantify CES, as interviews and surveys are limited by the cost and samples. Social media data, particularly geo-tagged photographs, has emerged as a rich new source to understand human-nature interactions while advances in deep learning have enabled large-scale analysis of the imagery uploaded to these platforms. Here, we assessed CES provided by the urban green spaces in central Beijing, China's highest density urban area, using user-contributed georeferenced photographs from Xiaohongshu, the Instagram in the Chinese world.

We demonstrate a novel approach, borrowing techniques from, natural language processing, machine learning (image analysis), and self-organizing maps (SOM), to collect, classify, and assessed 62,138 photographs taken by 9022 users between 2020 to 2021.

Clustering algorithms applied to results of the image analysis data revealed 9 distinct CES groups, which included those interested in art, recreation, garden structure, landscape historical monuments, nature appreciation, religion, and education. The most represented local CES categories were recreation 21,545 (34.67%), and nature appreciation 8158 (18.02%) was also highly represented, though no photographs depicting educational engagement. For each group, we produced high-resolution spatial and seasonal maps, identifying CES hotspots/coldspots, which matched known recreational attractions and annual festivals in central Beijing.

Our study explored the new means to quantify and map CES at broad spatial scales in the face of trends in the use of social media data and deep learning in the CES research and provided the basis for sustainable urban green spaces spatial management in the future Beijing.

# *Approaches integrating ecosystem services and disservices in social-ecological landscapes to foster sustainability*

## **Symposium organisers**

*Julien Blanco* (UMR SENS), *Pierre-Cyril Renaud* (Nelson Mandela University / University of Angers), *Juliette Mariel* (CIRAD)

## **Summary**

Ecosystem services and disservices (ES/EDS; ecological features that benefit or harm human well-being) have gained momentum in landscape ecology research. In particular, EDS have recently been advocated as complementary to ES to explore tensions and conflicts around natural resource management in multiuse landscapes and find new sustainable pathways. This symposium will focus on recent research that combines ES and EDS, discussing the potential and limitations of this dual approach to unpacking the social-ecological interactions that drive landscapes in order to improve their sustainability.

## **Description**

Multiuse or multifunctional landscapes are complex social-ecological systems where different species, habitats and diverse stakeholders with different views and objectives interact. Reconciling natural resource preservation and socio-economic development in these contexts is a critical challenge that requires a robust understanding of multilevel social and ecological interactions, fair and inclusive learning and governance processes, and active dialogue between stakeholders. The concept of ecosystem services (ES), defined as the ecological features that contribute to human well-being, has been pivotal in fostering this transdisciplinary enterprise. Landscape ecology, with its capacity to take into account different organisational levels, ecosystems and stakeholders, is a promising discipline for integrated ES research that can guide sustainability policies. However, concern has arisen about the capacity of ES to capture the adverse impact of certain ecological processes on humans (e.g. animal attacks on people or crop predation) and thus to address tensions and conflicts among stakeholders. This has led to the emergence of the 'ecosystem disservices' concept (EDS), defined as the ecological features that negatively impact human well-being, and for calls to employ integrated ES and EDS analyses in multifunctional landscapes. Such an integrated approach is advocated as a pathway towards a better understanding of socio-ecological dynamics and more just and sustainable landscape management and governance.

This symposium will discuss the question: What have landscape ecologists and other sustainability scientists learned so far in combining ES and EDS in their research? It will include conceptual and methodological contributions as well as case studies, to offer an interdisciplinary understanding of the potential and limitations of the ES/EDS concepts through different perspectives. There will be a particular focus on four key questions:

1. How can a dual ES/EDS approach contribute to uncovering the many biophysical processes and interactions that shape landscapes at different organisational levels?
2. How relevant are these concepts in revealing the subjective dimension of landscapes and in managing tensions and conflicts between stakeholders?
3. What strategies and practices are implemented by stakeholders at different levels to manage ES/EDS trade-offs?
4. How useful is an ES/EDS approach in analysing landscape governance processes, fostering dialogue and social learning between stakeholders, and ultimately guiding decisions and policy-making that promote sustainability?

In addressing these questions, this symposium aims to provide a discussion platform for the research community working with EDS, bringing different disciplines together to clarify the concept, whose continuing conceptual fuzziness hinders its operationalisation for landscape research and management.

## A NOVEL CASCADE MODEL FOR ECOSYSTEM SERVICES AND DISSERVICES APPLIED IN A BRAZILIAN WORKING LANDSCAPE

Julien Blanco<sup>1</sup> · Beatriz Bellón<sup>2</sup> · Liane Barthelemy<sup>3</sup> · Baptiste Camus<sup>3</sup> · Louise Jaffré<sup>3</sup> · Anne-Sophie Masson<sup>3</sup> · Alix Masure<sup>3</sup> · Fabio de Oliveira Roque<sup>4</sup> · Franco L. Souza<sup>4</sup> · Pierre-Cyril Renaud<sup>5,6</sup>

<sup>1</sup>UMR SENS · <sup>2</sup>Rhodes University · <sup>3</sup>ISTOM College of International Agro-Development · <sup>4</sup>Federal University of Mato Grosso do Sul · <sup>5</sup>Nelson Mandela University · <sup>6</sup>University of Angers

Since 2007, several authors have pleaded for complementing the ecosystem service (ES) framework with the ecosystem disservice (EDS) concept in order to consider both the benefits and detriments associated with ecosystems in the analysis of human-nature relationships. However, EDS are still a marginal concept in sustainability research, in particular because they suffer from conceptual ambiguity. As a consequence, it remains unclear how, together with ES, they can help better untangle social-ecological interactions in multi-use landscapes.

In order to bring clarity about the EDS concept, we devised a novel cascade model that explicitly integrates ES and EDS. In a landscape-based perspective, this E(D)S cascade model brings clarity on (1) the articulation and interactions between ES and EDS, (2) the distinction between intermediate and final E(D)S, and (3) the cascading links between ecosystem features, E(D)S and their associated benefits and detriments for diverse stakeholders. In addition, the E(D)S cascade model takes into account the feedbacks from human societies to ecosystem features and E(D)S through management practices, governance, and value attribution processes.

In order to discuss the E(D)S cascade model's strengths and limitations, we applied it in a case study in Brazil, in the Cerrado biodiversity hotspot, with the aim to explore how local farmers perceived and managed their rural forests. We conducted semi-structured interviews in 45 farms, asking farmers about (1) farm and farming system characteristics, (2) practices related to rural forest management, and (3) the diverse E(D)S they perceived in relation with rural forests.

We first found a total of 30 perceived ES and 18 perceived EDS associated with rural forests, including 15 final and 15 intermediate ES, and 6 final and 12 intermediate EDS. Harvestable timber, sheltering effect for reared animals, and habitat and feeding resources for reared animals were the most cited ES. Predation on crops and livestock were the most cited EDS. We also found a close link between E(D)S emergence and dynamics and farming practices. For example, crop expansion, associated with a ban on hunting local pigs, was reinforcing the importance farmers assigned to crop predation issues. Reversely, farmers have implemented several practices to be less vulnerable to most problematic EDS.

This novel E(D)S cascade model shows a great potential to better understand human-nature relationships in an inclusive perspective, acknowledging the existence of multiple subjective, yet legitimate, viewpoints about a given landscape. Furthermore, it allows to better highlight the importance of human practices and perceptions in the production and impact of ecosystems on human well-being. We therefore suggest that this framework can help identify solutions to reduce certain EDS while reinforcing ES and biodiversity conservation.

## METHODS AND INDICATORS FOR EVALUATING ECOSYSTEM SERVICES: A NEED FOR STANDARDIZATION

Claudia Canedoli<sup>1</sup> · Noemi Rota<sup>1</sup> · Ioannis Vogiatzakis<sup>2</sup> · Alexia Zanchi<sup>1</sup> · Harini Nagendra<sup>3</sup> · Emilio Padoa-Schioppa<sup>1</sup>

<sup>1</sup>University of Milano-Bicocca · <sup>2</sup>Open University of Cyprus · <sup>3</sup>Azim Premji University

**E**valuation of ecosystem services (ES) has become a fundamental subject in ecology and studies aiming to evaluate them are rapidly increasing worldwide. Despite the variety of methods and indicators employed currently to perform ES evaluations, a common standardization is currently lacking. This greatly limits our capacity to produce comparable studies and advance in ES provision understanding. This study presents a literature review of the current indicators and methods used to evaluate ES, limited to mountain environments. The aim is to identify the most common indicators used. Specifically, we address the following questions: (1) what are the indicators and methods currently used for ES evaluation, (2) which are the most common ES analysed, (3) which assessment is most frequent among ecological, economic, and social type, and (4) how frequently ES valuation is used to actually inform decision making. Using ISI Web of Knowledge we selected papers from 2015 to 2020 containing the words 'ecosystem services' AND 'mountains' in the topic. Based on MEA categories we identify 27 ES and for each article the following information was extracted: type of ES evaluated, indicator(s) used, input data used, type of valuation (ecological, economic, or social), scale (local, regional, national, global), country, mapping, and finally we indicated if the ES valuation was able to provide solutions for decision making. The search resulted in 965 papers, 350 of them were finally used in this study because they effectively applied at least one indicator to evaluate ES.

Results show that there is no common agreement about the type of indicators used in ES assessment. The most frequent ES assessed per category were food, freshwater, fuelwood, fibers (provisioning), climate regulation, erosion prevention, water regulation, natural hazard protection (regulating), recreational, aesthetics (cultural), and biodiversity (supporting). The most frequently used indicators are presented for each ES to try to delineate the current tendency in use. Ecological valuations are prevalent, but economic and social valuations are also represented. Studies that combine both ecological, economic, or social values are still few, despite the advocate of multiple valuations. Identifying the most frequently used indicators is useful to advance the process of ES indicators standardization, although these might not be the most effective. In this study, we also analyse with an expert-based evaluation the suitability of the most common indicators in terms of significance, simplicity, cost, replicability, ease of interpretation and policy relevance. Results obtained showed the overall suitability of a set of commonly used indicator. Although this study focused on mountain ecosystems the same tendency can be found in other ecosystems and this study suggests which indicators are more suitable to be applied.

## SEEKING FOR A SUSTAINABLE FIRE RESILIENT LANDSCAPE AT A LIVING LAB IN NORTHERN PORTUGAL

Inês Marques Duarte · Vanda Acácio · Ana Catarina Sequeira · Conceição Colaço · Susete Marques · Francisco Castro Rego · José Borges

University of Lisbon

The project FIRE RES – Innovative technologies and socioecological- economic solutions for fire resilient territories in Europe (December 2021 – December 2025) is a Horizon 2020 project that seeks novel approaches towards preventive landscape and community management for greater fire resilience. Within the project aims, several Living Labs (LL) across Europe and Chile will test innovative actions, with integrated ecological and socio-economical approaches, bringing together scientific research, local communities, and stakeholder engagement, in order to increase human safety, preparedness to firefighting, postfire restoration efficiency, and landscape resilience under increased fire risk.

The Portuguese LL “Vale do Sousa” is a forest valley landscape of about 14,500 ha located in northern Portugal and highly vulnerable to wildfires. The landscape is dominated by eucalypt and maritime pine forest, intermixed with small settlements, shrublands, vineyards and orchards. Over the past decades, wildfires became recurrent and severe, with occurrence of Extreme Wildfire Events (EWE) in recent years. In this territory, of mainly private property, over 360 landowners are associated to develop a joint landscape-level management plan to reduce wildfire risk while providing ecosystem services.

Within FIRE-RES project, we will use data already collected for the Portuguese LL (forest inventory data, ecosystem services and landowners’ management preferences) across more than 1000 management units to perform a landscape ecology assessment to help improving landscape configuration towards a sustainable and fire resilient landscape. We analyze landscape dynamics for a 50-year period (1970-2018), characterizing landscape composition and changes over time, rates of change, and the association of specific landscape changes with wildfire occurrence and other environmental and human variables. We are also calculating several metrics to better understand the evolution of the landscape mosaic in space and time. Results are linked with landowners’ management preferences, ecological and demographic data, and will be used to simulate possible future landscapes. Available data for the LL will also be used to assess the impact of past wildfires on the provision of ecosystem services (e.g., carbon release in the form of CO<sub>2</sub>) and how the proposed configuration towards a fire resilient landscape can mitigate such impact.

Preliminary results show that landscape composition had higher heterogeneity five decades ago, with a mosaic of agricultural land, forest, and pastureland. Chestnut, vineyards, orchards, pastures, which were present in the past, were identified as favorable potential landscape components to improve resilience against wildfires. In the present, the landscape is homogeneously dominated by eucalypt and maritime pine forest, prone to wildfires, which explains partially the occurrence of EWE. The landscape ecology assessment proposed, which integrates ecological and socio-economic data, will provide a good understanding of the past, leading to better design of the present landscape and to more accurate predictions of the future landscape configuration, towards a safer, sustainably managed, and fire resilient landscape.

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## URBAN WATERFRONT: POTENTIAL OF LANDSCAPE. CASE STUDY IN BACOLI

Dora Francese · Giulia Maisto · Valeria Memoli · Luca Buoninconti

University of Naples Federico II

Urban settlements upon time have widely modified natural landscape providing a number of critical aspects to biotic elements. Nonetheless the anthropic needs have sometimes improved the quality of landscape, both in terms of aesthetics and of life. Some regions have actually gained benefit from some human activities, by finding a new asset and new wildlife diversity. Waterfront is one typical example of mesh between man and nature which in some cases would create an increasing quality of landscape, but in others have actually been decayed and deprived of many fantastic realms.

The research we would like to present is actually dealing with these regions: a littoral mix of man and wildlife, made by both animals and plants, when city and nature interact trying to respect on one hand the variety and richness of the latter, but engaging the efforts for improving humans' quality of residence in the first. Therefore, the research we are dealing with is the identification of the ecosystem services and the maximum benefit that can be derived without damaging the structure and the functionality of the ecosystem itself, in order to conserve and preserve their quality.

By interaction between two different disciplines, Environmental technology of architecture and Ecology evolution, the research would study a method for establishing a number of parameters, able to describe as well as qualify the landscape characters from the two points of view: nature and city. It will take into account the potential of the waterfront areas, as well as the critical aspects, in order to establish a matrix of solutions, suitable for the regeneration of these regions by means of a sustainable and economic management. Bio-mimetic experience would provide the needed tools for the interaction of the two sciences: construction and ecology.

A case study will be presented as sample of the application of this new method, located in the waterfront called "Spiaggia Romana", in the municipality of Bacoli, south Italy. The paper will present the methodology and the tools, as well as the application, the actual carrying on of the research and the eventual results, in the shape of very reverential projects. The latest would provide, besides the aforesaid safeguard for the whole sphere of natural species and ecosystems, also the respect for the global hazards, such as climate change, pollution, carbon emissions, by proposing technological solutions which will be transient, flexible and recyclable, as well as with materials at high naturalness and reversibility. The results could actually provide a method for the landscape to guarantee ecosystems' services without compromising the environmental quality.

## WHAT, WHERE, AND WHY DO RESIDENTS EXPERIENCE IN THE URBAN RIVERSCAPE? INSIGHTS FROM THE PPGIS SURVEY

Tomasz Grzyb

University of Warsaw

The opportunity to directly contact with nature is one of the major factors that impact the quality of life in cities. Beyond urban parks and forests, river ecosystems play a key role in strengthening human-nature bonds. A broad palette of benefits and harms that impact on dwellers' physical and mental well-being while accessing nature has been identified. Treating the urban area as a complex social-ecological system, these benefits fall within the cultural ecosystem services (CES) framework, while several negative experiences are analysed using ecosystem disservices (EDS) approach. The knowledge of patterns of CES/EDS distribution and users' motivations should be profitable for stakeholders managing urban riverscape. This research aims to identify spatial patterns of CES and EDS delivery along the Vistula River in Warsaw, Poland, using PPGIS data.

Public Participation GIS (PPGIS) surveys enable to obtain spatially explicit information about people's activities and experiences. Survey participants are asked to identify several spatial locations, routes of areas, mark them on a map, and respond to a set of questions concerning their markers. In this study, the online questionnaire based on the Maptionnaire software was prepared and distributed among members of ca. 300 neighbourhood and district Facebook groups in November and December 2021. The questionnaire was addressed to residents who actually spend their time along the river. Participants were inquired to assess the benefits they experience in the particular place using the Likert scale with reference to 12 statements regarding various CES. They were also asked to identify what disturbs them along the river; EDS patterns were revealed using the mix of quantitative data and free comments made by participants. 462 Warsaw residents provided information about 998 places or routes along the river they prefer to spend their free time. Although the city centre attracts more residents, they perceive the riverscape of the city outskirts as more beneficial to them. Hierarchical clustering revealed three main bundles of CES: mind-connected (energy, spirituality, heritage, education), activity-connected (active recreation, aesthetics, maintenance for future, nature observation) as well as place-connected (social interactions, passive recreation, place attachment, sense of home). Another six main groups of EDS were identified: safety issues, gatherings, riverine wilderness, quality of river, shortcomings of amenities, and trade-offs between users. Spatial patterns of CES/EDS distribution are induced by the variety of land cover/land use.

The study contributes to the existing body of knowledge on the benefits and harms provided by the urban riverscape by (1) simultaneously assessing multiple CES and EDS by urban residents, (2) recognising bundles between these services.



## HOW DO YOUNG PEOPLE PERCEIVE HUMAN-WILDLIFE-INTERACTIONS?

Andreea Ionescu · Ileana Pătru-Stupariu · Mioara Cluiș

University of Bucharest

**H**uman-wildlife interactions (HWI) have become more common in recent decades. All positive and negative interactions, some of which are addressed in this research, are considered key components of the landscape's disservices. Recent studies are increasingly associating HWI as part of the disservices (Pătru-Stupariu et al., 2020). Among the HWIs identified especially from the online data (local newspapers, Facebook) we can mention: people being attacked by bears and wild boars, deaths, bears filmed on the ski slopes, etc. (Pătru-Stupariu et al., 2022).

This study aims to show the perception of middle school and high school students about their interaction (negative/positive) with wildlife, found in their hometown or on hiking. As the pandemic situation did not allow the field travel and the application of the questionnaire face to face, it was made in Google Forms and sent to 10 counties in Romania, both in urban and rural areas. A questionnaire with 22 questions was created and it was completed by a number of 400 respondents. The questions were designed to identify issues such as: (1) whether students saw wild animals (bear, wild boar, fox, wolf, deer) and where they observed them, (2) what were the interactions they had with these animals, and (3) what was their behavior and reaction to these animals. In a survey on 400 students a total of 58% of participants live in cities, while 42% live in rural areas; 53% of them attend high school classes, while 47% attend high school.

The result of the obtained data shows that 70% of students who responded to the study said they had seen wild animals in a zoo, while the rest said they had seen wild animals in their natural habitat (on mountain trails, in neighborhoods, or on the road). Some of the HWI were positive, and the following were related: *I touched a deer; I saw a bear when wandering lazily along a Borsec resort street; I stroked a fox when I was a child; At St. Ana's Lake, I met a small semi-domesticated bear; I had a baby deer, I raised it.* They did, however, mention certain negative interactions, as follows: *A deer slammed its horns into our car, breaking our windows, and the shards landed on me; When I went to Lake Saint Ana, I saw three bears approaching me; The outside walls of the cabin where I was staying were scratched by a bear while I was inside; I saw a fox running towards the hens; While traveling through the woods, I came across some wild boars. One of them cracked my car's wheel; The fox appeared in the yard of my grandparents.* In response to the question: Have you ever come across traces of wild animals? If such was the case, how did you feel? – the most common responses were: fear, dread, doubt, curiosity, and danger.

To summarize, middle school and high school students' perceptions differ mostly based on the environment in which they live and their age. As a result of our research, we plan to develop a behavior guide for students in terms of wildlife interaction.

Pătru-Stupariu I. et al. (2020). *Using social network methodological approach to better understand human-wildlife interactions.* Land Use Policy, 99: 105009.

Pătru-Stupariu I. et al. (2022). *Online environment as a tool to push forward the research: an example for landscape disservices.* Land, 11(2): 23.

## BEEKEEP CALM AND THINK IN COMMON: A GAME FOR THE GOVERNANCE OF FLORAL RESOURCES USE AMONG BEEKEEPERS

Léo Mouillard-Lample<sup>1</sup> · Gabriel Gonella<sup>2</sup> · Christophe Le Page<sup>3</sup> · Mickaël Henry<sup>1</sup> · Axel Decourtye<sup>4</sup> · Cécile Barnaud<sup>2</sup>

<sup>1</sup>INRAE, UR406 · <sup>2</sup>INRAE, UMR 1201 DYNAFOR · <sup>3</sup>CIRAD, UMR SENS · <sup>4</sup>L'ITSAP-Institut de l'abeille

**B**ees play a key role in providing ecosystem services such as pollination. However, recent ecological studies suggest that honey bee colonies introduction compete with wild bees. Exploitative competition for floral resources reveals antagonism between ecosystem services provided by honey bees – i.e. pollination, honey production – and those provided by wild bees – pollination and existence value of wild pollinators. In natural areas, beekeeping practices are seen as a source of ecosystem disservices that raised tensions over the shared harvesting of floral resources.

While existing studies have focused on ecological aspects of competition for floral resources, the present study explores floral resources management governance in a socio-ecological perspective. To this end, we draw on a conceptual framework combining collective action theories on common-pool resources management and the concept of ecosystem services. We applied this framework to analyze the social interdependencies among beekeepers within the area of Cévennes National Park, southern France. To turn it into action, and accompany new forms of floral resources governance, we adopted a companion modeling approach (ComMod), a post-normal science methodology based on co-construction of simulation models. We built a role-playing game based on 35 beekeepers' interviews, and organized 4 gaming workshops. The gaming sessions highlighted the dilemma between individual and collective interest in harvesting resources. Despite some interactions that revealed their awareness of some kind of interdependencies over floral resources, this paradigm shift appeared cognitively dissonant for them. The high degree of uncertainty, concerning resource production and carrying capacity of the environment, are major obstacles to collective organization. It affects the actors' motivation for a collective action that seems difficult to articulate with the temporal constraints of their activity. Beyond motivation, trust towards the other actors is crucial for transparency, and identifying the right facilitators and the right decision-making arenas are critical questions. Nevertheless, some participants were willing to move towards more transparent collective organization.

Floral resource management between beekeepers appears as a textbook case of common-pool resource governance in relation to ecosystem services. Combining social and ecological aspects, we hope to contribute to the emergence of operational resource sharing solutions, stemming from the local beekeepers themselves. It appears now crucial to explore further new forms of governance of floral resources that will reconcile beekeeping and wild bees conservation, in conjunction with agriculture and land managers who largely shape these resources.

## BENEFITS AND DISBENEFITS RELATED TO CULTURAL ECOSYSTEM SERVICES OF GREEN SPACES

Agnieszka Nowak-Olejnik

Jagiellonian University

Cultural ecosystem services (CES) are commonly defined as the non-material benefits people obtain from ecosystems through spiritual enrichment, educational value, reflection, recreation, and aesthetic experiences (MEA, 2005). On the other hand, there is no clear classification of ecosystem disservices, understood as functions of ecosystems that are perceived as negative for human well-being (Lyytimäki, Sipilä, 2009). Cultural ecosystem disservices (CEDs) may be defined as material (e.g., affecting crops and consequently farmer's livelihoods) or non-material (affecting mental well-being, identities, or aesthetics) harms to people from human-ecosystem relationships (Echeverri et al., 2019). Green spaces provide visitors with bundles of CES. At the same time, they are the source of numerous CEDs. Although not only CES but also disservices are important factors for managing green spaces (Lyytimäki, Sipilä, 2009), they are rarely researched (Echeverri et al., 2019).

The study aimed at reviewing the literature on CES and CEDs of green spaces. 114 papers on CES/CEDs of green spaces were analysed. While all of the papers investigated CES, only 15% focused on CEDs. The most often analysed benefits related to CES were aesthetics, strengthening social bonds and place identity. The most common disbenefits in the context of green spaces were a sense of fear, unpleasantness and noisiness. Besides, such disservices as allergens, harmful animals, humidity level and obscuring vision were mentioned. It should be also highlighted that some of the studies considered disservices caused by people, e.g., a sense of fear, unpleasantness and noisiness as well as overcrowding. In the case of several benefits, and disbenefits specific landscape features played an important role, e.g., strengthening social bonds was related to grass vegetation as well as existing infrastructure, and sense of fear was related to dense vegetation, whereas in the case of others no specific factors were identified. The knowledge on the landscape features favouring specific benefits and disbenefits may be used in the management of green spaces to enhance effects on human well-being.

Echeverri A. et al. (2019). *Iconic manakins and despicable grackles: Comparing cultural ecosystem services and disservices across stakeholders in Costa Rica*. *Ecol. Indic.*, 106: 105454.

Lyytimäki J., Sipilä M. (2009). *Hopping on one leg – The challenge of ecosystem disservices for urban green management*. *Urban For. Urban Green.*, 8: 309-315.

MEA (2005). *Ecosystems and Human Well-being: Synthesis*. Washington: Island Press.

## OPTIMIZING THE LANDSCAPE PORTFOLIO FOR THE PROVISION OF ECOSYSTEM SERVICES IN EASTERN PANAMA

Karla Pintado · Elizabeth Gosling · Thomas Knoke

Technical University of Munich

**D**esigning landscapes that can meet the needs of human populations while enhancing their capacity to deliver relevant ecosystem services might be crucial for balancing pressure on land resources and creating resilient systems in the face of ongoing environmental change, particularly for tropical regions. The present work evaluates trade-offs in the provision of multiple ecosystem services across different land-use types in Tortí, a forest frontier in eastern Panama, to generate theoretical compositions that could inform planners and decision-makers on opportunities to improve the landscape multi-functionality. To this end, secondary data of ecological and socio-economic indicators were integrated into the robust optimization approach developed by Knoke et al. (2015). This model determined the optimal land-use portfolios that balance the achievement of both economic and environmental objectives while accounting for uncertainty scenarios. Substantial trade-offs were found between ecological objectives, as well as between ecological and socio-economic goals. According to the results, diversifying the landscape composition is the optimal solution to minimize these trade-offs and achieve sustainability. For instance, a large combination of secondary forests, forest plantations, and agroforests would be necessary to compensate for the ecosystem services provided by mature forests and minimize trade-offs across desired ecological functions.

In general, this study provides valuable information to help identify the most efficient landscape composition along a range of possible development trajectories, which will reduce trade-offs between desired objectives. Results therefore could be potentially adopted in future land-use allocation decisions within the planning and management framework. The present study also allowed for a comparison between the optimal portfolios resulting from empiric studies with those derived from expert-based derived data from Reith et al. (2020). Results from this analysis further highlight the potential of implementing expert knowledge data as a cost-effective alternative for landscape optimization studies.

Knoke T. et al. (2015). *Optimizing agricultural land-use portfolios with scarce data – a non-stochastic model*. *Ecol. Econ.*, 120: 250-259.

Reith E. et al. (2020). *How Much Agroforestry Is Needed to Achieve Multifunctional Landscapes at the Forest Frontier? Coupling Expert Opinion with Robust Goal Programming*. *Sustainability*, 12: 6077.

## WATER MANAGEMENT IN RURAL AREA WITH NATURE-BASED SOLUTION: A CASE STUDY OF BAN PI, BAN LUANG DISTRICT, NAN PROVINCE, THAILAND

Nakrob Saithep · Onkamon Nilanon · Attana Vasuwattana

Chulalongkorn University

This study focuses on the possibilities of water management in a rural valley community area – Ban Phi, Ban Luang District, Nan province, Thailand. This study proposes to find new water management solutions which will improve Ecosystem services (ES) abilities and human well-being. In this study, the qualitative research method of collecting and analyzing data applies to the landscape ecology concepts. Site information is analyzed and summarized to identify ecosystem structures, processes, functions, and services. The results showed that the landscape provided suitable conditions and ES for settlement and agriculture, such as a lot of water supply in streams, moist microclimate, lush rainforest, and fertile soils. The ES, directly and indirectly, shape the way of life and affect the quality of life as Ban Phi has developed into an agricultural village in Northern Thailand. But the vast forest transformation to sloping agriculture during the increase of the agriculture sector has strongly disturbed water and people interactions. As a result of the event, we find the water supply and demand are imbalanced. Although reservoirs and check dams are constructed, the site is unable to retain water in the dry season. The water management method demonstrates two solutions to revive the ES by restoring hydrological processes with alternate landscape patterns based on the site water budget. The first solution is creating plant stripes on slopes and stream riparian areas to maintain soil moisture, filter, and reduce water runoff. Another solution is modifying agricultural water usage to be more efficient by integrating agroforestry systems into traditional agriculture. With these solutions, the green and blue infrastructures are created to connect and provide ES on a landscape scale.

## HOW TO IDENTIFY ECOSYSTEM SERVICES AND DISSERVICES WITH SUPPLY AND DEMAND?

William Sidemo Holm

Centre for Environmental and Climate Science

**E**cosystem functions that affect human well-being are typically classified as either ecosystem services (positive) or ecosystem disservices (negative). However, many ecosystem functions can produce both ecosystem services and disservices, depending on the context. Therefore, only considering one direction of how an ecosystem function can affect people may result in inaccurate value estimations, leading to suboptimal ecosystem management. We propose a conceptual framework that facilitates the consideration of both ecosystem services and disservices when evaluating the impact of ecosystem functions on human well-being. As has been done in previous frameworks, we identify ecosystem services as spatially and temporally explicit matches in supply and demand. However, we additionally add that spatially and temporally explicit matches between supply and demand to avoid generate ecosystem disservices. We illustrate the convenience of using supply and demand to distinguish both ecosystem services and disservices by assessing examples from the literature of the impact of moose, insect pollination and soil nutrient mineralization on human well-being. We show that depending on stakeholders, and spatial and temporal context, all three can generate ecosystem services and disservices. We also show that this needs to be considered for optimal management of ecosystems to benefit human well-being.

## A MULTI-CRITERIA METHOD FOR ASSESSING THE VALUE OF ECOSYSTEM SERVICES FOR CATCHMENT PROTECTION IN NORTHEASTERN POLAND

Marta Sokół · Grażyna Łaska

Białystok University of Technology

**W**etlands, including river catchments, provide a range of ecosystem services such as biodiversity, recreational use and medicinal properties. These services are mainly determined by the type of land cover, presence of protected species, legal protection of habitats, continuity of ecosystems, presence of old and stately trees, distance from marsh and wetlands, and the broadly defined medicinal properties of the catchment area. Often the land near the riverbed has a special natural, recreational, and medicinal values that should be protected. The valorization of river valleys makes it possible to evaluate an area in terms of its natural values. Taking into account the areas enabling proper functioning of ecosystem services, it is possible to indicate fragments of the catchment area with the greatest values, intended for protection. The aim of this paper is a multi-criteria method for assessing the value of river valley ecosystem services to enable the identification of protected catchment fragments. Designation of areas protected from development and with potential for oxbow restoration will maximize the functioning of selected ecosystem services. Borda's method was used for multi-criteria analysis. The research analyzed archival, inventory and source materials as well as spatial databases. The QGIS program (version 3.16.13) was used to develop maps.

The multi-criteria analysis using Borda's method, taking into account the values of ecosystem services, allowing for the identification of areas particularly distinguished by high biodiversity, preferred recreational use and high medicinal properties within the catchment of the studied river. It was found that the lowest natural, aesthetic and recreational values fall on the fragment of the river basin located in the very centre of the city. Ecosystem service values in these sections are the lowest. These areas do not require special protection because they do not show high natural values, which is due to their location among dense development and heavy conversion. The Biała river basin requires special protection in the parts least transformed by humans, free from dense construction, used for recreation, rich in biodiversity and with high medicinal properties. Protecting the watershed will inhibit irrational expansion of developed land and reduce destructive approaches to land use. The catchment areas at the beginning and end of the river should be given a protective function, and at the same time, such a development should be proposed in this area that will enable the full use of ecosystem services. Catchment protection is one of the natural solutions that enable sustainable urban development by preserving the most valuable parts of the city and ensuring human well-being.

## 2. Learning from nature

### *How to develop a “successful” environmental governance for the protection of biodiversity?*

#### **Symposium organisers**

*Christine Fürst* (Martin Luther University Halle-Wittenberg), *Luis Inostroza* (Ruhr University Bochum), *Daniele LaRosa* (University of Catania), *Marcin Spyra* (Martin Luther University Halle-Wittenberg)

#### **Summary**

The symposium sheds light on the nexus between ownership in nature, value and governance systems and their impacts on biodiversity. We invite presentations that address changes in ownership forms and consequences for land use. Related value systems and governance instruments (legal, economic, rights and norm-based, community actions) should be analysed. Impacts on biodiversity should stretch over time series or consider significant changes in societal values and governance.

#### **Description**

With this symposium, we would like to open up an interdisciplinary forum considering how ownership, related value systems and governance instruments are connected considering their impacts on biodiversity. Ownership means the right to use or protect nature / natural resources related to or decoupled from land tenure. The symposium intends to enhance a highly integrative analysis on the level of the related social-ecological systems. It will compare in a global context how cause-effect relations in such systems contribute to conserving biodiversity or pose high risks for it in a global context.

The presentations in this symposium should shed light on the nexus between forms of ownership in nature, governance instruments (legal, economic, right / norm-based, community actions), value systems and biodiversity. Understanding this nexus is mainly important in regions with a highly intensive societal and environmental transformation. Examples are former Open Cast Mining areas, regions with changes from more family to industrial agriculture and transformations in urban and peri-urban contexts driven by different types of development processes (residential, infrastructural, commercial). Presentations can address, for instance, historical documents (cadastral data, legal and administrative texts, planning documents) related to land ownership and power balances in governing nature, data sets/bases from monitoring, observation networks, exploratories and any other kind of environmental surveys regarding proxies for biodiversity. Presentations are welcome considering processes of how historical data (e.g. documented surveys) and contemporary witnesses are included regarding how the changes in ownership and land governance have impacted the perception of the value of nature and can be connected with planning or management measures that impacted positively or negatively impacted the biodiversity proxies.

Also, approaches describing how expert opinion will be consulted to explore how different actor groups over time were or became players in using and governing nature and how they were and are involved in land use, management and planning are warmly invited.

Presentations might also address how the past and current state of biodiversity can be assessed by reviewing historical data in publications, collections and databases, which allow assessing the change in biodiversity as a function of land ownership and management, and of governance instruments.

In urban and peri-urban contexts presentations can investigate on the relation/trade-off between public and private land ownership, discussing and proposing different policy and planning instruments and support tools that could increase the amount of public spaces able to provide key ecosystem services. In result, we intend to develop a joint special issue in Social-Ecological Practice Research, thus, contributions from practical planners / regional development managers are also warmly welcome in this symposium.



## FOREST LANDSCAPE UNDER INVOLUNTARY BIODIVERSITY CONSERVATION APPROACH: LANDOWNER’S ATTITUDE TOWARDS BIODIVERSITY CONSERVATION IN PRIVATE FORESTS

Ģirts Baranovskis<sup>1,2</sup> · Oļģerts Nikodemus<sup>1</sup> · Guntis Brūmelis<sup>1</sup> · Didzis Elferts<sup>1</sup>

<sup>1</sup>University of Latvia · <sup>2</sup>Nature Conservation Agency of Latvia

Integration of private land into biodiversity conservation strategies is widely used approach across the world. Under involuntary conservation approach a landowner has rights to express an attitude towards incorporation of his land in protected area, however his/her opinion is not binding. Such approach goes hand in hand with socio-economic conflicts and raise question about landowner’s willingness to take active part in biodiversity conservation process.

Forest biodiversity conservation strategies (protected areas and system of micro-reserves) in Latvia are based on involuntary approach. We used this background in order to understand which factors influence landowner’s readiness to implement biodiversity conservation measures in private forests of Latvia. We utilized mixed-mode surveys in order to gather information from 386 private forest owners.

Data analysis showed that private forest owners are heterogeneous community with very different attitude towards biodiversity conservation measures. We found out that higher proportion of forestry income, larger size of forest property, lower education level and lower general conservation values were factors negatively affecting landowners attitude. Forestry education and occupation had a significant influence as well.

Our results suggested that there is high potential for introduction of voluntary biodiversity conservation mechanisms in Latvia. Especially landowners of smaller forest properties and those who are not dependent on forestry income have positive attitude towards biodiversity conservation in private forests. This voluntary involvement potential could be utilized for developing coherent network of protected areas according to EU Biodiversity Strategy for 2030.

## ‘NATURE AND TOURISM’ VERSUS ‘NATURE OR TOURISM’. SEARCHING FOR THE RIGHT BALANCE THROUGH THE CULTURAL ECOSYSTEM SERVICES APPROACH

Sylwia Kulczyk<sup>1</sup> · Piotr Matczak<sup>2</sup> · Krzysztof Mączka<sup>2</sup> · Marta Derek<sup>1</sup> · Alina Gerlée<sup>1</sup>

<sup>1</sup>University of Warsaw · <sup>2</sup>Adam Mickiewicz University

Cultural ecosystem services (CES), understood as intangible benefits people get from nature, are widely recognized as important to human well-being but rarely included in governance processes. The relative character of CES (i.e., the dependence on the opinions and behaviors of users), together with its high dynamics, are the main impediments to the quantification, mapping, and bundling CES. The aim of this presentation is to show how these bundles and trade-offs influence local governance, taking the example of tourism in a nature-based destination.

The municipality of Węgorzewo (north-eastern Poland) will serve as a case study. It represents the post-glacial rural landscape. The mosaics of fields, forests, and lakes decide on its high tourist potential. However, for local development, the perspectives and needs of multiple groups of stakeholders, from local farmers to external tourism entrepreneurs, need to be taken into account by local authorities. Various views on local development are related to different perceptions of CES. In order to know and understand them, a qualitative study was carried out in September 2021. First, 15 in-depth interviews were conducted with local stakeholders who represent different perspectives on using nature and its management. This included local authorities, NGOs members, entrepreneurs, a hunter, a fisherman, and other local experts. Second, qualitative data were supplemented by quantitative and spatial data collected via a questionnaire survey. The survey questions encompassed both the perceived importance of various types of CES and the actual activities undertaken in nature. The respondents comprised two groups: local residents and tourists.

The results revealed that although all stakeholders perceive CES as a component of well-being and an important driver of local development, their views on how to manage them are often contradictory. The greatest controversy is related to the use of natural resources for tourism and recreation. The importance of tourism as a source of economic revenue leads to prioritizing planning and management decisions that will support investments in tourism. These are not in line with the needs of local residents or current visitors, who perceive the ongoing changes as deteriorating the high degree of naturalness of the area.

Both quantitative and qualitative tools proved to be helpful in identifying and mapping bundles and trade-offs between different CES and other groups of ES. They show that local development in nature-based destinations is a huge challenge, and, as there exist a diversity of the points of view of the stakeholders, there is no ‘one and only’ solution how to manage the natural potential.

## DESIGNING BIODIVERSITY FRIENDLY LANDSCAPES AS A PROMISING APPROACH TO INCREASE EFFECTIVENESS OF AGRI-ENVIRONMENTAL SCHEMES

Gisela Lüscher<sup>1</sup> · Eliane S. Meier<sup>1</sup> · Felix Herzog<sup>1</sup> · Eva Knop<sup>1,2</sup>

<sup>1</sup>Agroscope · <sup>2</sup>University of Zurich

**E**cological focus areas (EFAs) are key elements of agri-environmental schemes in Europe. Best-known and longest-existing EFAs are action-based EFAs where farmers get subsidies for specific management actions. A second approach are result-based EFAs, for which farmers get payments if predefined ecological objectives are met. A third approach are landscape-focused EFAs. They are defined in order to guarantee connectivity between habitats and sufficient resources for wildlife. Here, we use data of the biodiversity monitoring of Swiss farmland to evaluate the benefit of the three EFA approaches, which are characterized by increasing complexity and effort required for implementation. Doing this, we go beyond a local-scale comparison of  $\alpha$ -diversity to understand patterns of  $\gamma$ -diversity at landscape scale.

Species richness of plants, butterflies and birds in 123 squares (1 km<sup>2</sup> each) distributed across Switzerland was related to the area of all EFAs (action-based EFAs), the percentage of result-based EFAs, and the percentage of landscape-focused EFAs and their interactions. To control for environmental influences, topography, climate, nitrogen deposition, and area of protected areas were included as predictor variables. Species richness was tested as  $\alpha$ -diversity at local scale (agricultural area within 10 m<sup>2</sup>, 5000 m<sup>2</sup> and 10,000 m<sup>2</sup>, for plants, butterflies and birds, respectively) and as  $\gamma$ -diversity at landscape scale (agricultural area within 1 km<sup>2</sup> square).

High area of all EFAs and high percentage of landscape-focused EFAs increased  $\alpha$ -diversity of all taxa under study and  $\gamma$ -diversity of plants. For  $\alpha$ -diversity of birds, the interactions of result-based EFAs and the area of all EFAs, and of landscape-focused EFAs and the area of all EFAs were significant, also. For butterflies,  $\gamma$ -diversity was significantly enhanced by the interaction of increasing area of all EFAs and increasing percentage of landscape-focused EFAs. For birds,  $\gamma$ -diversity increased with high area of all EFAs and high percentage of result-based EFAs.

EFAs contributed positively to species richness in farmland. Although environmental drivers determined the ecological niches available and set the limits for physiological processes, the occurrence of EFA added key resources for farmland biodiversity. A high percentage of landscape-focused EFAs was beneficial for  $\alpha$ - and/or  $\gamma$ -diversity of all taxa. The effort of elaborating a coordinated, landscape-focused action plan with a long-term perspective was rewarded by higher species richness. Interestingly, result-based EFAs were not very successful. The limitation on a set of indicator species and ecological structure characteristics had a minor effect on overall farmland biodiversity.

## A NEW MODEL OF POLLINATION SERVICES POTENTIAL USING A LANDSCAPE APPROACH: A CASE STUDY OF POST-MINING AREA IN POLAND

Damian Łowicki · Katarzyna Fagiewicz

Adam Mickiewicz University

**G**iven that 90% of the world’s plant species are pollinated by animals, pollination is a crucial service which is strongly connected to biodiversity in general. Consequently, it should be considered in spatial planning, especially in the reclamation of post-mining areas as well as the restoration of abandoned land and post-industrial sites. These processes consist of creating a new land use pattern and giving new functions to areas degraded by humans, providing a great opportunity to increase the bundle of ecosystem services. This study demonstrates how a landscape approach can be incorporated into mapping and assessments of pollination services by proposing a new model of potential for pollination services (PPS). Using the example of the Adamów-Koźmin post-mining area (Poland), the effect of reclamation on the potential for pollination was assessed. Ecosystems in the early stages of succession and created as a result of reclamation treatments, such as meadows and young forests as well as legumes, can be highly suitable as foraging and/or nesting areas for bees. This study’s results can be used by the companies planning the land restoration or reclamation model to use, by beekeepers when choosing a location for apiaries and by farmers when planning the structure of sowings.

## WARSAW BIODIVERSITY INDEX – TOWARDS NEW URBAN BIODIVERSITY GOVERNANCE INSTRUMENTS

Gabriela Maksymiuk · Agata Cieszewska · Renata Giedych · Magdalena Błaszczuk · Agnieszka Gawłowska · Marzena Suchocka · Magdalena Wojnowska-Heciak · Piotr Sikorski

Warsaw University of Life Sciences

**B**iodiversity is a crucial factor for city resilience in times of climate change. The requirements of the environmental protection policy require the intensification of city’s activities and efforts put towards the protection of biodiversity. Thus ultimately, the proposed Warsaw Biodiversity Index (WBI) is designed as a tool associated with the policy document – an Environmental Protection Programme, and it aims to serve as a self-assessment tool for the city to benchmark and monitor its progress in biodiversity conservation efforts. It is also intended to improve of the environmental protection management system by increasing the role of green infrastructure in the city's policy. The presented research was performed on commission of Capital City of Warsaw in 2021.

The point of departure for the research aimed at elaboration of a new city biodiversity governance instrument was the Singapore Index on Cities' Biodiversity. The research included an analysis of 6 European cities (i.e. Helsinki, Stockholm, Tallin, Brussels, Lisbon and Edinburgh) in regards to application of City Biodiversity Index and stages of its implementation. The conducted review allowed for selection of good practices on how to implement individual indicators. Next, for Warsaw case study, the resources, knowledge base and potential of City Biodiversity Index implementation have been studied.

In results, based on world experience, an expert model of Warsaw Biodiversity Index has been developed that matches the specific conditions of capital city. The framework of the index comprises two parts: a profile of the city (providing background information) and 28 indicators measuring native biodiversity, ecosystem services and governance and management of biodiversity in the city. While developing the index's assumptions, particular attention was paid to environmental and social aspects, ecosystem services, and the management and implementation of urban policy. Based on the Warsaw actual resources, we recommended 12 indicators for implementation in the first stage, starting from 2022. These are among others: Change in Number of Native Bird Species, Institutional Capacity, Cross-sectoral and Inter-agency Collaborations, and Community Science.

The application of WBI allows for: depicting the biodiversity state and changes taking place over time, showing the gaps in the current knowledge that require further research and identifying problem areas that require action. It is a tool involving different actor groups, who can become players in governing city biodiversity.

## HOW GRASSLAND FARMERS RELATE TO BIODIVERSITY: A CASE STUDY FROM THE NORTHERN ITALIAN ALPS

Alma Maria Moroder · Maria Lee Kernecker

Leibniz Centre for Agricultural Landscape Research

To successfully understand and shape biodiversity conservation in Alpine grasslands, it is crucial to understand what influences farmers’ actions. In this study, we explored how farmers perceive and value biodiversity, how this is related to agricultural and land use practices, and how they view themselves affecting it. In-depth interviews were conducted with 22 farmers of three municipalities in the northern Italian Alps and with 6 experts in the fields of grassland management, agriculture, and environmental conservation in 2020. The farmers’ answers were analyzed and interpreted using a mental model approach, relational thinking, and the literature on the ‘good farmer’. We found that the farmers’ different mental models of biodiversity are associated to different aspects of agricultural management practices and symbolic meaning of farmers’ roles in mountain agricultural landscapes. Instrumental values of biodiversity are negative and strongly perceived as such by farmers, while relational values associated with biodiversity are positive, but more weakly perceived. We found these differing and somewhat opposing perceptions and values to be associated with two roles that farmers have, as both producers and landscape stewards, and how they value fodder quantity and quality. Furthermore, we found that most farmers don’t include considerations related to the conservation of biodiversity in their management decisions, and mostly do not envision any changes in biodiversity or management in the future. Effective biodiversity conservation in Alpine grasslands will therefore need to tap into these dual roles and the associated instrumental and relational values of biodiversity for a meaningful dialogue on conservation.

## MANAGEMENT FRAMEWORK DEVELOPMENT FOR SMALL ISLAND ECOSYSTEMS: CASE OF POLILLO ISLANDS SEASCAPE

Leajim Villanueva<sup>1</sup> · Ma. Victoria Espaldon<sup>2</sup> · Inocencio Buot, Jr.<sup>2</sup> · Agnes Rola<sup>2</sup> · Sheila Vergara<sup>3</sup> · Dante Vergara<sup>2</sup>

<sup>1</sup>University of the Philippines · <sup>2</sup>University of the Philippines Los Baños · <sup>3</sup>ASEAN Centre for Biodiversity

Small Islands Ecosystems (SIE) are physically secluded areas surrounded by water measuring no more than 10,000 km<sup>2</sup> and 500,000 or fewer residents (Hess, 1990). SIE's resulting limitations on space, resources, products, and services (Wong et al., 2005; Balzan et al., 2018) influence ecosystem services which are important for human well-being. SIEs are important as sites for settlements of communities and as strongholds for threatened flora and fauna. It serves as a habitat to more than 10% of the world's population or 650 million people (Petzold, Magnan, 2019) and is considered as biologically important sites.

The management of islands in an archipelagic nation such as the Philippines is a significant issue. In a country composed of 7461 islands with a land area of approximately 300,000 km<sup>2</sup> (Licuanan et al., 2018), the role of islands and islets for community habitation is evident. One of the country's small island ecosystems vulnerable to anthropogenic threats is the Polillo Islands. This study aims to evaluate the impacts of population structures and distribution on the seascape condition of Polillo Islands, describe the influences of institutional setup and political structures and dynamics on the management of the seascape of Polillo Islands; describe the change in provisioning ecosystem services from the seascape environment; and propose a management framework for island ecosystems using the case of Polillo Islands. Tools to characterize landscape and ecosystem services changes, and the influences of a changing population, institutional and political structures are utilized to contribute to the development of a management framework that would capture the management interventions addressing the unique characteristics of this ecosystem. The role of governance at different levels highlighting its influences on agenda setting and priority programs implementation was identified as one of the key influences that determine the changes to the seascape environment.

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## ***'Half Europe': where and how can biodiversity conservation be achieved in the Anthropocene?***

### **Symposium organisers**

*Emilio Padoa-Schioppa* (University of Milano-Bicocca), *Claudia Canedoli* (University of Milano-Bicocca), *Ioannis Vogiatzakis* (Open University of Cyprus)

### **Summary**

The symposium aims to start from the provocative work of E.O. Wilson, and try to analyze the state of the art of the conservation of biodiversity and ecosystem services in Europe. In particular, we want to understand how far we are from the targets of EU biodiversity strategy of 2030. The symposium we give priority to fragile landscapes such as small islands, mountain areas and roadless areas.

### **Description**

Living in a geological epoch, which is by now referred to as the Anthropocene we are witnessing the magnitude of the negative effects of human activities on both biodiversity and ecosystem services (ES). Recently some of the lead ecologists of our times advocated urgent measures to halt biodiversity loss, like the controversial proposal of conserving half of the Planet. Inspired by the idea that we need more spaces for biodiversity conservation to reverse the trend of increasing habitat loss, this symposium seeks for studies that examine the current situation of Europe. In particular: which are the most important areas for biodiversity and ecosystem services in Europe? At what level is our knowledge about them? Which are the methods and techniques to identify biodiversity and ES crucial area today? Having missed the 2020 deadline, can we realistically achieve the targets set by the new EU biodiversity strategy for 2030?

Besides identifying important biodiversity and ES areas, there is a need to identify conservation initiatives and practices which take into account the natural and social context, in order to identify the best ones (parks, protected landscapes, or other forms of conservation). Thus, additional topics of discussion include the following: What is the current know-how that we have implemented? Which are the different forms of biodiversity and ecosystem services conservation existing today, and what is their contribution? What can we say about the limitations or advantages of these conservation forms we have been applying?

Finally, given that Europe is characterized by high population density and a high degree of urbanization, an important aspect is reserved for the coexistence of nature conservation and humans presence and needs.

This symposium welcomes studies that bring new ideas to the assessment, monitoring and mapping of biodiversity or ES in Europe, European countries and regions. It will present case-studies of biodiversity and ES conservation in Europe, discuss advantages and limitations of different measures and techniques of biodiversity and ES conservation, explore the relationships with society in terms of supporting, impeding or being affected by nature conservation measures and initiatives. The symposium we give priority to fragile landscapes such as small islands, mountain areas and roadless areas.



## IF OTHER ANIMALS CAN DEFINE THE COUNTRYSIDE, ARE THEY “NATURE”?

Aleksandra Ćwik-Mohanty

University of Warsaw

The paper explores the place of non-human animals in defining rurality while acknowledging the evolution of this role. AMO and Rem Koolhaas define countryside as “the 98% of the earth's surface not occupied by cities”. The perception might be criticized for not giving enough justice to the nuances of non-urban landscapes. However, it is close to accurate if the criteria for defining the landscape's character are based on the subjectivity of their non-human dwellers. The same approach blurs the line between cities and countryside; hence this paper focuses on rural areas in Poland as elements of the countryside and their evolution in embracing the presence of animals.

Suppose the role of animals in landscape formation is visualized on a tinted line. In that case, it is the most intense where human intervention is the strongest and nearly invisible where non-humans dominate. Rural areas would be in the middle, with landscapes shared between humans, pets, farm animals, and wild species. Nonetheless, which of the mentioned belong to nature? The paper analyses the position of rural animals in three aspects, from the most exploitative to the one which seemingly places animals at the center of a farm's functioning: industrial farming, traditional farming, tourist-oriented educational farms (Zagroda Edukacyjna). By linking the presence of animals in each type of landscape with other natural components and the reciprocated relationship with a human, the author will establish a typology of animals as rural landscapes defining factors and juxtapose them with other numerous methods to define rurality. The basic premise is that natural components are mutually dependent. The more human-dependent rural animals are (in the popular portrayal), the more objectified assets they become. However, the natural versus temporal asset dichotomy lacks animals' subjective rather than passive participation expressed in their capacity to define the landscape and their reciprocated role toward humans.

The study is a part of the author's doctoral research project, focusing on thematic villages and eco-museums in Poland. The study describes factors that propelled rural dwellers to engage in tourism, such as cultural heritage, peripheral location, and their relationship with the landscape. Methods that contribute to the poster include a literature review and case studies, and a national survey among owners of educational farms (officially referred to as Zagrody Edukacyjne).

The conclusion is pertinent to the panel's theme. It attempts to foresee the consequences of landscape ecology, which does not include animals as its natural (as opposed to human) component, but a proportionate piece. Results emphasize animal welfare in landscape ecology, often linked to social sciences with their human-centered approach.

## WILDERNESS VS. CULTURALNESS: OPPOSING CONCEPTS OR COMPLEMENTARY SCHEMES?

Panayotis Dimopoulos · Ioannis P. Kokkoris

University of Patras

Areas of intact nature are in practice absent in the western part of the world, while most landscapes, especially in the Mediterranean region, are characterized by human induced land uses and cultural landscapes. By this, wilderness areas, seem to be limited or should be redefined, based on current reference environmental conditions, and identified trends. Roadless areas have already been proposed as regions of significant importance in terms of limited human access and disturbance. However, wilderness areas should include more attributes to be characterized as such. Simultaneously, wilderness and culturalness areas co-exist in spatial and management terms, in EU and national Environmental Strategies, guiding the need for an integrated approach for nature conservation and human well-being. In Europe, the Natura 2000 network is institutionalized to provide protection and support conservation priorities for species and habitats, including areas of unique natural environments, fragile ecosystems, as well as areas occupied by human activity and infrastructure. In Greece, where the landscape approach has been followed to delineate Natura 2000 boundaries, wilderness and culturalness co-exist in management and policy decisions, even if not clearly described in qualitative, quantitative, and spatial terms.

Main goals of our study are to identify (1) wilderness areas in Greece, inside and outside the Natura 2000 network, (2) wilderness hotspots and the patterns with cultural areas. Spatial data have been used for topographical characteristics, human land uses to identify and classify remote areas (remoteness), important plant species (endemics, local endemics, range-restricted, endangered) and habitat types of EU and national importance (e.g., endemic habitats such as *Abies cephalonica* forests). The already developed culturalness map of the Natura 2000 sites in Greece has been used and updated for the recently added Natura 2000 sites.

Our present analysis provides a national map of wilderness and culturalness areas, with hierarchical classification based on the characteristics of each wilderness area, and spatial correlation analysis with cultural areas. Moreover, the overlap with the Greek Natura 2000 sites identifies potential areas in need of attention for conservation outside the Natura 2000 network. Based on these results, a baseline assessment is provided to support decision making and to be considered in future development needs, biodiversity, and landscape conservation, as well as in the zonation drafting of the future, special management studies for the Natura 2000 network in Greece. Moreover, the results highlight that even human uses and pressure is more intense than ever before, there is still an opportunity to safeguard invaluable landscapes and resources that sustainably support a variety of ecosystem services and thus, human well-being.

## THE POTENTIAL OF NATURA 2000 AND AREA-BASED CONSERVATION FOR ENHANCING FUNCTIONAL FARMLAND BIODIVERSITY

Francesca Libera Falco<sup>1</sup> · Tamar Dayan<sup>1</sup> · Eran Feitelson<sup>2</sup>

<sup>1</sup>Tel Aviv University · <sup>2</sup>Hebrew University of Jerusalem

European farmed landscapes host a number of species intimately associated with and contributing to agricultural production through the provision of crucial ecosystem services. However, their habitat is rapidly deteriorating due to agricultural intensification and abandonment of marginal land, a tendency that the EU CAP and its set of mostly farm-based environmental measures have tackled ineffectively to date. This study focuses on farmed Natura 2000 protected sites to empirically evaluate the effectiveness of area-based conservation measures in preserving and enhancing high-quality habitat for functional farmland biodiversity (FFB).

The Natura 2000 network covers 10.6% of the total EU agricultural land. It should be noted that Natura 2000 aims to protect Europe's threatened species and ecosystems, not focussing specifically on FFB. Thus, specific EU-wide studies on its effects on the agroecosystem are lacking. On QGIS, we selected all farmed Natura 2000 sites that include the three EU CORINE land cover classes where farmed landscapes have the highest heterogeneity, presence of natural and semi-natural areas and exclude intensively managed land, using such selection as an indicator for high-quality FFB habitat. We then created our control group using buffer areas of 5 km around the selected sites and we ran a fixed-effects model to estimate how the area covered by the selected classes changed over time inside and outside the protected sites, before and after their designation.

The results – which make explicit the initial differences between protected and buffer sites – are extremely clear. They show a general negative trend over the years in control sites, both in terms of hectares and percentage of high-quality FFB habitat. In contrast, designation as a Natura 2000 site appears to halt such decline, with the strongest effects after few years from the designation. Running the same model on sites designated earlier shows an anticipated similar trend, in accordance and confirming the theoretical expectations.

Although Natura 2000 is still underperforming with regard to its targeted species and habitats, our study shows a significant positive effect on high-quality FFB habitat, in contrast with the recent evaluations of the EU CAP measures. Differently from the latter, Natura 2000 is area-based and applies consistent conservation standards at the landscape-scale on a non-voluntary basis for farmers, supported by economic compensations. The collective engagement of neighbouring farmers may also play a role in the effectiveness of the measure, as a leading force in creating environmental stewardship. In the context of the new CAP and national Strategic Plans, our study suggests to rely and invest more on the synergy with the Natura 2000 network as well as to extend as much as possible the main characteristics of the area-based approach to the new array of CAP measures.

## VALUATION OF ECOSYSTEM SERVICES AT THE LANDSCAPE LEVEL FOR SPATIAL PLANNING

Damian Łowicki · Małgorzata Stępniewska · Andrzej Mizgajski

Adam Mickiewicz University

The study aims to present the possibility of assessment and mapping of ecosystem services taking into account the benefits, not from individual ecosystems, but their pattern in space. This approach is based on the paradigm that the structure of the landscape determines its functions. This approach can be used not only to assess the functions of ecosystems, but also the benefits that humans derive from them, i.e. ecosystem services. The analysis of ecosystem services at the landscape level is particularly important in the assessment of regulating services, especially where the service carrier is mobile. This applies, for example, to the migration of pollutants or pollinators between different ecosystems. This approach makes it much easier to apply the results in practice, especially in spatial planning. The study shows the use of a landscape approach to assess and map several regulating ecosystem services at the local and national scale, taking into account services demand and supply and their interrelationships, potentially increasing the bundle of ecosystem services.

*The study is a part of project “Services provided by main types of ecosystems in Poland – an applied approach” received funding from Iceland, Liechtenstein, and Norway within the EEA Financial Mechanism 2014-2021.*

## VALUING ECOSYSTEM SERVICES AND BIODIVERSITY IN NATURAL PROTECTED AREAS: THE CASE STUDY OF THE GRAN PARADISO NATIONAL (ITALY)

Emilio Padoa-Schioppa<sup>1</sup> · Claudia Canedoli<sup>1</sup> · Noemi Rota<sup>1</sup> · Ioannis Vogiatzakis<sup>2</sup>

<sup>1</sup>University of Milano-Bicocca · <sup>2</sup>Open University of Cyprus

**E**cosystem services have become an important tool for analysing landscapes and building cost-benefit scenarios for decision-makers. Identifying, quantifying, mapping and evaluating ecosystem services requires specific study and analysis methods, integrating the use of models and data collection in the field and new technologies (eDNA, drones, etc.).

The aim of this communication is to identify, by means of a number of case studies, what the current prospects are for estimating the ecosystem services of a given territory, and how this quantification can contribute to determining the territory's identity and prospects. A first study analyses in detail the carbon stored in a protected area (Gran Paradiso National Park). Here we can see that the study obtained through extensive field data collection allows for more precise mapping than national inventories. The use of eDNA (environmental DNA), again in the Gran Paradiso National Park, has made it possible to better describe the biodiversity and fauna of some alpine habitats, and to relate them to the characteristics of the vegetation, soil and local topography.

The results allow some important guidelines to be identified:

1. it is necessary to complete the knowledge of the European biodiversity, expanding the libraries for metabarcoding;
2. it is necessary to continue and deepen the study on the role of single taxonomic units in providing ecosystem services;
3. field analyses require a considerable effort, in terms of time and energy. They require more detail, but then allow for more precise spatial definition and can help to build more refined models.

For landscape ecology, the results obtained from this type of analysis on the one hand allow a better overall management strategy for the landscape (which patches to keep as they are, which to direct towards a different stage...); on the other hand, they propose a problem typical of our discipline, i.e. the change of scale (technically up-scaling by moving from a local dimension to a larger one).

## SOIL BIODIVERSITY CONSERVATION: EVALUATION OF THE ALPINE EDAPHIC SOIL FAUNA USING eDNA METABARCODING

Noemi Rota<sup>1</sup> · Claudia Canedoli<sup>1</sup> · Chiara Ferrè<sup>1</sup> · Gentile Francesco Ficetola<sup>2</sup> · Alessia Guerrieri<sup>2</sup> · Emilio Padoa-Schioppa<sup>1</sup>

<sup>1</sup>University of Milano-Bicocca · <sup>2</sup>University of Milan

**D**espite the fundamental role in ensuring many ecosystem functions, soil biodiversity is still poorly known, due to the time-consuming methods and difficulties in the classification. This lack of knowledge is one of the threatening factors for pedofauna conservation. Thus, there is an urgent need to study and comprehend the edaphic fauna communities, both because of their intrinsic relevance and their role in the provisioning of ecosystem services. This work aims to provide a description of the alpine edaphic fauna using environmental DNA (eDNA) metabarcoding, hence identifying correlations with environmental features.

The study area is the Gran Paradiso National Park, an alpine protected area situated in Italy and the oldest National Park of the Italian territory. Alpine areas are one of the most vulnerable environments regarding the effects of climate change. A total of 122 plots was investigated with a stratified random plot sampling scheme, also we collected soil and vegetation samples, and we described the study area features. Environmental features were described as soil features (pH in water, soil organic carbon, total carbon and nitrogen, humus forms) and tree vegetation features (height, species, DBH, biodiversity indexes). The eDNA metabarcoding analyses detected 18 families of Arthropods, expressed as the frequency of sequences.

Generally, the most representative taxa were Isotomidae, Entomobryidae, and Hypogastruridae, whereas depending on the habitat examined differences in the community composition of arthropods were recorded. Mixed coniferous forests were mostly composed of Isotomidae, Entomobryidae, Hypogastruridae, and Onychiuridae, while Isotomidae, Cicadidae, Culicidae, and Neelidae were the most representative of mixed deciduous forests. Acidic and calcicolous forests resulted in other families, such as Scarabaeidae, Curculionidae, Brachyceridae. A Canonical Component Analysis (CCA) was carried on to detect the correlations between soil edaphic communities and environmental features. Coniferous and deciduous forests communities were correlated with site features (altitude), soil features (organic layers and organic carbon stock), and vegetation features (presence of mixed deciduous forest, tree basal area, tree biomass, Shannon index), interestingly grasslands were also correlated with soil pH and slope. This work attempted to take a first step towards the description of the complex composition of soil fauna communities. Environmental needs resulted as the driver of changes across the habitats, even though the cause-effect relationship between the correlations found still have to be studied. The comprehension of the interactions between the soil fauna and the environment will lead to the understanding of ecosystem functions and services. Eventually, once an exhaustive description of the soil biodiversity will be developed, specific and highly effective biodiversity conservation actions can be achieved.

## SODA ASH DUMPING GROUNDS: ARE THEY ATTRACTIVE HABITATS FOR BEES AND WASPS (ACULEATA)?

Lucyna Twerd

Kazimierz Wielki University

**P**rotection of anthropogenic habitats is a major problem of nature conservation now. In spite of the more and more often reported high environmental value of some types of post-industrial wastelands, so far they have been rarely used as areas that can support biodiversity.

The study was conducted in 2007-2010 at sites located on the investigations were conducted in soda ash wastelands that were still in use and unique in Poland, owned by Soda Polska CIECH sp. z o.o., with two soda ash facilities: Soda Mątwy in Inowrocław (52°45'17.03"N, 18°14'16.00"E) and Janikosoda in Janikowo in Poland. Highly saline, alkaline and moist solid waste and industrial wastewater are disposed of and hydraulically drained into sedimentation basins in areas next to the factory sites. The waste heaps are up to 16 m high. In total, the dump sites cover ca. 100 ha in Inowrocław and ca. 125 ha in Janikowo. The vegetation in Inowrocław is subject to ecological succession, whereas most of the filled waste beds in Janikowo have been subject to bioremediation.

Field research was conducted in 20 permanent plots in areas affected by sodium industry. Insects were collected in coloured pan traps in 3 types of microhabitats reflecting stages of plant succession.

The attractiveness of Solvay waste beds was assessed on the basis of contributions of selected groups of the Aculeata: Apiformes (bees), Spheciformes (sphecoid wasps), and Chrysididae (cuckoo wasps). In total, during the study period, 251 species of these groups were recorded, represented by 16,867 individuals. In respect of species richness, contributions of these groups was similar in both study areas: bees accounted for 60%, sphecoid wasps for about 20%, and cuckoo wasps for 12%. Differences concerned primarily their abundance. In the area of Soda-Mątwy, percentage contributions of bees and chrysidid cleptoparasites were comparable. In contrast, in the area of Janikosoda, the contribution of bees to total abundance was the highest (about 43%). Results of this study provide valuable tips for managers of Solvay-based chemical plants. Proper use of post-industrial wastelands will allow maintenance of their biodiversity and protection of many groups of organisms, while meeting the standards of environmental protection.

## ADEQUACY AND EFFECTIVENESS OF THE NATURA 2000 NETWORK IN CYPRUS

Charalambos Christodoulou<sup>1</sup> · Geoffrey Griffiths<sup>2</sup> · Ioannis Vogiatzakis<sup>3</sup>

<sup>1</sup>Ministry of Agriculture, Rural Development and Environment · <sup>2</sup>University of Reading · <sup>3</sup>Open University of Cyprus

The aim of the work was to evaluate whether the Natura 2000 network (N2K) provides adequate and effective protection for the threatened plants of Cyprus. Relying on principles of systematic conservation planning (SCP) and Marxan software, priority areas for the conservation of 252 taxa were identified using two scenarios: (1) the Annex II species of the Habitats Directive (19 taxa), and, (2) all Red Data Book species (RDB). For each scenario, four variations were examined based on varying the cost of implementation (cost surface) and the boundary length of the reserve network (Boundary Length Modifier). Conservation gaps were identified mainly outside state forest land in the area under the effective control of the Cyprus Government (CYGCA). Within this area the existing N2K network fails to achieve the specified targets for the RDB species under both scenarios. The total area required to satisfy the targets ranged from 2.23 to 5.46% of the area of the island. Solutions with uniform (area) cost achieve targets for the lowest cost but have the smallest overlap with the existing N2K network (52.5-60.3%). Solutions with variable cost achieve significantly higher overlap with N2K (72.9-75.9%). Scenario variations with variable cost result in a considerably higher proportion of irreplaceable planning units (PUs), and promote clustering without using BLM. Applying BLM reduces fragmentation and increases the number of irreplaceable PUs in both scenarios. The analysis identified 60 hotspots of threatened species of which 34 are within N2K (only for CYGCA). The overlap of irreplaceable PUs with hotspots is moderate (26 out of 60) but high with the rarest species (64% of irreplaceable PUs contain 50% of the occurrences of Critically Endangered species). Results corroborate that state-owned land can provide protection to most threatened species, but there is also a need to designate reserves in privately owned areas to protect many threatened species. The identification of conservation gaps combined with the independent selection of sites through a transparent and repeatable process will assist the competent authorities to designate new sites as part of a comprehensive and resilient reserve network.



## POSITIVE AND NEGATIVE ECOLOGICAL ASPECTS OF THE CURRENT SPITSBERGEN LANDSCAPE DEVELOPMENT

Wiesław Ziąja · Wojciech Maciejowski

Jagiellonian University

The Arctic landscapes and seascapes develop quickly due to intensive climate warming since the end of the 20th century. There is a wide ecological literature on negative results of this process. Hardly anybody of ecologists described its positive aspects. Our aim is to show them in Spitsbergen. What are the positive environmental phenomena under the global change? Surely, an increase in biodiversity and a bigger absorption of carbon dioxide by plants in photosynthesis belong to them.

Ice ablation – and thus glaciers' recession – is the first result of the warming. Hence, extensive areas were abandoned by glaciers. Afterwards, new landscapes and seascapes developed there. On deglaciated areas above the sea level, new landforms and deposits as well as water bodies have been formed and colonized by animals, followed by plant succession and soil formation. Many ice-freed areas on the coasts were inundated by the sea and colonized by marine biota.

Our field investigations were carried out in three areas representative for different parts of the island: central Spitsbergen, its SW coast, and its SE coast.

In central Spitsbergen, the inland mountain glaciers were thinned and shortened. Some of them are just in the process of transformation from valley glaciers into cirque or slope (hanging) glaciers. Areas abandoned by them became new mountain slopes or marginal zones built mainly of moraines (frontal and lateral) and sandurs on dead ice. They undergo a further transformation, including plant succession from a rich tundra nearby. Also on the mountain slopes, the upper limit of plants has been raised.

Some areas on the unglaciated SW coast (in Sørkapp Land), devoid of plant cover due to severe climatic conditions previously, have begun to overgrow with plants since the 1980s. The upper limit of plants is slowly going up in mountains. Unfortunately, the regeneration of reindeer herd (after extermination by trappers) from ca. 0 in the 1980s to ca. 170 in 2008 led to overgrazing.

The SE coast has extensively released from glaciers since the end of the 20th century (apart from bays' heads). Afterwards, animal colonization and plant succession (from small areas fertilized by birds) have begun. E.g., on the coast's part surveyed by us (ca. 15 km long), only 14 bird species (6 of them nesting) were found in 2005 and 2 new species appeared in 2016; the number of vascular plant species increased from 15 in 2005 to 18 in 2016. Numerous new plant patches appeared after 2005. A desert, prevailing in this coast, is just at the beginning of transformation into a high Arctic tundra.

Summing up: biodiversity of the island increases quickly, wilderness is becoming less glacial and more biotic; absorption of carbon dioxide by plants is bigger but still small; and all the described transformation will lead to a new landscape if the current warming continues.

## *Road ecology in times of rapid road construction: Recent advances and growing challenges*

### **Symposium organisers**

Jochen Jaeger (Concordia University), Wenche Dramstad (Norwegian Institute of Bioeconomy Research)

### **Summary**

The current rate of construction of transport infrastructure on the planet is astonishing. Roads and railways have many negative effects on wildlife populations, e.g., road mortality, barriers to movement, reduced connectivity, loss of roadless areas, the spread of invasive species. Road mitigation measures are urgently needed.

The symposium will address questions such as:

- What is the state of the art in road mitigation measures?
- How effective are they? Are wildlife passages or wildlife fences more important?
- What study designs, are effective at evaluating mitigation measures?

### **Description**

Roads and railroads have become ubiquitous features in landscapes around the world. The current rate of ongoing and planned road construction is unprecedented and has been termed a 'global infrastructure tsunami'. A major example is the Belt-and-Road Initiative (BRI) launched by China in 2013, which involves a large-scale expansion of land transportation infrastructure. The negative effects of roads on wildlife include road mortality, barriers to movement, habitat loss, subdivision of populations into smaller and less viable sub-populations, pollution (noise, light, chemicals), loss of roadless areas, the spread of invasive species, and easier access for poachers, among many others. To address this rapidly growing problem, better mitigation measures and more robust knowledge about their effectiveness is urgently needed, in particular at the population level, and for the protection of remaining roadless areas. Otherwise, the installation of mitigation measures is likely to be used as an excuse to justify road construction everywhere, including sensitive areas of high biodiversity, while in fact the effectiveness of these mitigation measures is highly questionable. Road ecology will need to better connect with connectivity conservation.

The symposium will address the following questions, among others: What are the thresholds in the effects of road density on wildlife populations? How long are response times of wildlife populations to the construction of new roads? What is the state of the art in road mitigation measures? How effective are they? Are wildlife passages or wildlife fences more important? How long should wildlife fences be? How does the fence-end effect depend on fence length? To what degree do animals use existing crossings structures under roads, and how does their use depend on human activity levels? What study designs, monitoring schemes, and measurement endpoints will be effective at evaluating road mitigation measures?

## EFFECTS OF ROAD LIGHTING ON INSECTS: ASSESSING THE ROLE OF LANDSCAPE AND VEGETATION STRUCTURE ALONG ROADS IN NORWAY

Ulrike Bayr · Nina S. Johansen

Norwegian Institute of Bioeconomy Research

Light pollution has become a growing concern in many developed countries as a result of a strong urban development throughout the past century. Artificial street lighting contributes to this issue and is known to have diverse effects on habitats that are located close to roads. In this regard, nocturnal insects are particularly exposed due to their strong sensitivity for light. Recent research has shown that light pollution is a major driver of declines in global insect populations. However, insects represent a large and diverse organism group which responds very differently to artificial light. Moreover, only few experiences exist about the effects of road lighting under arctic and sub-arctic conditions.

The aim of our study was to get an overview of the extent of this problem in Norway. For this purpose, we review the general effects of artificial road lighting on insects. In addition, a geospatial analysis along main roads in Norway is performed to identify the most vulnerable habitat types and which insect species are observed in those based on national register data. In this regard, a strong focus lies on understanding the role of landscape and vegetation structure along roads for the visibility of road lighting over large distances. Finally, we discuss the potential of different practical and technical solutions that may reduce the negative impacts on insects. Results from this study are intended to increase the general knowledge on the effects of artificial lighting on insects in northern latitudes. Moreover, it provides a basis for making more targeted recommendations to policymakers and authorities on which mitigation measures might have the largest potential to counteract further declines in insect populations.

## CAN ACOUSTIC STIMULI BE USED TO REDUCE UNGULATE-TRAIN COLLISIONS? RESULTS OF A BEHAVIOURAL EXPERIMENT

Manisha Bhardwaj<sup>1</sup> · Denice Lodnert<sup>2</sup> · Mattias Olsson<sup>3</sup> · Aina Winsvold<sup>4</sup> · Svein Morten Eilertsen<sup>5</sup> · Andreas Seiler<sup>2</sup>

<sup>1</sup>University of Freiburg · <sup>2</sup>Swedish University of Agricultural Sciences · <sup>3</sup>EnviroPlanning AB · <sup>4</sup>University Centre Dragvoll · <sup>5</sup>Norwegian Institute of Bioeconomy Research

Ungulate-train collisions can cost millions of euros each year in loss of life, distress, damages, and delays. Reducing collisions risks is a high priority for many transportation agencies and railway companies, however cost-effective solutions are not yet widely available or implemented. In order to develop such tools, we build on previous research that suggests early warning of an oncoming train can induce flight in wildlife in time to reduce the risk of collisions. Early warning through acoustic stimuli, particularly stimuli associated with predation may be most effective, as a natural anti-predatory behaviour in prey species is to flee.

To test this hypothesis, we created a two-phase experiment. In the first phase, we conducted controlled behaviour experiments in which investigated the behavioural response of roe deer (*Capreolus capreolus*) and moose (*Alces alces*) to acoustic stimuli. In before-during-after-control-impact experiments, we compared the likelihood of roe deer and moose to flee from: (1) predatory stimuli associated with hunting, (2) non-predatory stimuli such as bird calls and novel sounds, and (3) silent controls.

We found that predatory stimuli elicited flight in roe deer and moose more often and more consistently than non-predatory stimuli or silent controls. Roe deer fled in 42% of cases when predatory stimuli were used, 23% of the cases when non-predatory stimuli were used and 23% of the cases when no stimuli were used. Moose showed similar results, and fled in 60% of cases when predatory stimuli were used, 39% of the cases when non-predatory stimuli were used, and 13% of the time when no stimuli were used. We also found a slower rate of habituation towards predatory stimuli, and a longer time to return to sites after such stimuli were displayed. These findings suggest that acoustic stimuli can be used to modify the behaviour of roe deer and moose, and motivate them to leave a site and stay away temporarily. In the next phase of the project, we test the same stimuli at railways and evaluate their effectiveness to reduce the rates of collisions.

## UNGULATES AND TRAINS – FACTORS INFLUENCING FLIGHT RESPONSES AND DETECTABILITY

Manisha Bhardwaj<sup>1</sup> · Mattias Olsson<sup>2</sup> · Emma Håkansson<sup>2</sup> · Pär Söderström<sup>3</sup> · Andreas Seiler<sup>4</sup>

<sup>1</sup>University of Freiburg · <sup>2</sup>EnviroPlanning AB · <sup>3</sup>SJ AB, Rolling Stock Division · <sup>4</sup>Swedish University of Agricultural Sciences

Collisions between wildlife and trains can result in loss of life, damages, scheduling delays and psychological distress, amounting to societal costs exceeding millions of euros annually. To manage and reduce the ecological and socio-economic impacts of wildlife-train conflicts, many transport agencies across the globe invest in strategies to prevent collisions. Strategies often include fencing; however, railway networks are rarely completely fenced due to cost and technical restrictions, and wildlife inevitably come onto the tracks. Thus, alternative methods of collision-prevention must be developed. However, the mechanisms behind collisions are currently poorly understood, and this has a limiting effect on the successful development of mitigation strategies. To address this gap in knowledge, we explored two major mechanisms of wildlife-train collisions: the response of wildlife to oncoming trains and the detection of wildlife by drivers.

In this study, we used dashboard cameras to explore the response of roe deer (*Capreolus capreolus*) and moose (*Alces alces*) to oncoming trains. We investigated their flight behaviour according to the use of warning signals and train speed, and explored which factors, such as lighting and physical obstructions, affect their detection by drivers. In a majority of cases, roe deer and moose fled from an oncoming train, at an average flight initiation distance (FID) of 78 m and 79 m respectively. Warning signals had controversial influences on flight behaviour. Use of warning signals induced earlier flight in roe deer, which fled on average 44 m further from the train when warned. However, this induced flight was usually in the direction of danger and towards the train. FID of moose was unaffected by the use of a warning horn. As train speed increased, moose had a lower FID, but roe deer FID did not change. Finally, detection of wildlife was predominately obstructed by the vegetation and terrain in the rail-side verge, which could increase the risk of collisions.

Our results indicate the need for early detection and warning of wildlife to reduce the risk of collisions. We propose detection systems should include thermal cameras to allow detection behind vegetation and in the dark, and warning systems should use acoustic cue to warn of an oncoming train earlier and allow wildlife to escape the railway corridor safely.

## ARE OLFATORY REPELLENTS REASONABLE ALTERNATIVES TO FENCING ALONG SECONDARY ROADS IN PREVENTION OF UNGULATE-VEHICLE COLLISIONS?

Michal Bíl

Transport Research Centre

Traffic crashes of motor vehicles with ungulates (UVC) are a safety issue in many European countries where wild ungulates (e.g., roe deer, wild boar) live in large populations. Many preventive measures, in relation to safety of drivers, have been applied along primary roads. Fences, which aim at preventing ungulates from entering a road, are among the most widely used. Their construction and maintenance are, however, costly and time consuming. Overall costs are further increased when underpasses or even overpasses are built in order to secure landscape connectivity.

Secondary roads with lower traffic volumes and speed, than those usually measured on primary roads and motorways, are also places where UVC occur. Due to their extent and rather low benefit when compared to costs of fences accompanied by underpasses or overpasses, effective and affordable measures are needed for these roads.

Olfactory repellents (OR) are widely applied in many European countries in order to prevent UVC. OR are chemical substances, usually injected into a foam and placed on sticks installed with spacing of approximately 10 m along the riskiest road sections. The problem is that these measures have only rarely been reliably tested. Its effectiveness, in terms of roadkill (as well as traffic crash) reduction, have usually not been based on sound data and robust study designs. The majority of data and results come from either OR producers or local wildlife managers who only applied before-after study designs at best.

Over the last five years, we studied OR effectiveness using two approaches: the change in the number of carcasses (Bíl et al., 2018) and changes in roe deer behaviour near roads (Bíl et al., 2020). Whereas the first study, based on the Before-After-Control-Impact approach, showed the UVC reduction between 26-43%, the second approach, where we studied roe deer behaviour, indicated no clear effect of OR.

We began this year with a large-scale three-year study on Czech roads focused on OR effectiveness. During the first year, ungulate carcasses will be monitored at 133 places along the secondary roads (at both case and control sections). OR will be applied during the next year to case profiles only. Finally, the evaluation of the OR effectiveness will be evaluated. Together with this study, ungulate behaviour will be determined for several individuals equipped with GPS collars, at profiles where OR will be alternately applied. We also plan, as part of this study, to perform a cost benefit analysis related to OR costs and expected effectiveness.

Bíl M. et al. (2018). *An Evaluation of Odor Repellent Effectiveness in Prevention of Wildlife-Vehicle Collisions*. J. Environ. Manage., 205: 209-214.

Bíl M. et al. (2020). *No clear effect of odour repellents on roe deer behaviour in the vicinity of roads*. Wildlife Biol, 20(4): 1-11.

## SPATIO-TEMPORAL DISTRIBUTION OF WILDLIFE-VEHICLE COLLISIONS IN THE POLISH CARPATHIANS BETWEEN 2015 AND 2021

Wojciech Haska · Michał Jakiel

Jagiellonian University

The rapid development of linear infrastructures worldwide, resulting in an increased landscape fragmentation and habitat loss. One of the most important direct impacts on wildlife is the collision with vehicles (Forman, Alexander, 1998; Pagany, 2020). Currently wildlife-vehicle collisions (WVCs) are of increasing concern, on public roads in Poland. Between 2010 and 2021, the number of WVCs in Poland increased by nearly 52%, compared to the record year 2019, when the number of documented collisions was 29,714, including 215 accidents in which 251 people were injured and 16 more lost their lives. WVCs have important social, economic and ecological consequences. In addition to the significant risk of loss of life, health and property of people, these events also may have a negative impact on animal populations. According to the data from the Police Headquarters, at least several thousand animals were killed in collisions every year. The problem of collisions is directly related to the negative effects of landscape fragmentation by expansion of road networks and the lack of appropriate infrastructure (Pagany, 2020). The aim of our research was to determine spatial and temporal distribution of WVCs and better understanding influencing factors of collision risks such as landscape pattern, topography, road characteristics and seasonal differences. It also allowed us to identify WVCs high risk areas and comparison with existing ecological networks.

The study was carried out within the Polish Carpathians. The Carpathians are an important biodiversity hot-spot, where many species of large mammals have existed for a long time, and that is why there is a need for better monitoring of WVCs and to implement appropriate and efficient mitigation measures. The data for the analysis were obtained from the Police Headquarters and the National Register of Road Collisions with Animals.

Forman R.T.T., Alexander L.E. (1998). *Roads and their major ecological effects*. *Annu. Rev. Ecol. Syst.*, 29: 207-231.  
Pagany R. (2020). *Wildlife-vehicle collisions – Influencing factors, data collection and research methods*. *Biol. Conserv.*, 251: 108758.

## ADDRESSING THE FLOMS TRADE-OFF: HOW LONG DO WILDLIFE FENCES ALONG ROADS HAVE TO BE TO MITIGATE THE FENCE-END EFFECT?

Jochen Jaeger<sup>1</sup> · Stefano Re<sup>2</sup>

<sup>1</sup>Concordia University · <sup>2</sup>Polytechnic University of Turin

**W**ildlife fences are highly effective at reducing road mortality caused by wildlife-vehicle collisions (WVC) and are often used in combination with wildlife passages. Will a Few Long Or Many Short (FLOMS) fences be more successful at reducing roadkill? In theory, fencing many short road sections would require a shorter total amount of fence for the same predicted reduction in mortality than fencing a few long sections (Spanowicz et al., 2020). However, animals can move along the fence and around the fence ends and often get killed there. This ‘fence-end effect’ reduces the effectiveness of fencing. While more effective measures exist (e.g., placing roads in tunnels underground or raising roads on pillars), they are often unrealistic. Less expensive measures such as wildlife warning signs and reflectors have been shown to be ineffective in most cases. Mortality-reduction graphs can be employed to prioritize road sections for fencing, following an adaptive fence-implementation plan (Spanowicz et al., 2020). The ‘fence-end effect’ makes the use of many short fences less effective than the use of a few long fences, because animals moving along a long fence are more likely to change course before arriving at the fence end. This trade-off between the total number of fence sections and the length of the fence sections has been called the FLOMS (Few-Long-Or-Many-Short) fences trade-off (Spanowicz et al., 2020). When considering the fence-end effect, how long is long enough for a fence to be effective?

We present a novel analytical model for predicting the fence-end effect as a function of fence length ( $L$ ). We compare four variations of the model with empirical data. Effective fence-length is  $L_{\text{eff}} = L - R$  in Model A,  $L_{\text{eff}} = L - 0.5 R$  in Model B,  $L_{\text{eff}} = L - 0.4521 R$  in Model C, and  $L_{\text{eff}} = L - 0.226 R$  in Model D, where  $R$  is the radius of the home range of the target species. Accordingly, the probability of fence success is  $\text{PFS} = 1 - R/L$  in Model A,  $\text{PFS} = 1 - 0.5 R/L$  in Model B,  $\text{PFS} = 1 - 0.4521 R/L$  in Model C, and  $\text{PFS} = 1 - 0.226 R/L$  in Model D. We use these models to predict the minimum length of wildlife fencing that can be expected to be effective for various species. We also present modifications to these models for fences that are poorly maintained. The models are included in the mortality-reduction graphs to predict the effectiveness of any amount of fencing at reducing wildlife mortality and to help planners design effective and efficient configurations of fencing.

Spanowicz A.G. et al. (2020). *An adaptive plan for prioritizing road sections for fencing to reduce animal mortality*. *Biol. Conserv.*, 34(5): 1210-1220.



## INCORPORATING THE LANDSCAPE ECOLOGICAL RISK INDEX IN ASSESSING THE IMPACTS OF ROAD NETWORKS (CASE STUDY: CHAHARMAHAL & BAKHTIARI PROVINCE, IRAN)

Shekoufeh Nematollahi<sup>1</sup> · Sima Fakheran<sup>1</sup> · Ali Jafari<sup>2</sup> · Felix Kienast<sup>3,4</sup>

<sup>1</sup>Isfahan University of Technology · <sup>2</sup>Shahrekord University · <sup>3</sup>Swiss Federal Institute for Forest, Snow and Landscape Research · <sup>4</sup>ETH Zürich

Roads are an integral component of landscapes and play a key role in describing the landscape pattern. On the one hand, roads deliver a wide range of social and economic benefits such as providing connectivity and enabling communities to expand into previously remote areas. On the other hand, road networks cause diverse negative effects, including habitat loss, decrease in habitat quality for wildlife population, and barrier effects, which affect ecological processes and speed up habitat destruction, eventually resulting in ecological risks. The latter refers to the ability of an ecosystem to maintain its functions despite exterior interferences caused by human activities, including land use change and road networks development.

The aim of the present study was to quantitatively assess the ecological risks of road networks on natural habitats of vulnerable species with a set of spatially explicit indicators. The usefulness of our indicators was tested in a case study – the Chaharmahal & Bakhtiari Province (Ch & B) located in the central part of the Zagros Mountain Chains, Iran. The area has a rough terrain and climate varies considerably. This causes high ecosystem diversity and provides suitable habitats for a great variety of plant and animal species, including wild sheep (*Ovis orientalis*) and Persian leopard (*Panthera pardus*), classified as vulnerable and endangered species on the IUCN red list, respectively. However, due to the high density of road networks, these natural habitats are highly vulnerable, calling for ecological restoration measures at the most effective locations.

To find these locations and to assess habitat disturbance caused by road networks, we utilized the so-called Landscape Ecological Risk Index (ERI). ERI was composed of the Landscape Disturbance Index (Ei) and Frangibility Index (Fi). The Ei quantified the magnitude of outside interferences on natural habitats and was based on three sub-indices of Landscape Splitting index (Si), Landscape Fragmentation index (Ci), and Landscape Dominance index (Di). The Fi evaluated the internal ability of the landscape type to preserve its stability in reaction to outside stresses and was assigned based on the local condition and expert knowledge.

After mapping ERI, we found that the index was distributed irregularly over Ch & B. Higher ERI values were found in the central and north-eastern parts, in places dominated by dense road networks and urban settlements. Lower values of ERI were found in the eastern, southern and western parts which were dominated by mountainous areas encompassing forest and grassland and low level of urbanization. Protected areas have between 8-15% high-risk areas. Thanks to our indicators we know exact geographical locations of these critical areas and are able to suggest appropriate mitigation strategies.

## ORTHOPTERAN ASSEMBLAGES IN A ROADSIDE HABITAT: ADVERSE EFFECTS OF TRAFFIC NOISE AND VEGETATION HEIGHT

Fran Rebrina<sup>1</sup> · Klaus Reinhold<sup>2</sup> · Nikola Tvrtković · Andreja Brigić<sup>1</sup>

<sup>1</sup>University of Zagreb · <sup>2</sup>Bielefeld University

**A**s integral elements of the 21st century landscape, major roads have a profound environmental impact, inducing changes in roadside habitats both directly through pollution and soundscape alteration, and indirectly through changes in vegetation structure and microclimate. Despite their importance in terrestrial ecosystems, ecological effects of roads on insects are still rarely considered in road-planning and management due to the scarcity of data, particularly at the assemblage level.

In a five-month study conducted along the largest Croatian motorway in 2018, we sampled orthopteran (Insecta: Orthoptera) assemblages at five distances from the road: 10, 25, 50, 100 and 500 m, in eight locations within a homogeneous grassland habitat. We used two sampling methods: pitfall trapping and sweep netting. Generalized linear mixed models were constructed to test for spatial differences in assemblage metrics and to assess the relationships between orthopteran assemblages and road-influenced environmental factors: traffic noise, vegetation height and soil moisture. Variation partitioning and redundancy analysis were performed to evaluate the influence of these factors on spatial distribution of orthopteran species in the study area.

Orthopteran assemblage metrics exhibited significant spatial variation with distance from the motorway in the pitfall dataset. Decrease in abundance, species richness, diversity and conservation value within the first 10 m from the road was likely associated with negative responses of geobiont and geo-chortobiont species with low-frequency signals to traffic noise and, potentially, low soil moisture. At larger distances, however, these species may benefit from noise reduction by overlaying vegetation; traffic noise had a stronger overall impact on chortobiont species sampled by sweep-net. Nevertheless, orthopteran assemblages were primarily affected by road-induced changes in vegetation height; an increase in habitat heterogeneity compared to more distant sites may have prompted an increase in assemblage metrics at 25 m from the road. In contrast to previous findings, pitfall trapping proved to be a useful method for road impact assessment and monitoring of roadside Orthoptera.

This study shows, for the first time, that major roads affect orthopterans at the assemblage level, but different subsets of orthopteran assemblages are affected in different ways. Our findings have profound implications for roadside vegetation management strategies aiming to mitigate negative impacts of transport infrastructure, and anthropogenic change in general, on terrestrial invertebrates.

## NO PLACE TO GO: WILDLIFE AND ROAD NETWORK IN AN ISLAND ENVIRONMENT

Savvas Zotos · Vassilis Litskas · Stalo Leontiou · Ioannis N. Vogiatzakis

Open University of Cyprus

**H**uman activities on islands are inevitably conditioned by space. In Cyprus, the island landscape forms a mosaic of competing and often conflicting uses. For wildlife one of the major implications is that road development leads to habitat loss and fragmentations with direct and indirect impacts on species ecology, genetics and behaviour, affecting in turn any conservation effort.

Despite the dramatic increase of the road network over the past few decades and its current high density, roads on the island are still expanding while news plans have been drafted for developing additional highways. This comes in direct conflict with the high number and proportion of protected areas covering the island (62 Natura 2000 sites; 59 sites designated under national laws; 37.6% of land) and its high biodiversity (299 species and 47 habitats protected under EU law). Roadless areas are limited, protected habitats are highly fragmented, while no proper evaluation of direct, or indirect, impacts of the road network on wild fauna has been conducted to date. In addition, data on Wildlife Vehicle Collisions (WVC) to date remain fragmented, collected in an ad hoc manner with absence of centralized sharing and analysis. This results in underreporting of WVCs and inconsistent assessment (and planning) regarding its contribution to biodiversity loss, which in turns hinders the use of any information for decision-making.

The paper reports on the extent of the phenomenon as currently known by analysing two WVCs datasets acquired through different approaches: (1) citizen science initiative developed to monitor and report WVC on the road network, (2) current government records of WVC on highways.

The volume of available information was spatially analysed using ArcGIS and R. Statistical analysis revealed relations between WVC distribution and road characteristics while a multi-level Habitat Suitability Modelling (HSM) framework was used to identify areas showing a high probability of roadkill occurrence throughout the island (~19,500 km) based on multi-scale environmental determinants. We emphasize the urgency of acting retrospectively, for the current road network, and advice in proactive measures for new road infrastructures, to minimize fragmentation and conserve biodiversity. Using Cyprus as a case study, we elaborate methods and steps that can be followed to restore habitat connectivity in an island environment.

# *Assessing and monitoring connectivity restoration and conservation at local and regional scales*

## **Symposium organisers**

*Ulrich Walz* (Dresden University of Applied Sciences), *Jochen Jaeger* (Concordia University)

## **Summary**

The connectivity of natural and semi-natural landscape elements and large-scale landscape areas is becoming increasingly important in our rapidly sprawled, fragmented, and intensified landscape. Connectivity conservation and restoration will require some consistent form of assessment and monitoring to be able to evaluate the needs for action and any progress made. This symposium welcomes contributions to local and regional projects aiming at identifying and restoring connectivity approaches to monitoring, e.g., using landscape metrics, and on the integration of connectivity into planning.

## **Description**

In summer 2020, the IUCN published their new report providing "Guidelines for conserving connectivity through ecological networks and corridors" (<https://portals.iucn.org/library/node/49061>). This report emphasizes the importance of preserving, maintaining, and restoring well-functioning corridors in the habitat network for the preservation of biodiversity. Large-scale corridors at both national and regional level play a role here, as does the structural diversity of the landscape in the spaces between the corridors. In order to identify needs for action and to demonstrate progress, suitable tools are needed for monitoring and evaluation on a regular basis. Current concepts of regional planning and nature conservation stipulate that a certain proportion of connected habitats should be present in all landscapes in order to maintain their ecological functions. For this purpose, connectivity conservation will require some form of monitoring at the landscape level.

The symposium will address the following issues, among others:

- Examples of local and regional projects aiming at the identification, restoration, protection, or maintenance of habitat networks.
- Approaches to monitoring based on landscape metrics from local to regional scales.
- Comparison of different approaches to model connectivity (circuit theory, graph theory, ...) and available software and Metrics like Circuitscape, Omniscape, Linkage Mapper, or indicator 2 of the City Biodiversity Index (CBI).
- Consideration of functional connectivity and structural connectivity.
- Verification of connectivity models: How appropriate is the use of roadkill data?
- Consideration of ecological connectivity in planning and in EIA: Where are performance gaps, and where is need for improvement?

## ASSESSING THE STRATEGIC IMPORTANCE OF VEGETATED AREAS IN MULTI-DWELLING UNITS TO RESTORE ECOLOGICAL CONNECTIVITY IN THE FRENCH METROPOLITAN AREA OF LYON

Marc Bourgeois<sup>1</sup> · Thomas Boutreux<sup>1,2</sup> · Bernard Kaufmann<sup>2</sup>

<sup>1</sup>CNRS, UMR 5600 · <sup>2</sup>CNRS, UMR 5023

Urbanisation leads to the destruction and fragmentation of natural habitats. For the last decade, public institutions have been encouraging urban densification to prevent urban sprawl, which has resulted in a shrinking of vegetation in private plots which constitutes 75% of the total green area in the metropolitan area of Lyon (1.4 million inhab.). While individual gardens have received considerable scientific attention, vegetated areas in multi-dwelling units have remained absent from the literature. In this work, we show the importance of vegetated areas of multi-dwelling units for urban biodiversity, focusing on ecological connectivity.

For this work, we produced a high-resolution land cover map (1 m) of the metropolitan area of Lyon (534 km<sup>2</sup>) with 35 classes including five vegetation types classified by height. Using this map, we identified the potential habitats of four species profiles living in cities: mammals with shrubs as habitat (e.g. hedgehogs), mammals with large trees as habitat (e.g. squirrels), birds with small and large trees as habitat (e.g. great tits), flying insects with herbaceous vegetation as habitat (e.g. butterflies). Based on expert knowledge and bibliographic data, we identified for these four profiles: habitat patches, movement preferences (by assigning costs to each class), patch area and dispersal distance. We modelled landscape graphs (nodes as habitat patches, links as potential movements) and computed connectivity metrics using Graphab software. To assess the importance of vegetated areas in multi-dwelling units for the global connectivity of the metropolis area, we designed four scenarios with modification of their plot land cover: (1) maximum theoretical connectivity: all the surface (including buildings) is replaced by vegetation of species habitat class, (2) minimum theoretical connectivity: all the surface is replaced by the built-up class, (3) unsealing and greening: all the surface (excluding buildings) is replaced by vegetation favourable to species movement but not considered as habitat, and (4) maximum renaturization: all the surface (excluding buildings) is replaced by vegetation of species habitat class.

Global and local connectivity metrics were computed for each species and compared to the current state. The results demonstrate the importance of the vegetated areas in multi-dwelling units. By acting in a targeted way on only 4% of the metropolitan area, connectivity can be significantly improved. For some species connectivity values can double between the current state and the 'max. theoretical connectivity' and be multiplied by 1.5 for the 'max. renaturization'. The 'min. theoretical connectivity' only reduces connectivity by 5 to 10% for all species profile which suggests that vegetated areas in multi-dwelling units could currently be unattractive for biodiversity and could be largely improved both in terms of quality and quantity of habitat. These results open the discussion on urban planning to enhance urban biodiversity.

## ECOSYSTEMS AS COMPLEX NETWORKS: A STUDY OF THE NETWORK TOPOLOGY OF TWO CONTRASTING ECOSYSTEMS, SUCH AS DRYLAND AND RIVER-FLOODPLAINS

Sonia Recinos Brizuela<sup>1</sup> · Shubham Tiwari<sup>2</sup> · Laura Turnbull-Lloyd<sup>2</sup> · Thomas Hein<sup>1</sup> · John Wainwright<sup>2</sup> · Andrea Funk<sup>1</sup>

<sup>1</sup>University of Natural Resources and Life Sciences, Vienna · <sup>2</sup>Durham University

In the last two decades, network theory has been widely used to study the connectivity of ecosystems. The main idea behind this framework is to obtain crucial information about the system by studying its underlying network topology. However, a clear conceptualization of connectivity in some ecosystems is still needed to better understand the spatial relations and to quantify biophysical fluxes and the related adaptation paths of ecosystems.

In this work, we provide conceptualizations of structural (SC) and functional connectivity (FC) under ecological and geomorphological perspectives, as well as examples and characteristics of network-based abstractions for two contrasting ecosystems: dryland and river-floodplain. We use two case studies for dryland and riverine ecosystems to study how system characteristics and discipline perspectives influence network topology. The first study case corresponds to the grassland-shrubland transition zone in the Sevilleta Long Term Ecological Research (LTER) Program, in the Chihuahuan desert of the southwestern United States. Here we focus on ecogeomorphology and land-degradation feedbacks. The SC of this system is derived from the flow routing and presence of vegetation sink, while the FC represents the hydrological and sediment fluxes (runoff and sediment transport). The second case study corresponds to a floodplain section of the Donau-Auen National Park, located along the Danube River in Austria. In this case we maintained an ecological perspective to assess the effects of river restoration measures on the overall habitat connectivity of benthic macroinvertebrates (connectivity between habitat patches via dispersal). Here the SC derives from the 'architecture' of the river-floodplain system, before and after the restoration measures were implemented. On the other hand, the FC represents the dispersal flows of benthic macroinvertebrates through the SC template. After building the SC and FC networks for both of the study cases, we calculated node-level metrics (degree centrality, node strength, betweenness centrality and PageRank centrality) and network-level metrics (link density, assortativity coefficient, and global efficiency).

In our results, the different network metrics allowed us to identify local and system-level patterns of connectivity, highlighting how different vegetation types SC and FC in dryland ecosystems, and the increase in the overall structural connectivity after the implementation of river restoration measures. The application of network theory can help us to understand the emergent properties of real-world complex ecosystems. It represents a valuable toolset to study the degradation and can also be used to assist the management and conservation of endangered ecosystems.

## ASSESSING THE INFLUENCE OF TERRESTRIAL PESTICIDE EXPOSURE ON AMPHIBIAN POPULATION NETWORKS

Greg Churko<sup>1</sup> · Erich Szerencsits<sup>1</sup> · Benedikt Schmidt<sup>2</sup> · Annette Aldrich<sup>1</sup>

<sup>1</sup>Agroscope · <sup>2</sup>University of Zürich

**S**eventy percent of the native amphibian species in Switzerland are considered endangered. Their population declines are attributed to many factors, including the use of plant protection products (PPPs) by the agricultural industry. While numerous studies as well as protective policies exist concerning the flow of plant protection products into the aquatic habitats of amphibians, PPP exposure in their terrestrial habitats is comparatively poorly addressed. Through reduced fitness or mortality of individuals following the dermal absorption of PPP-associated toxins, terrestrial PPP-exposure is expected to negatively affect amphibian population growth and dispersal between populations.

To identify areas where conservation measures are required, we modelled the population networks of twelve amphibian species and compared them to spatial data on agricultural activities in a nationwide analysis. We first generated habitat suitability maps for each species by evaluating the correlation between terrestrial species occurrences and various landscape attributes using multiple algorithms at multiple scales. Where available, we used local landscape genetic studies from the literature to validate and select the most appropriate distribution model for each species. We then modelled dispersal routes between all recorded breeding sites for each species with Circuitscape, using the habitat suitability maps as the basis for the resistance surfaces.

The habitat suitability and connectivity maps allow the localization and quantification of potential hotspots for PPP-exposure within the core habitat around each species' breeding sites and along the movement routes between them. By highlighting differences among species, we identify species which are particularly at risk and gain insight into the mechanisms with which PPPs in terrestrial habitats influence these networks. Together, the maps provide policy makers with a flexible tool that can identify and prioritize regions for the implementation of locally adapted management strategies.

## CONSERVATIVE ARBORICULTURE: PERSPECTIVES FOR ENHANCING LANDSCAPE CONNECTIVITY AND PROMOTING BIODIVERSITY IN URBANIZED LANDSCAPES

Davide Corengia<sup>1</sup> · Michele Corengia<sup>2</sup> · Elisa Cardarelli<sup>3</sup> · Claudia Canedoli<sup>3</sup>

<sup>1</sup>Associazione Arboricoltori · <sup>2</sup>University of Italian Switzerland · <sup>3</sup>University of Milano-Bicocca

**T**rees are fundamental elements of the landscape because they contribute to the biophysical structure and to the maintenance of landscape connectivity and functionality. In particular, old trees are central to sustaining biodiversity, because they are rich in the so-called 'Tree related Microhabitats' (TreMs). TreMs are distinct, well-delineated structures occurring on living or standing dead trees, that constitute particular and essential substrates or life sites for species. Despite their importance, TreMs are very scarce in cities because of management practices that deplete and simplify trees' architecture and structure and thus threaten biodiversity. The current trend is to remove thoughtful 'problematic' trees (for example because they have rotting or ruptures) and replace them with young specimens, unable in the short and medium-term to replace the ecological role of the removed trees.

By linking ecological knowledge and management practices, we aim to propose a novel concept of modern arboriculture, a conservative arboriculture, which objective is to reconcile human needs related to safety with the conservation of biodiversity in urbanized landscapes. We present an examination about which are the current arboricultural criteria that determine trees' management choices, what is the relationship between these factors and biodiversity levels, and how the current practices are affecting the provision of habitat for species and ecological connection.

Our results show that three are the main foundation criteria of modern arboriculture: safety for people and artifacts, ornamental beauty, plant health. All these factors decreased when trees reach the more mature stages, which is the phenological phase where biodiversity associated with trees starts to increase. These contrasting trends generate a conflict between human intervention and biodiversity conservation. We discuss how this conflict can be overcome by highlighting which are the paradigms and practices that need to be rethought: the difference between objective safety and perceived safety, the cultural concept of 'beauty' associated with trees, and management practices. We finally present examples of these practices such as maintenance of deadwood in the crown, simulation of natural breakages, or creation of TreMs.



## VALIDATION OF GRAPH-BASED CONNECTIVITY MODELS USING GENETIC DATA

Alexandrine Daniel<sup>1</sup> · Paul Savary<sup>2</sup> · Jean-Christophe Foltête<sup>2</sup> · Aurélie Khimoun<sup>1</sup> · Cyril Eraud<sup>3</sup>  
· Bruno Faivre<sup>1</sup> · Anthony Ollivier<sup>1</sup> · Hervé Moal<sup>4</sup> · Gilles Vuidel<sup>2</sup> · Stéphane Garnier<sup>1</sup>

<sup>1</sup>CNRS, UMR 6282 · <sup>2</sup>CNRS, UMR 6049 · <sup>3</sup>French Biodiversity Agency · <sup>4</sup>ARP Astrance

**M**odelling the functional connectivity of habitats is crucial for biodiversity conservation. By modelling potential dispersal paths among habitat patches, landscape graphs are often used to quantify landscape connectivity. While this approach seems promising, it often lacks biological validation. To ensure its ecological relevance, we assessed the ability of connectivity metrics calculated from landscape graphs to predict population genetic structure that closely reflects the dispersal of individuals, and thus functional connectivity. We modelled the habitat network of a forest bird species (Plumbeous warbler, *Setophaga plumbea*) in Guadeloupe using three graphs constructed either from expert opinion, habitat specialization indices, or a species distribution model (SDM). Genetic data (microsatellites) were also collected on 712 individuals in 27 populations. This genetic dataset was used as an empirical validation tool for the three landscape graphs, using two approaches: (1) relating the cost-distances obtained from the graphs to between-population genetic distances, (2) relating the connectivity metrics obtained from the graphs to within-population genetic diversity. The large proportion of variance in genetic distances explained by least-cost paths and the strong correlation between connectivity metrics and genetic diversity indices demonstrate the ability of landscape graphs to model the influence of landscape connectivity on dispersal. In addition, our results provide insight into the relationships between construction costs and ecological relevance of landscape graphs, as the most complex approach (SDM) is not always the most efficient.

## SPATIO-TEMPORAL NETWORKS FOR WETLAND BIODIVERSITY CONSERVATION

Nivedita Varma Harisena · Maarten Jan van Strien · Adrienne Grêt-Regamey

ETH Zürich

Socio-ecological systems analysis for biodiversity conservation often only considers the size and quality of habitats, but ignores their spatial connections and evolution over time. This can lead to results that are not mechanistically intuitive e.g. an increase in habitat area or quality does not correlate to biodiversity increase. The confounding factors here are two-fold: first, spatial fragmentation or topological changes between habitat patches can influence occupancy of the patches and second, a time lag may exist in species response to past anthropogenic stress. In an effort to model both types of factors, the study proposes the use of spatio-temporal habitat networks. These habitat networks are identified by using least cost paths (LCP) to model the connectivity. Using different scenarios of resistance surface, the LCP for the different pairs of patches are optimised by maximising the correlation between the cost distances matrices and the species composition matrices (i.e. the more connected the more similarity in species composition).

The resistance scenarios are further augmented with historical landcover information over a time span of 150 years (1870-present) such that the legacy impacts of such past change can be included in the resistance surface for the current wetland biodiversity. This landcover information as well as the core wetland patches, are extracted from historical maps of Switzerland (i.e. the Siegfried maps and old National maps). This rich dataset further allows us to quantify unique spatio-temporal indicators such as the time-period of branching of larger wetlands patches to smaller ones that can dictate the similarity in species composition between spatially disaggregated patches (terrigenetic distance). The study has been conducted for the highly fragmented wetlands of the Swiss Plateau to explain alpha and beta diversity in amphibian and dragonfly species.

The results confirm that spatio-temporal network indicators (e.g. terrigenetic distance, historical landcover changes) show a significant and higher contribution to the contemporary biodiversity in wetlands species compared to models using purely contemporary spatial indicators. Along with increasing our knowledge on key spatio-temporal processes that determine biodiversity patterns, the results also show how to develop spatial planning solutions (for e.g. the planning of regional wetland infrastructure) aimed at conserving biodiversity in socio-ecological systems.

## HOW ARE LANDSCAPE FRAGMENTATION AND CONNECTIVITY RELATED? COMPARING METHODS FOR MEASURING LANDSCAPE CONNECTIVITY

Jochen Jaeger · Clara Freeman-Cole

Concordia University

**W**e clarify the relationship between several concepts of landscape fragmentation and connectivity. This is necessary in order to avoid their interchangeable and confusing usage, to highlight potential misunderstanding of certain subtypes of fragmentation and connectivity, and to assess the suitability of available landscape metrics for landscape monitoring. We address three research questions: (1) What are the most relevant definitions of fragmentation and connectivity in the literature? (2) What exactly is the nature of the relationship between fragmentation and connectivity? (3) Which methods available for measuring landscape connectivity consider within-patch connectivity and which ones do not?

We compare common definitions of fragmentation and connectivity (and their subtypes) from the literature. For example, we compare the concept of habitat fragmentation per se with a more general understanding of habitat fragmentation. We then characterize the nature of the link between fragmentation and connectivity in both a conceptual and a quantitative discussion of the concepts of within-patch and between-patch connectivity. We created five sets of landscapes, or 'tests', to examine the behaviour of a variety of measures of connectivity. The four main features examined were within-patch connectivity, between-patch connectivity, relative patch size of component size, and barrier strength or matrix properties (resistance to movement). Definitions of fragmentation tend to refer to the breaking apart of a variety of aspects of the landscape, such as land-cover types or habitats. A key finding is that fragmentation and connectivity are not inversely related concepts. More precisely, and perhaps surprisingly for some readers, fragmentation per se is equivalent to a reduction of within-patch connectivity (with no habitat loss) and vice versa. Between-patch connectivity, on the other hand, may either increase or decrease depending on the distances between the resulting fragments. Metrics that do not include within-patch connectivity often lead to erroneous results and misleading conclusions when the total area of habitat changes or when habitat patches become fragmented.

The results highlight a crucial need to consider the balance between within-patch connectivity and between-patch connectivity when measuring and monitoring landscape connectivity. The results provide an assessment of the suitability of a variety of common metrics employed to quantify connectivity, and help identify the most appropriate measures for general use.

## THE INFLUENCE OF THE SPATIAL DEVELOPMENT ON THE ECOLOGICAL NETWORK MANAGEMENT AT A LOCAL AND REGIONAL SCALE. CASE STUDIES IN WIELKOPOLSKIE PROVINCE

Marta Kubacka

Adam Mickiewicz University

Latest evaluation of European Environment Agency (EEA, 2020) shows Europe's nature in serious, continuing decline. The EU Biodiversity Strategy for 2030 remarked that “in order to have a truly coherent and resilient Trans-European Nature Network, it will be important to set up ecological framework to prevent genetic isolation, allow for species migration, and maintain and enhance healthy ecosystems” (EC, 2020). On the other hand the lack of comprehensive and consistent data on this aspect has made the management effectiveness element surprisingly hard to assess (Kubacka, 2019; Kubacka, Smaga, 2019; Kubacka et al., 2022)

The main goal of this study involves the accomplishment of the following partial objectives: (1) determination of land use/land cover (LULC) changes within the ecological network in terms of time and space, (2) determination of the integrity of the spatial stature of the ecological network, as well as the degree of fragmentation and isolation of components, and (3) characteristics of planning and strategic studies in terms of spatial development of ecological network areas.

Preliminary results of the research clearly show a linear trend for changes in the structure of land cover and land use within the areas included in the ecological network in Wielkopolska. The increase in artificial areas and the decrease in agricultural areas are particularly noticeable. These are not big values, but they have to be looked at from the point of view of the structure of the ecological network, in which nodal areas (85.65%), which include mainly legally protected areas (i.e. landscape park, Natura 2000 areas, forest areas) constitute the biggest share. The remaining part (14.35%) are areas of ecological corridors, which due to their functions and spatial nature (often narrow lanes) are subject to strong human pressure. The low percentage share of the Wielkopolska region coverage by local plans (21.1% in 2019; for Poland 31.2%) not only lengthens the administrative route of the investment process, but, most frequently, leads to numerous conflicts between the public and local government, and in consequence to a disruption of spatial order. This prevents the rational management of natural resources and has a negative impact on the ability to protect biodiversity.

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## FUNCTIONAL AND TAXONOMIC STRUCTURE OF CARABID BEETLE ASSEMBLAGES IN FOREST FRAGMENTS AND HEDGES IN HETEROGENEOUS AGRICULTURAL LANDSCAPES

Ronan Marrec · Soline Chaudet · Adèle Le Naviel · Vincent Le Roux

CNRS, UMR EDYSAN

The spatiotemporal connectivity of forest patches and hedgerows in lowland agricultural landscapes and their total amount matter to explain current biodiversity patterns across local to regional extents. However, whether such networks and habitats allow maintaining a high taxonomic and functional diversity of taxa remains largely unclear. In particular, can both forest specialists and open-habitat species benefit from the same landscapes, or do they require contrasted landscape structures? A better understanding of their relative responses can have important consequences for ecosystem functioning and the delivery of ecosystem services. Focusing on carabid beetle assemblages, we assessed the relative importance of local-to-landscape attributes in driving local  $\alpha$ -diversity and species dissimilarity between patches ( $\beta$ -diversity), considering both taxonomic and functional facets of community diversity.

We sampled 32 deciduous forest patches and 67 hedges in two 5 × 5 km landscape contexts with contrasting management intensities in northeastern France. Functional diversity of carabid beetles was characterized based on morphological measurements and preferences in habitat requirements. We quantified the multi-level environmental influence using mixed-effects models and variation partitioning analysis. We found that  $\alpha$ -diversity was primarily determined by habitat-patch characteristics, acting as a local-scale ecological filter on carabid assemblages. However, both  $\alpha$ - and  $\beta$ -diversity were significantly influenced by the landscape context and the level of connectivity in the agricultural mosaic. Nevertheless, responses of carabid assemblages varied depending on species' preferences in habitat requirements (i.e., habitat openness and humidity). Consequences on biodiversity protection and ecosystem services maintenance is discussed.

## A GREEN-BLUE INFRASTRUCTURE TO IMPROVE CONNECTIVITY IN BIZKAIA

Lorena Peña · Ibone Ametzaga-Arregi · Beatriz Fernández de Manuel · Unai Ortega

University of the Basque Country

In the last century, changes in the landscape have been drastic, with an increase in artifice and in landscape fragmentation, and a decrease in the surface of natural areas. In the case of Bizkaia (Basque Country), these changes have been evident throughout the territory, where fast-growing forest plantations are the predominant vegetation, while the Atlantic mixed forest (potential vegetation) has been relegated to a few small patches. To reverse this situation, a new land management model has emerged, the green-blue infrastructure (GBI), which encompasses, in addition to landscape connectivity, its multifunctionality, that is, the ability to provide a wide range of ecosystem services (ES), with the aim of conserving biodiversity and facing future challenges, such as climate change.

The objective of this study is to propose a GBI for Bizkaia taking into account both the multifunctional areas that provide multiple ES and their connection. The multifunctional areas are identified by mapping seven regulatory services and their overlap. Subsequently, core areas were identified, which were connected by a network of ecological corridors for three key faunal species and an extensive corridor network in the multiple ES provision assessment. The connectivity analysis was carried out using the Linkage mapper program, with which the least cost routes and bottlenecks were identified, that is, those areas where the connection is poorer. In addition, priority areas were identified to establish future improvement actions.

The results indicated that, in the case of core areas based on the movement of key species, 33 patches of natural forest greater than or equal to 100 ha were identified, occupying an area of 7314 ha (3% of Bizkaia). In the case of core areas based on ES provision, 59 patches were identified, occupying an area of 18,830 ha (9% of Bizkaia). A total of 157 ecological corridors and 116 corridors based on ES provision were acquired. In total, the GI for Bizkaia occupies an area of 77,034 ha.

## THE CONSEQUENCES OF ASH DIEBACK ON FUNCTIONAL AND GENETIC CONNECTIVITY

Fiona Plenderleith<sup>1,2</sup> · Stephen Palmer<sup>2</sup> · Justin Travis<sup>2</sup> · Lesley Lancaster<sup>2</sup> · Jenni Stockan<sup>1</sup> · Ruth Mitchell<sup>1</sup>

<sup>1</sup>James Hutton Institute · <sup>2</sup>University of Aberdeen

Trees outside woodlands facilitate dispersal between woodlands and may buffer against impacts of fragmentation. *Fraxinus excelsior* (ash) is common outside of woodlands and along roadsides but is currently threatened by the fungal disease ash dieback (*Hymenoscyphus fraxineus*). Loss of ash trees to disease or pre-emptive felling could represent a substantial loss in connectivity (Henry et al., 2017). Previous research has considered the direct impacts of ash dieback for the 241 species of invertebrates that rely on ash in the UK but the indirect impacts due to this apparent loss in connectivity are largely unexplored (Mitchell et al., 2014). We aim to assess the impact of tree disease and the pre-emptive felling of non-woodland ash trees on dispersal and gene flow of forest invertebrates.

We use a stochastic individual-based modelling platform, RangeShifter, to explore impacts of tree loss on the spatial dynamics of 'virtual' ash-reliant insects with varying dispersal abilities and population densities (Henry et al., 2017). We simulate the loss of individual trees in and out of woodlands in 24 real landscapes and estimate functional and genetic connectivity in relation to the species dispersal ability and habitat-dependent movement costs.

Removal of 10% of ash trees resulted in a reduction in successful dispersers of up to 14.6%, and an increase in isolated woodlands of up to 2.9%. In some landscapes this resulted in increased isolation by distance (IBD – correlation between genetic and geographic distance). Carrying capacity impacted the proportion of isolated patches and IBD. Species experiencing low dispersal cost were more successful at dispersing under high tree loss, and this increased IBD. The consequences of tree loss for woodland connectivity are influenced by the species dispersal traits, but the consequences for gene flow may depend on the arrangement of trees within the landscape.

This study highlights the potential for spatially realistic, process-based models to be used to assess the impact of tree diseases on landscape connectivity for species that depend on those tree species. Ultimately, this modelling can be extended to inform management options for improving connectivity following tree-diseases, including the repopulation of resistant individuals of tree species.

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## HOW TO APPROACH THE HABITAT CONNECTIVITY – COMPARISON OF FOUR METHODS

Marcela Prokopová<sup>1</sup> · Vilém Pechanec<sup>2</sup> · Renata Včeláková<sup>1</sup> · Lenka Štěrbová<sup>1</sup> · Ondřej Cudlín<sup>1</sup> · Jan Purkyt<sup>1</sup> · Jiří Jakubínský<sup>1</sup> · Pavel Cudlín<sup>1</sup>

<sup>1</sup>Global Change Research Institute, Czech Academy of Sciences · <sup>2</sup>Palacký University Olomouc

**E**xtinction of natural habitats, their fragmentation and isolation emphasizes the need to support species migration and dispersion, making habitat connectivity increasingly important. There are several methods that have been proposed to assess landscape connectivity, but their results may vary and their use may be limited at certain scales.

Our objective was to compare four different approaches to assess the connectivity of natural habitats in the landscape:

1. Structural connectivity based on landscape metrics derived from the size, shape, composition, and configuration of habitat patches in the landscape.
2. 'Distance to Nature', which is calculated in a raster map for each pixel of an area of interest and is based on its average distance to the nearest natural or semi-natural habitat, taking into account the resistance of the surrounding matrix (Rüdisser et al., 2012).
3. Our approach, called Broad-scale Functional Connectivity, which considers habitat- or species-specific aspects (i.e. distance limits and matrix resistance values) because it divides natural and semi-natural habitats into habitat groups with similar habitat types. The connectivity value is derived from the distance to the nearest habitat that belongs to the same habitat group. The distance is calculated as the least-cost path and the matrix resistance values are defined separately for each habitat group. Another included parameter is the size of the natural habitat area, which is related to the minimum habitat area required for the long-term existence of this habitat.
4. Functional connectivity based on graph theory and calculated by software Conefor (Saura, Pascual-Hortal, 2007). This method is very complex and is based on distances for each pair of habitat patches. It also uses the least-cost path to define the distance and calculates different indices, of which the probability of connectivity is the most recommended.

These approaches differ in complexity, input data and information, and processing time. We applied all four methods to the cadastral area of the medium-sized city of Liberec, which is located in the north of the Czech Republic near the Jizera Mountains Protected Landscape Area. The results of the four methods, parameterized on a common scale, are presented and compared using overlapping spatial operations to define the overlap of each connectivity category. The percentage of connected area resulting from the different methods is also compared. The use of these different methods attempting to capture the complicated problem of habitat connectivity in the landscape is discussed with suggestions for the optimal choice of methods at different scales. These results may be useful for landscape planning, urban green infrastructure proposals, and landscape analysis.

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## ASSESSING THE INFLUENCE OF THE AMOUNT OF REACHABLE HABITAT ON GENETIC STRUCTURE USING GRAPHS

Paul Savary<sup>1,2</sup> · Jean-Christophe Foltête<sup>1</sup> · Maarten J. van Strien<sup>3</sup> · Hervé Moal<sup>2</sup> · Gilles Vuidel<sup>1</sup>  
· Stéphane Garnier<sup>1</sup>

<sup>1</sup>University of Burgundy – Franche-Comté · <sup>2</sup>ARP Astrance · <sup>3</sup>ETH Zürich

The genetic structure of populations is made of two components: the genetic diversity of every population (intra-population) and the genetic differentiation between every pair of populations (inter-population). These two components are influenced by genetic drift and gene flow, which are driven by the joint influence of the amount of habitat and of its spatial configuration in the landscape. Habitat amount and configuration are highly interdependent and together determine habitat connectivity, i.e. the amount of reachable habitat (ARH) at several scales. Adopting such a conception of habitat connectivity makes it possible to describe habitat patterns by considering simultaneously intra-patch and inter-patch connectivity, dispersal capacities and matrix resistance. Using an empirical genetic dataset concerning 34 large marsh grasshopper (*Stethophyma grossum*) populations from a Swiss agricultural landscape, we tested whether three ARH metrics computed from patch-based graphs (patch capacity, flux and betweenness centrality metrics) are good predictors of genetic structure indices computed from population-based graphs (total and private allelic richness, population-level genetic differentiation indices). The relationships between connectivity metrics and genetic indices were studied through correlation and PLS regression analyses. ARH metrics were relevant predictors of both genetic diversity and differentiation, providing an advantage over commonly used habitat metrics, such as the amount of habitat in a circular buffer around populations or the distance to the nearest habitat patch. Although in the best model allelic richness was significantly explained by three ARH metrics assessing habitat connectivity either in the focal patch or between this patch and others, genetic differentiation indices were essentially related with between-patch connectivity. Considering several matrix resistance scenarios was also key for explaining the different genetic responses. We call for a wider use of the ARH concept in future research.

## CONCEPT FOR MEASURING CONNECTIVITY FOR SPATIAL REFERENCE UNITS TAKING BARRIERS INTO ACCOUNT

Martin Schorcht<sup>1</sup> · Ulrich Walz<sup>2</sup> · Jochen Jaeger<sup>3</sup>

<sup>1</sup>Leibniz Institute of Ecological Urban and Regional Development · <sup>2</sup>Dresden University of Applied Sciences ·  
<sup>3</sup>Concordia University

The objective of this presentation is to develop metrics to measure the connectivity of habitats and small landscape elements for various reference units such as administrative boundaries (municipalities, counties) and natural spatial units or a regular grid (INSPIRE Grid). For the habitat types 'wet habitats', 'wood-dominated areas or forests' and 'dry habitats', we examined connectivity with the inclusion of small-scale landscape elements. Thereby, we measure on different administrative levels, whereby habitats lying on borders are considered as a whole. Furthermore, the focus is on the implementation of barriers that are impossible or difficult for animals to cross, such as roads, rivers, or train tracks.

Two measurement concepts used in the City Biodiversity Index (Chan et al., 2021, p. 15) and the Proximity Index (Gustafson, Parker, 1992) are compared and expanded accordingly. The City Biodiversity Index (CBI) is a set of 28 indicators, including the two indicators 'Proportion of Natural Areas' and 'Connectivity Measures for Ecological Networks', the latter measuring the connectivity of ecological networks in cities. The Proximity Index is a measure of the proximity and size of neighboring elements and is described by four variants (PX92, PXpt, PXfg and PX94). With the Proximity Index, it is possible to integrate movement barriers into the evaluation algorithm, so that the interruptions of the habitat networks by roads etc. were taken into account, as is already the case with 'Connectivity Measures for Ecological Networks'. The transferability to the spatial reference units can be achieved by means of spatial aggregation, so that larger habitats that extend across regional boundaries were also adequately taken into account. In the results for the CBI, it was found that the two indicators examined should always be viewed in conjunction. It has been shown that paying attention to barriers significantly influences the results. Overall, the values aggregated into levels (grid or administrative units) lead to results that are comprehensible and clearly presentable as maps and statistical measures. In summary, we are convinced that the selected indicators, taking barriers into account, can be used for regular monitoring of the environmental status of the landscape even in larger areas and can thus be an important basis for spatial planning and success evaluation.

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## FOCAL PATCHES ISOLATION AND THE ROLE OF TRANSIT PATCHES IN STUDIES ON LANDSCAPE CONNECTIVITY

Jerzy Solon · Wojciech Pomianowski

Institute of Geography and Spatial Organization, Polish Academy of Sciences

The concept of connectivity has given rise to many different approaches, theoretical and practical, including the development of modeling connections between specific structures in the landscape. Searching for the least cost path or defining the cost surface is now possible thanks to the availability of a large number of different tools. Less emphasis in research is placed on assessing the degree of isolation of individual patches or areas.

In our approach, based on analysis of landscape mosaic expressed in vector form, connectivity is determined through the Minimum Spanning Tree (MST) between patches of interest. With newly developed GraphScape software it is possible to define several metrics, based solely on landscapes composition and configuration (structural metrics) and covering two groups: Transit Density Statistics and Steps Statistics. Transit Density (TD) is defined as a count of MST paths crossing a patch. Unweighted Step Number describes the number of patch boundaries that must be crossed along the path between focal points. The Weighted Step Statistic, on the other hand, determines the relative ecological cost of traveling the most favorable route, taking into account Patch Class Resistance, Patch Individual Resistance and Transfer Resistance.

These characteristics can also be used to determine the degree of isolation of individual patches. Preliminary studies on models relating to land cover differentiation (expressed in terms of ecosystem types) for the selected fragment of northeastern Poland, using measures calculated in GraphScape and more traditional metrics characterizing isolation (e.g. proximity index, nearest neighbor distance) or the role of intermediate patches in connectivity (e.g. centrality measures) indicate the presence of several relationships of a more general nature: (a) the number of patches and the mean distance between patches are strongly correlated with each other, but are much less (or not at all) correlated with measures of ecological isolation, (b) measures of patch isolation determined by the minimum number of passes and the sum of pass path resistances are correlated with each other but do not substitute for each other, (c) measures of ecological isolation are particularly important at small physical distances between patches whereas for large distances a sufficiently good measure of the degree of isolation is the distance to the nearest neighbor, and (d) individual ecosystem types differ markedly in their degree of ecological isolation, even if they have a similar number of patches and similar mean smallest distances between patches.

The measures used create a complementary set that allows not only scientific assessment of the degree of isolation, but also planning of protective measures and assessment of the consequences of land cover changes.

## CONNECTIVITY ESTIMATION METHODS: A COMPARATIVE APPROACH FOR CONSERVATION PLANNING

Marie Soret<sup>1</sup> · Sylvain Moulherat<sup>1</sup> · Sandra Luque<sup>2</sup> · Maxime Lenormand<sup>2</sup>

<sup>1</sup>TerrOiko, OikoLab · <sup>2</sup>INRAE, UMR TETIS

**E**cological connectivity is a virtual property representing the capacity of spatial interactions between species and landscapes. It cannot be directly measured and assessed, but can only be estimated through proxies that inform on the intensity and sustainability of species interactions within the landscape mosaic. Landscape connectivity results from the combination of complex ecological processes including stochastic and dynamic variables which can make it difficult to evaluate. The scientific community designed numerous frameworks and tools to answer the many challenges underlying connectivity. Typical study's framework usually starts off with data sampling on both the structural composition of the landscape and species needs and behaviors within it. Data acquisition focuses particularly on resource requirements and mobility abilities. These data are incorporated into models reflecting the ecological processes at stake.

The model outcome depends on the reliability of both input data and hypothesis of modeling. Hypothesis of modeling represents a set of rules and assumptions admitted to depicted the ecological reality of the system. These assumptions influence connectivity analysis outcomes. We propose to compare their impact on connectivity analysis for critical modeling hypotheses commonly used in connectivity software. We focus on three aspects of connectivity analysis : firstly, the location and qualification of resource patches; secondly the location and qualification of interaction between pairs of patches across the landscape matrix; and thirdly the sensibility of connectivity metrics derived from graph theory. For the first part we compared patch outcome from two identification methods: typological definition and species distribution models. For the second part we compared 4 different methods of patch's pairwise interaction and spatialisation: (1) direct euclidean path in a homogeneous matrix, (2) least cost path in a resistance map, (3)circuit theory, and (4) stochastic movement simulator. All methods were implemented on a study site in France for three local species with different habitat preferences and mobility abilities. Finally we combined the results from the two first parts to build a graph representing the ecological network. The different combinaisons led to 8 different graphs that we compared regarding global networks metrics. We aim to discuss here the critical differences between approaches and the logical ecological interpretation of connectivity to target conservation solutions for territorial planning.

## CONNECTIVITY OF PROTECTED AREAS IN COLOMBIA: IDENTIFICATION AND PRIORITIZATION OF POTENTIAL LINKAGES

Sara Pineda Zapata<sup>1</sup> · Sergio González Ávila<sup>2</sup>

<sup>1</sup>IALE-Colombia · <sup>2</sup>Technical University of Madrid

In Colombia there are around 19 million hectares of protected areas (PAs), resulting from an effort to conserve the high biodiversity areas of the country. Although the National System of Protected Areas keeps growing, there is a lack of knowledge about the corridors and areas that could sustain connectivity between current or planned PAs.

In this study we aimed to assess the connectivity between current PAs in Colombia, identifying potential linkages and prioritizing them according to their contribution to total habitat availability in two scenarios: conservation and restoration.

We followed the combination of methods previously applied in a similar work in Spain (De la Fuente et al., 2018), which also allowed us to test this workflow in a different environment and compare the insights provided in both study areas. As a result, we integrated graph-based analyses, least-cost path modelling and the Probability of Connectivity metric, considering two ecoprofiles based on mammal species and their preferred habitat type.

Our work produced a comprehensive connectivity analysis at the national scale. As such, the identification of priority connectors and their characterization could be of importance for managers and planners, both from regional and national administrations, allowing them to incorporate specific spatial data on ecological connectivity to land use planning and forests and biodiversity conservation.

De la Fuente B. et al. (2018). *Natura 2000 sites, public forests and riparian corridors: The connectivity backbone of forest green infrastructure*. *Land Use Policy*, 75: 429-441.

## *Forest expansion, landscape dynamics and ecosystem services in Europe*

### **Symposium organisers**

*João Carlos Azevedo* (Polytechnic Institute of Bragança), *Pinar Pamukcu-Albers* (University of Bonn), *Dolors Armenteras* (National University of Colombia)

### **Summary**

This seminar will address forest expansion and its impacts on landscape pattern, functioning and the wellbeing of society at several scales. The seminar will provide a science-based background to debate: (1) the role of forests in the process of increasing socioecological and climate resilience in Europe, (2) the processes of transformation in forest cover in Europe and their relations to landscape sustainability and resilience, and (3) the participation of forest and landscape scientists and practitioners in forest landscape change and their contribution to improving ecosystem services.

### **Description**

Forests in Europe expanded very rapidly from early 20th century to the present day. Europe is currently the region in the world where forest cover is the largest, both assessed as area and in percentage of the land. In addition, the prospects for further expansion are high according to international and national forest, environmental and development policies (e.g., EU Forest Strategy; European Green Deal and the Paris Agreement) as well as ongoing socioeconomic processes that result in increasing land available to natural reforestation or planting.

The expansion of forests in Europe has direct impacts on landscape pattern, affecting also plant and animal species' habitat availability and configuration. Also a series of ecological processes are affected, such as hydrological processes, carbon dynamics or fire disturbances, processes with an impact on society through their effects on the supply of a large array of ecosystem services.

In this seminar, we propose to address forest expansion from the point of view of the changes it has caused and will cause on landscape pattern, on ecological systems functioning and on wellbeing of society at several scales. We invite participation both from within the forest landscape ecology community and other communities with an interest in forests and landscape ecology.

Our overall aim with this seminar is to provide a science-based background for debating the role of forest systems in the process of increasing socioecological and climate resilience in Europe and in individual countries. We will focus on the processes of transformation in forest cover in Europe and how this relates to overall landscape sustainability and resilience in the subcontinent and at local scales. Finally, we will emphasize the participation of forest and landscape scientists and practitioners in the processes related to forest landscape change and how to avoid undesirable impacts and improve the benefits to the society.

## REVIEW OF LANDSCAPE INDICES TO ACCESS CONDITION AND FUNCTIONING OF DISTURBED FOREST LANDSCAPES – THE EXAMPLE OF TUCHOLA FOREST, NORTHERN POLAND

Sanjana Dutt · Mieczysław Kunz

Nicolaus Copernicus University

Understanding the intricacies of landscape-level interactions across scales becomes increasingly important as governments move toward more environmentally sustainable paradigms. Since it is acknowledged that the spatial arrangement of elements in a land-cover mosaic controls the biological processes that work within it, management strategies frequently strive to modify the structure of a landscape to achieve specific management goals.

This work uses GIS and remote sensing analyses data from two time periods, before (2016) and after disturbance (2018), over approximately 12,500 ha in Brusy Commune, Northern Poland, with the goal of obtaining a better understanding of the landscape metrics that are most suitable to study forest disturbance by a natural disaster. The hurricane that occurred on 11-12th August 2017 had gusts up to 150 km/h and destroyed about 80,000 ha of forests in central and western Poland. In the Brusy Commune, apart from forest areas, 1040 residential buildings, 1050 farm buildings, as well as 120 km of roads and 7 km of bicycle paths were destroyed. Municipal property losses were estimated at 18.6 million PLN, while private property losses were about 12.5 million PLN.

A number of review papers focusing on integrating landscape measures to ecological processes published within the last four decades were reviewed in order to create the groundwork for developing relationships connected to essential ecological processes. Furthermore, scientific literature searches were conducted using the terms 'landscape ecology', 'forest landscape', 'spatial metrics or spatial indices' and 'hurricanes'. Spatial landscape measurements were identified using the same corpus of literature, including indices found in the software program FRAGSTATS, which is a widely used application for computing landscape metrics and mapping corresponding patterns. Twelve broad landscape measures were characterized as a first-order analysis using FRAGSTATS standard designations (e.g., area/density/edge, shape, connectedness, diversity, etc.).

The landscape metrics analyses revealed crucial indicators about the nature of landscape changes, as well as important insights about the underlying ecological processes that shape them. This research is a critical first step in understanding which landscape metrics are the most suitable to study forest landscapes that are affected by windstorms. More importantly, it lays the groundwork for future studies that will link these findings to long-term ecological modeling.

## FOREST HABITAT AVAILABILITY IN SPAIN: RECENT CHANGES AND RETROSPECTIVE RESILIENCE ASSESSMENT

Sergio González-Ávila · César López-Leiva · Juan Manuel Duch · Ramón Elena-Rosselló

Technical University of Madrid

Landscape changes and forests dynamics are a major concern for biodiversity conservation and forest management. Forests provide different ecosystem services, being habitat provision for species a key service that should be considered in planning. In this regard, habitat connectivity promotion is gaining momentum. In Spain, this has been recently acknowledged by adopting the new national strategy on green infrastructure (GI), connectivity and restoration by the Ministry for the Ecological Transition, responsible for biodiversity conservation. In this context, better knowledge on forests habitat temporal trends and its patterns gains relevance. Moreover, being the barrier effect exerted by linear infrastructures a major threat to habitat connectivity, it is crucial to assess the resilience of landscapes to the disturbance they produce.

We aimed at characterizing trends in changes in forest area in the entirety of Spain, for the 1956-2018 period. Additionally, our objective was to evaluate the retrospective resilience of forest habitat to new linear infrastructures development. For that purpose, we used the Equivalent Connected Area (ECA) index, which measures forest habitat availability at the landscape scale (thus, taking into account connectivity). We calculated ECA using data derived from the Spanish Landscape Monitoring System ([www.sispaes.com](http://www.sispaes.com)). This dataset consists of 206 square samples of 4 × 4 km, covering the whole diversity of environmental templates in Spain. Five surveys have been carried out (1956, 1984, 1998, 2008 and 2018), producing landscape models for each sample and date. These models allowed us to track changes in forest area as well as in forest habitat availability for small sized terrestrial animals. Then, we simulated the appearance of a new linear infrastructure in each sample and date and recalculated the ECA index. In this way, we simulated this disturbance in the landscape and were able to assess how much this affected habitat availability. Moreover, by considering the temporal dimension we could also assess hypothetical trends and degree of recovery from the simulated disturbance on real landscapes. Finally, we analyzed geographical patterns of ECA values and changes, comparing both real and simulated scenarios, and some variables that could be driving differences in these patterns (i.e. abundance of forest, climate type, lithological type, date and mean resistance value for movement of animals).

Our results indicate that the degree of abundance is determinant of the resilience forest habitat, being landscapes with values around 65-75% those in which the effects could be more intense.



## COPING WITH FIRE IN A MEDITERRANEAN BIOSPHERE RESERVE: A MULTIOBJECTIVE PLAN UNDER UNCERTAIN FUTURE GLOBAL CHANGE

Miguel Cánibe Iglesias<sup>1,2</sup> · João C. Campos<sup>3</sup> · Cláudia Carvalho-Santos<sup>4</sup> · Virgílio Hermoso<sup>5</sup> · Adrián Regos<sup>2</sup> · Ângelo Sil<sup>1,3</sup> · João C. Azevedo<sup>1</sup>

<sup>1</sup>Polytechnic Institute of Bragança · <sup>2</sup>University of Santiago de Compostela · <sup>3</sup>University of Porto · <sup>4</sup>Minho University · <sup>5</sup>University of Seville

Co-management is vital to ensure the persistence of biodiversity and the supply of ecosystem services (ES). However, effective co-management needs to address potential trade-offs between conflicting objectives. The UNESCO zoning scheme is a good tool for this purpose since it integrates multiple management zones that avoid trade-offs between management objectives. Moreover, in Mediterranean ecosystems, management also needs to account for drivers like wildfires and traditional land cover and uses that have historically shaped landscapes and the biodiversity they hold.

Here, we present a case study in the Meseta Ibérica Transboundary Biosphere Reserve, a Mediterranean landscape located in the north-western Iberian Peninsula between Portugal and Spain, affected by wildfires and land use/cover change, including the expansion of forest cover. We aim (1) to identify optimal management zone allocation for biodiversity conservation and maintenance of ES under future climate and landscape management scenarios while accounting for fire hazard, and (2) to analyse the role of the current protected area network established within the reserve in species conservation and ES supply in the future.

We used Marxan with Zones to prioritise the spatial allocation of management zones under alternative climate and landscape management scenarios. The zones considered were Core zone (dedicated to conservation), Buffer zone (conservation and Core zone buffer) and Transition zone (sustainable management). Scenarios differed in the distribution of species, ES, and fire intensity and were obtained via adapted modelling exercises calibrated under recent conditions to represent the following trends: (1) Afforestation, defined by forest expansion, (2) BAU, defined by current trends of rewilding and land abandonment, (3) FarmReturn, defined by sustainable agriculture expansion, and (4) Firesmart, defined by agriculture and agroforestry expansion promoting fire resilient-landscapes.

Our results showed that despite levels of ES varied under different scenarios, we were able to allocate management zones that help to maintain currently observed levels under all future landscape management scenarios. Biodiversity showed a high degree of temporal turnover, with some species projected to disappear from the study area or have a steep decline in their distribution which made meeting their targets within the reserve impossible. When comparing to the established zonation, our results suggest that a redesigning of the zoning is needed in the area, especially to extend the Core zone. This should also be considered for the design of protected areas in the future.

Based on our results, we recommend that future planning and management in the reserve should: (1) expand conservation areas to ensure that biodiversity and ES are well represented in the future, and (2) implement practices aiming to develop a fire resilient landscape and promote traditional agriculture and agroforestry.

## WHY UNDERSTANDING STAKEHOLDER PERSPECTIVES AND EMOTIONS IS IMPORTANT IN UPLAND WOODLAND CREATION: A CASE STUDY FROM CUMBRIA, UK

Sara Vangerscov Iversen

Aarhus University

Upland regions in the United Kingdom (UK) are increasingly under consideration as potential areas for the creation of woodlands. This is driven by a combination of factors, including the aims of UK forestry and environmental policy to increase woodland cover, meeting international greenhouse gas emission reduction targets, agro-environment schemes in national and international policy, and an increasing public awareness of the ecosystem service benefits landscapes can deliver for society. Creating new woodlands in upland areas is challenging, partly due to concerns of the potential impacts from a change in land use and due to stakeholder perspectives. In the UK, the upland landscape is in multiple ownership and currently managed by multiple land managers and stakeholders with contrasting aims and objectives. This research adds a much-needed qualitative element to the overall understanding of this complex topic, by carrying out a Q-methodology investigation of stakeholder perspectives of upland woodland creation. Three characteristic groups of stakeholders are identified as: (1) 'Not enough is done to protect the environment', (2) 'Changing the landscape is changing us', and (3) 'Let's not let our emotions get in the – seeing the bigger picture'. The clear potential for antagonism, and even conflict, in ideologies and approaches between these groups highlights the importance of engaging with stakeholders and employing approaches rooted in mutual understanding, participation and collaboration. Stakeholder perspectives are a powerful influence on if, and how, woodlands are created and maintained, thus understanding emotions and attitudes is a vitally important part of the challenge of creating new woodlands in the uplands of Cumbria.

## EXTENT AND SPECIES COMPOSITION OF FORESTS DEVELOPED AFTER 1940s-HUMAN DISPLACEMENT IN THE NE CARPATHIANS

Zofia Jabs-Sobocińska<sup>1</sup> · Andrzej Affek<sup>2</sup> · Jan Matuszkiewicz<sup>1</sup>

<sup>1</sup>University of Warsaw · <sup>2</sup>Institute of Geography and Spatial Organization, Polish Academy of Sciences

**D**ue to the displacements of Ukrainian-speaking population in the 1940s, Polish Carpathians were affected by widespread agricultural land abandonment which resulted in forest expansion. Therefore, the region is covered now with large areas of 60-70 years old recent forests, but in close distance to well-preserved ancient beech forests protected by East Carpathian Biosphere Reserve. Because of the anticipated further forest cover increase in Europe, investigating forests that developed recently and are mature enough to compare their understory species composition with ancient forests is crucial for the research on regeneration and biodiversity of both existing and future secondary forests.

Our goal was first to map post-displacement forests in the NE Carpathians, and then to compare their species composition with local ancient forests. To map post-displacement forests in the study area we used archival remote sensing data: German Flown Aerial Photography from 1944, Corona satellite images from 1969 and Sentinel-2 satellite images from 2020. Then, we randomly selected 294 forest plots, 194 in recent and 100 in ancient forests. On each plot we took a phytosociological relevé, a hemispherical photograph, and collected a soil sample (C, N and S content). Based on the analysis of relevés, we indicated understory species that occur significantly more often either in recent or in ancient forest. Then, we parametrised multiple regression models to find the most important plant traits and environmental variables that explain the differences in species frequency between recent and ancient forests.

We found that there are 87,500 ha of ancient forests and 53,800 ha of 60-70 years old recent forests in the Polish NE Carpathians. The results of field investigation revealed 15 ancient forest species (out of 215 understory species) and 9 species with significantly higher cover and frequency in recent forests. We compared these species with the species that are on the lists of ancient-forest species compiled for Poland and Europe and found significant discrepancies. First, only 15 species revealed to be indicative of ancient forests in our research area, second, because three species from those lists (*Brachypodium sylvaticum*, *Impatiens noli-tangere* and *Circaea lutetiana*) occurred significantly more often in the Carpathian recent forests. Our conclusion is therefore that the existing broader-scale lists are of limited use when it comes to the identification of ancient forests in the NE Carpathians. We also demonstrated that the specific traits (life form, leaf persistence and dispersal mode) of ancient-forest species explain better the differences in species composition between ancient and recent forests than environmental variables.

## APPLICATION OF SIG (TROPIC SOIL INDEX) IN ECOSYSTEM SERVICES OF POST-ARABLE SOILS AFFORESTED WITH SILVER BIRCH

Bogusława Kruczkowska<sup>1</sup> · Jerzy Jonczak<sup>1</sup> · Aleksandra Chojnacka<sup>1</sup> · Urszula Jankiewicz<sup>1</sup> · Marek Kondras<sup>1</sup> · Lidia Oktaba<sup>1</sup> · Jarosław Oktaba<sup>1</sup> · Izabella Olejniczak<sup>2</sup> · Edyta Pawłowicz<sup>1</sup> · Sandra Słowińska<sup>3</sup> · Edyta Regulaska<sup>3</sup>

<sup>1</sup>Warsaw University of Life Sciences · <sup>2</sup>Cardinal Stefan Wyszyński University · <sup>3</sup>Institute of Geography and Spatial Organization, Polish Academy of Sciences

A quantitative index of essential soil properties created by Brożek et al. (2008), the Trophic Soil Index (SIG), is calculated based on fundamental soil chemical and physical properties, such as content of the  $\phi < 0.02$  mm fraction, sum of exchangeable alkaline cations, hydrolytic acidity, total nitrogen and organic carbon contents, soil bulk density and genetic horizons thickness. Diagnosing trophic variants of soil subtypes by means of indexes as SIG may lead to the simplification of soil division into groups with similar properties, regardless of the soil type or subtype. This study attempts to determine the potential of forest soils to provide selected ecosystem services using SIG.

Research was conducted on post-arable areas afforested with silver birch (*Betula pendula* Roth) located in central Poland. Stands of different ages and soil types (Brunic Arenosols – BA and Cambisols – C) were selected for the study. For comparison, the research was also carried out on agricultural soils located in the direct vicinity of examined forests. Such variables as: particle-size distribution, content of basic cations, hydrolytic acidity, total contents of organic carbon and nitrogen, bulk density were identified in collected soil samples.

The application of SIG showed variation in the quality of the same soil types, depending on the stand age and specificity of land use, reflected in the form of trophism, and thus diversity in their potential to provide ecosystem services. The studied soils represented all trophic types, from dystrophic to eutrophic. In five out of ten compared pairs of profiles or, as in the case of the BA-40 site – five profiles, an increase of trophism was observed in soils with a similar typology in favor of agricultural soils due to fertilization.

Particular components of the SIG are adequate indicators for assessing the potential of soils to provide ecosystem services. Their impact on soil functioning and effect on individual elements of the natural environment is of such importance that they are also considered when constructing other existing soil quality indicators. Soil quality, as expressed by organic carbon content, among others, is expected to be relatively high in soils covered by older stands. Application of the SIG showed that in the case of Brunic Arenosols there is high dynamics of their trophism, whereas the above-mentioned relationship does not occur. Cambisols demonstrate a much higher stabilization of trophic conditions, regardless of the stand age. The obtained results indicate greater stability of the potential to provide ecosystem services (mainly in the Regulation and Maintenance section according to CICES V5.1) of Cambisols in comparison to Brunic Arenosols. The SIG index can be employed in identifying similarities and differences in the potential of typologically identical soils to provide selected ecosystem services.

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Brożek S. et al. (2008). Liczbowy indeks troficznych odmian podtypów gleb bielocowych i rdzawych. Roczniki Gleboznawcze, 60(1): 7-17.

## FOREST LANDSCAPE CHANGES AFTER DEEP LAND USE AND HUMAN POPULATION CHANGES: A CASE STUDY IN LA RIOJA REGION (SPAIN)

César López-Leiva · Sergio González-Ávila · David Ballesteros-Gutiérrez · Álvaro Benito-González · Eduardo Fernández-Fuertes · Elena Hidalgo-Gómez · Fernando Bezares-Sanfelip

Technical University of Madrid

The Rioja region (Spain) is a representative territory of the central northern part of the Iberian Peninsula, covering about 5045 km<sup>2</sup>. It comprises two defined sectors: the Ebro Valley and the mountainous area in the Southern side. Land uses changed abruptly over the last 70 years. In the mountains, the previous pastures, created by means of forest cutting, clearing and burning, were shaped from medieval times until the mid-20th century. Once the outstanding transhumance activities collapsed due to the decrease of human population, pastures and marginal agricultural terraced lands evolved into a mosaic of emerging forests and scrublands. The abandonment was driven by emigration and the subsequent urban sprawl, mostly located in the Ebro Valley, which is mainly devoted to agriculture. This dynamic framework led to passive ecological restoration, providing new ecosystem services such as the increase of biogenic quality, habitat connectivity, carbon capture, biodiversity, water regulation and erosion control, albeit other negative effects may arise (i.e., wildfire risks derived from the increase of biomass).

Through different studies, we aimed at producing quantitative data related to landscape transformation in Cameros (855,59 km<sup>2</sup>), the central mountainous Riojan core, within the period 1956-2017 by means of a thorough classification of land use types based on structural traits of plant communities. At a more detailed scale, we analysed the rise in cover density in 17 open forests ('dehesas') scattered in the area as municipal common lands. These 'dehesas' were reserved for low intensity management, a cultural practice currently abandoned. We uncovered the spatial pattern of trees within each 'dehesa', the substitution of dominant canopy and the magnitude of change for the same period. In the Eastern Cameros the change processes showed a slower temporal pattern, in our view due to a highly Mediterranean climate, but in the Western, a wetter area, a more rapid encroachment occurred. The recent urban-based ecotourism may enhance the re-evaluation of ecological and cultural signs in the landscape whilst a proper understanding of forest management and historical evolution – inseparable from human action – should be conveyed.

In addition, we also analysed landscape changes from 1956 to 2017 in some pilot municipalities. We mapped polygons (vegetation tesserae), linear elements (hedgerows) and points (isolated trees). Opposite-sign effects took place in these agricultural areas of the Valley. Until the 1970s, natural vegetation enclaves still remained prior to the intensification of agriculture (predominant since the Roman rule). In the last five decades, a large number of isolated natural *Quercus* patches and several scrubs disappeared as a consequence of land consolidation and infrastructure construction. Through these complementary analyses in the area we characterised both expansion and reduction of forests following deep socioeconomic changes.

## TOWARDS A NON-MONETARY VALUATION OF FOREST ECOSYSTEM SERVICES AT THE LOCAL SCALE: A CASE STUDY IN SOUTHERN GERMANY

Markus Meyer<sup>1</sup> · Christoph Schulz<sup>2</sup>

<sup>1</sup>Anhalt University of Applied Sciences · <sup>2</sup>Bavarian Forest Agency

The ecosystem services concept challenges established management and planning tools. To test the potential added value in forest management and planning, we applied the ecosystem services concept at a local level addressing the spatial and organizational forest management entity. We assessed the current state of biodiversity and 15 ecosystem services (ES) for an urban and a rural forest area, owned and managed by the municipality of Augsburg, Germany. We mapped provisioning areas and quantified flows of ecosystem services. We approached ecosystem services' benefits and values by means of stakeholder valuation and by four additional conceptualizations: range of benefiting areas, number of beneficiaries, categories of well-being and designated protected areas.

Both, the urban and the rural forest area provide on average seven ES, ranging between three and 13 ES. Patterns of overlapping ES provisioning areas led to more than 200 different combinations of ES (ES bundles). Provision and protection of water and recreation were the most valuable ES in the urban forest, while timber production dominated in the rural forest.

While ES provisioning areas and ES flows serve to locate and quantify ES, our valuation approach helps to rank ES within ES bundles. In dependence on priority areas, ES bundles with the same ES combination than have locally different rankings and help to make local management decisions.

However, collection of local ES data was complex and laborious and still revealed considerable differences in accuracy with available modeling tools developed for regional-scale ES assessments. Thus, improved local ES data from models and realistic approximations are necessary to incorporate the ES concept in local forest management and planning.

## ASSESSING THE EFFECT OF FIRE SEVERITY AND MULCH STRIPS IN MITIGATING SOIL EROSION AND CARBON LOSSES AFTER THE SIERRA BERMEJA MEGAFIRE (2021)

Sergio Prats<sup>1</sup> · Sandra Nicolas<sup>2</sup> · Sara De Paula<sup>2</sup> · Sergio Prats-Fons<sup>3</sup> · Carlos Prats-Alegre<sup>3</sup> · Francisco Senra<sup>4</sup> · Javier Madrigal<sup>2</sup>

<sup>1</sup>University of Evora · <sup>2</sup>National Institute for Agricultural and Food Research and Technology – Center for International Forestry Research · <sup>3</sup>Grupo Mandrágora · <sup>4</sup>AMAYA. Agencia de Medio Ambiente y Agua de Andalucía

**W**ildfires strongly enhance the hydrologic and erosion responses of burned forest, with important implications on carbon dynamics. Wildfires impact on society through their effects on the supply of a large array of soil ecosystem services, i.e., water provision, erosion prevention, carbon storage or climate regulation. This study aims to assess the implications on soil erosion and carbon losses of the Sierra Bermeja megafire, which burned 10,000 ha in southern Iberian Peninsula in September 2021, on steep, peridotite-derived pine forest soils. Specifically, we assessed: (1) the effect of fire severity on soil erosion at point-hillslope (1-40 m<sup>2</sup>) scales, (2) the capacity of mulch strips to reduce soil erosion, and (3) the implications of fire severity and mulch strips on soil carbon balance for the first 4 post-fire months.

To this end, in the framework of the INTERREG CILIFO project (0753-CILIFO-5-E), 9 study sites were instrumented: 3 unburned, 3 low-severity and 3 high-severity burned sites. Automatic rainfall gauges, small (1 m<sup>2</sup>) and hillslope (40 m<sup>2</sup>) soil erosion plots and litter traps were installed in these sites. Additionally, on the high severity sites 3 hillslope plots were treated with a minimum mulch strip on the lower 3 m of the 4 × 10 m hillslope plots (pine-slash applied at 3 Mg ha<sup>-1</sup> over the entire plot). Soil, litter and sediment samples are being processed for evaluating C, N and P contents.

Preliminary results show that rainfall amount was low (301 mm) but intense (maximum rainfall intensity in 30 minutes of 53 mm h<sup>-1</sup>). Soil erosion of the topsoil layer, the richest in soil carbon, was very high for the high severity sites, totalizing 11 and 10 Mg ha<sup>-1</sup>, respectively for the small and hillslope plots. Soil erosion was substantially lower for the low severity sites, with 0.1 and 2.3 Mg ha<sup>-1</sup>, respectively for the small and big plots, and it was below 0.07 Mg ha<sup>-1</sup> for all the unburned plots. Litter amount, mostly composed of needles falling from the dead trees, was only 0.3 Mg ha<sup>-1</sup> on the high severity sites, while it was 3.9 Mg ha<sup>-1</sup> on the low severity and 0.8 Mg ha<sup>-1</sup> on the unburned sites. These results showed that the high amount of litter on the low severity protected the soils from erosion of the rainfall drops. Additionally, the effect of the mulch strip reduced the amount of soil erosion in 80%, as compared to the untreated high-severity erosion plots. We conclude that sites attaining a ground cover after the wildfire – such as the low severity sites – are protected against soil erosion and therefore, not target for intervention. Additionally, the application of a minimum mulch strip, using local pine wood, can effectively reduce soil erosion. These findings will guide future interventions in order to minimize soil erosion and increase carbon storage in burned areas. Future research will focus on the calculation of soil C, N, P balances and the implications of strip mulching on the ecosystem services after megafires.

## THE EFFECTS OF PLANTING BIRCH FORESTS ON EARTHWORM COMMUNITY IN POST-ARABLE SOILS

Edyta Regulska<sup>1</sup> · Andrzej Affek<sup>1</sup> · Marek Kondras<sup>2</sup> · Sandra Słowińska<sup>1</sup> · Jerzy Jonczak<sup>2</sup> · Bogusława Kruczkowska<sup>2</sup> · Lidia Oktaba<sup>2</sup> · Edyta Pawłowicz<sup>2</sup> · Izabella Olejniczak<sup>3</sup> · Urszula Jankiewicz<sup>2</sup> · Jarosław Oktaba<sup>2</sup> · Aleksandra Chojnacka<sup>2</sup>

<sup>1</sup>Institute of Geography and Spatial Organization, Polish Academy of Sciences · <sup>2</sup>Warsaw University of Life Sciences · <sup>3</sup>Cardinal Stefan Wyszyński University

**S**ilver birch (*Betula pendula* Roth) is one of the most widespread birch species in the Europe, which results from its ability to perform well on a great diversity of soils. It commonly occurs in the naturally regenerating and planted forests, usually as a forecrop at post-arable sites. In recent decades, afforestation with birch instead of other species has become more popular. One of the reasons is that it is recognized as a pioneer species improving forest resilience and biodiversity (Dubois et al., 2020). However, there are many knowledge gaps regarding the impact of birch trees on soil biota, including on the earthworms (Jonczak et al., 2020), which are important ecosystem engineers, providing a variety of crucial ecosystem functions and services, e.g., decomposition, nutrient cycling and climate regulation (Blouin et al., 2013).

Our aim was therefore to determine the effects of planting birch forest on earthworm community in post-arable soils. We formulated the following research question: Is there a difference, and if so, how do the communities of earthworms differ in arable soil and in soil of post-agricultural birch forest? Ten birch stands aged 15-80, located in central Poland, were selected as the study area. Different age groups were studied because with increase in birch age, the chemistry of the soils also changes with input of litter quality. Five stands were located on Brunic Arenosols (light-textured, nutrient-poor soils), and the other five – on Cambisols (medium-textured, nutrients-rich soils). In each stand and in the neighbouring arable land earthworms were sampled. Three 0.25 × 0.25 × 0.30-m soil blocks were handsorted in spring and late summer/early autumn 2020 and 2021 (in total twelve samples were taken per site). Individuals were counted, weighed and divided into three ecological groups (epigeic, endogeic and anecic species).

Our results showed that much higher biomass and density of earthworms was in Cambisols than in Brunic Arenosols, both in birch forests and in arable land. Furthermore, there were a greater abundance of earthworms in birch stands than in the neighbouring fields in both Cambisols (except intermediate age birch stands) and Brunic Arenosols (except the youngest birch stands).

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## COMPARING THE EFFECT OF FIRE MANAGEMENT STRATEGIES ON FIRE REGULATION CAPACITY IN A MEDITERRANEAN MOUNTAINOUS LANDSCAPE UNDERGOING FARMLAND ABANDONMENT AND CLIMATE CHANGE

Ângelo Sil<sup>1,2,3</sup> · João C. Azevedo<sup>3</sup> · Paulo M. Fernandes<sup>2</sup> · Adrián Regos<sup>1,4</sup> · João Campos<sup>1</sup> · João A. Santos<sup>2</sup> · Teresa Freitas<sup>2</sup> · João P. Honrado<sup>1</sup>

<sup>1</sup>University of Porto · <sup>2</sup>University of Trás-os-Montes and Alto Douro · <sup>3</sup>Polytechnic Institute of Bragança · <sup>4</sup>Forest Science and Technology Centre of Catalonia

**F**ire is a fundamental Earth process that influences most terrestrial ecosystems. In turn, global change drivers (e.g., land use/cover change, climate change) may alter characteristics of fires and affect fire regimes in the future. In recent past decades, many mountainous regions of the Mediterranean Basin experienced significant landscape changes caused by farmland abandonment that fostered the encroachment of semi-natural vegetation on former cropland and the expansion of natural or planted forests. Consequently, such changes may have increased fuel hazard in the landscape which, together with future climate aggravation, can lead to the occurrence of fire events that exceed the landscape capacity to regulate them posing challenges to the future management of these regions. In this context, modelling and simulation approaches are useful to test alternative landscape management strategies under climate change scenarios and predict their effect on future fire regimes and ecosystem functions and services (e.g., fire regulation).

In this study, we applied the LANDIS-II forest landscape model to a fire-prone mountainous landscape of the Mediterranean Basin undergoing farmland abandonment. We simulated landscape and fire dynamics (2020-2050) to explore the effect of different fire management strategies (e.g., business-as-usual, forest-oriented and silvopasture-oriented management) on the landscape capacity to regulate fire (FRC) under two climate change scenarios (RCP 4.5 and 8.5). Then, we analysed the simulated fire regime attributes and landscape dynamics and compared them to historical (1989-2019) observed data for the area and among each combination of fire management and climate scenarios in the future.

Overall, our results suggest that FRC tend to decrease in the future, particularly under the RCP 8.5 climate scenario. However, the magnitude of the effect varies depending on the fire management strategy implemented. Based on the results of this study, we discuss the implications of alternative management strategies for the supply of fire-related ecosystem services (e.g., fire protection) in mountainous fire-prone landscapes of the Mediterranean region in the context of global changes.

## CONTEMPORARY LOCAL SCALE TRANSFORMATION ON POST-AGRICULTURAL LANDSCAPES IN CENTRAL POLAND

Agnieszka Sosnowska · Andrzej Harasimiuk

University of Warsaw

Over the past thirty years in Poland there was a significant forest expansion in post-agricultural landscapes. It was a consequence of socio-economic changes, e.g., outflow to cities, transformation in agriculture, small farms merging, and excluding fields from agricultural use. The main reason for the latter was a decline in profitability of soil cultivation of the least fertile soils or those transformed by erosion. Fields' abandonment has led to important landscape transformation. Those changes proceeded quickly, so it makes them a valuable basis for macroscopic observations. They are mainly expressed in changes of plant cover as well as in functioning, seen in the cycle of elements (their bioconcentration in soils and plants).

The main research issue was to define the ways of functioning in the post-agricultural lands and to compare it with those of arable and forest lands. The research was focused on soils and vegetation and their mutual relations, as other natural components, such as climate, geological substratum, and water conditions, are relatively constant. The research was carried out in Central Poland (Middle Mazovian Lowland) where the features of the natural environment (low trophic substrate), together with a socio-economic transformation influenced an increase in fallow lands. It was observed that a termination of cultivating led to huge changes in land cover. In result of secondary succession were observed a development of plant communities consisting mainly of pioneer and invasive species characterized by high expansion and dynamics of colonization (e.g., silver birch *Betula pendula* Roth., Aspen poplar *Populus tremula* L., Scot's pine *Pinus silvestris* L., goldenrod *Solidago* L. or wood small-reed *Calamagrostis epigejos* L.). Sites of different density and age of vegetation, as well as species composition (different stages of secondary succession) were chosen for detailed research, with plant and soil material collected from them. The plant material included whole plants (goldenrod, wood small-reed), and individual organs (leaves, bark, wood, branches) of birch, poplar and Pedunculate oak *Quercus robur* L., which enters in the later succession stages as an admixture. In the case of poplar and oak, several-year-old individuals were taken together with the monolith of the surrounding soil to the depth of the root zone. Macro- and microelements were determined in the collected samples. On this basis were determined: a relationship between content and concentration of elements in individual plant organs, and an impact of plant supply on changes in the chemical properties of soils. Those changes contributed to a formation of a new spatial and functional landscape structure in the post-agriculture lands.

The final stage of the research was an attempt to create functional models based on variability of chemical characteristics and the mass balance of nutrients under various types of use (agricultural, post-agricultural and forest).

## REGENERATION PROCESSES OF FOREST STANDS OF THE TUCHOLA FOREST (RYTEL FOREST DISTRICT, POLAND) AFTER HURRICANE WINDS IN 2017 – PRELIMINARY RESEARCH RESULTS

Barbara Waldon-Rudziolek · Renata Hoffmann · Anna Frymark-Szymkowiak · Mikołaj Matela

Kazimierz Wielki University

Climate change is increasingly causing extreme weather phenomena. During the night of August 11-12 in 2017, hurricane winds blowing at a speed of over 150 km/h damaged around 80,000 ha of forests in Poland. As a result of the “hurricane of the century”, the forests of the Rytel Forest District in Tuchola Forest, suffered the greatest losses, where 64% of the stands were destroyed.

In 2019, in cooperation with the State Forests, Rytel Forest District, long-term research was initiated to observe the rate and directions of regeneration processes in forest fragments designated for natural regeneration (reference areas, without interference) and stimulated in various ways by foresters – by planting in Szymański’s areas and in rows, after previously removing the wood and mulching the remaining biomass. Undamaged control areas were delimited in the closest possible vicinity of each of the regeneration areas. The observations were carried out within alder forest, mixed marsh forest, fresh forests, mixed fresh forests and fresh coniferous forest. Phytosociological relevés were performed in each area by using the Braun-Blanquet method and in fresh coniferous forests, an analysis of respiratory activity of soil microorganisms was additionally made.

The destroyed fragment of the alder forest, differed from the control plot by a greater proportion of *Ribes nigrum* and *Rubus idaeus* in the subgrowth and *Urtica dioica* in the undergrowth.

The mixed swamp forest with damaged tree tops was characterized by an abundant undergrowth of *Populus tremula* and a significant share of helophytes in the undergrowth.

In the case of fresh forests, the damaged areas differed from the control ones by the strong development of brambles, mainly *Rubus idaeus*, greater coverage of *Deschampsia caespitosa*, and generally a greater number of species. Seedlings of *Betula pendula*, *Fagus sylvatica*, as well as synanthropic plants such as *Conyza canadensis* and typical for open places: *Hieracium pilosella*, *Hypericum perforatum* appeared.

The damaged areas of fresh mixed forests were characterized by the abundant undergrowth of *Populus tremula*, *Acer platanoides*, *Quercus robur*, *Sambucus nigra* and *S. racemosa*. In the undergrowth, however, nitrophilous species (*Chaerophyllum temulum*, *Chelidonium majus*, *Geranium robertianum*), as well as hygrophilous (*Phragmites communis*, *Solanum dulcamara*) and meadow (*Deschampsia caespitosa*, *Poa pratensis*) species appeared. One of the areas was distinguished by a large share of *Quercus rubra* seedlings and a significant coverage of *Deschampsia flexuosa*.

In fresh forest, despite the destruction of the stand, the undergrowth was still dominated by *Deschampsia flexuosa*, and the moss layer was well developed. The destruction of trees also resulted in a significant reduction in the activity of soil microorganisms, regardless of the method of regeneration of the site.

## 3. Learning from data

### *Big data science in social-ecological systems towards sustainable landscape management*

#### **Symposium organisers**

*Martin Schultze* (Martin Luther University Halle-Wittenberg), *Evelyn Asante-Yeboah* (Martin Luther University Halle-Wittenberg), *Praveen Kumar* (Jawaharlal Nehru University), *Christine Fürst* (Martin Luther University Halle-Wittenberg)

#### **Summary**

Forecasting sustainable landscape management under future scenarios of climate change aspects, land-use changes and different socio-economic drivers demand integration of new knowledge sources across scientific disciplines. The symposium will bring together scientists, practitioners and students discussing big data approaches, monitoring methods as well as novel modelling concepts relevant to questions such as (1) How does big data facilitate a better understanding of human-nature interactions? and (2) What frameworks and strategies do ensure a successful implementation to achieve sustainable landscape management practices?

#### **Description**

Earth's ecosystems toward sustainable management practices are often severely impacted by complex social, economic and environmental interactions. Human behaviour that threatens land sustainability is closely connected to multiple spatio-temporal scale processes such as climate change, agricultural (mis-) management or soil depletion. A key challenge to unveil such social-ecological system dynamics requests for novel approaches to reconsider nature provisions to human well-being. The growing awareness of traditional research about land use changes or ecosystem resilience to disturbances can deliver essential information strengthening future nature's health. Thus, converting the retrospective into forward-looking tools allows to set up sustainable environmental baseline targets to action best land practices. This is often referred to as big data science touching increasingly real-world complexity, including different streams of knowledge. Possibilities occurring from big data are considered pivotal to gain an understanding that can inform stakeholders, practitioners or even decision-makers. The proliferation of social media, earth observing systems and ecological monitoring networks have generated large pools of data sources. These technologies provide the capacity to create, aggregate and cross-reference big data to design alternative land management strategies. Such advances promote significant analytical importance addressing social-ecological system properties along identifying landscape boundaries, essential drivers or ecosystem functions. Complementing the creation of big data in ecosystem management will need the incorporation of simulation systems. Arising innovative modelling techniques from multiple disciplines fosters both (1) a culture of sharing datasets and (2) supporting an integrated coupling of socio-economic and environmental systems from local to global scales. Recent developments in data-driven approaches such as machine learning allow to process big data, whereas cloud computing sustains a flexible supply of on-demand services. This relation between big data and modern technologies ensures a robust concept according to complex social-ecological questions such as how human interventions impact the stability of environmental processes and biodiversity.

Hence, the symposium aims at bringing together complementary perspectives in simulating social-ecological systems toward future landscape management. Session talks should focus on the following themes:

- Advancement in using multiple data sources such as social media, sensor information as well as networks for modelling social-ecological systems.
- Novel technical solutions to handle big data (e.g. artificial intelligence, open system initiatives), data-sharing practices and cloud computing.
- Supporting decision-makers in designing sustainable land management strategies by involving modern simulation systems

## AGRICULTURAL LANDSCAPE CHANGE IMPACT ON THE QUALITY OF LAND IN AREAS OF GAIN AND DISPLACEMENT

Felicia Akinyemi<sup>1,2</sup> · Chinwe Ifejika Speranza<sup>1</sup>

<sup>1</sup>University of Bern · <sup>2</sup>University of Neuchâtel

**D**espite the loss of agricultural lands as well as abandonment in certain world regions, agricultural land area is increasing globally. This increasing trend stems mainly from increased demand for agricultural products (that is, food and non-food) and changing preferences in people's diet. As agriculture is a major factor driving global environmental degradation, practicing agriculture sustainably with minimal negative environmental impacts is a challenge, especially in biodiverse, tropical regions.

A comprehensive assessment of change in agricultural landscapes and the associated land quality was conducted between 2000 and 2018. Land quality was established based on the change in Net Primary Productivity (NPP), Soil Organic Carbon content (SOC), percent change in crop yield and Crop Suitability Index for five crops of global importance (maize, rice, soybean, wheat, and alfalfa). NPP connotes the land's biological productive capacity (e.g., for providing food, fiber); SOC is a proxy for soil health and fertility; crop yield and land suitability for cultivation are productivity metrics. We identify influencing factors and model the quality of land associated with agricultural land gains and losses.

We examine the case of the continent Africa, considering its cropland expansion frontiers of global note. Agricultural land expansion in Africa is occurring in the context of heightened population pressure, increasing distal demands for land-based products and foreign and domestic land acquisitions. Here, the knowledge about major agricultural land use transitions and their impacts on the quality of land is still very limited. With pressure mounting to halt biodiversity loss and stem land degradation in agricultural areas, promoting sustainable agriculture requires not only an understanding of agricultural land-use change but also the impacts on land quality.

Distance to settlement and major roads was important in explaining agricultural land dynamics. Most cropland gain areas were associated with large distances away from major roads, suggesting remoteness of gained croplands. Land quality was better in gained croplands than in those lost, whereas gained grasslands were of lesser quality compared to areas of grassland loss. Five typologies of countries were developed based on net yield and amount of land cultivated per crop in cropland change areas. Type 1 typifies net yield increase and cultivated land decrease, while type 2 is characterized by yield increase consequent upon cropland expansion. Net yield and land remain unchanged in type 3, while in type 4 cultivated land increased but yield decreased as in 40% of African countries for maize, and in type 5, both yield and land area decreased. This study thus provides evidence about the quality of land in gained and lost agricultural areas and generalizable insights on their dynamics.

## THE IMPACT OF LAND-USE/LAND-COVER CHANGES DRIVEN BY SOCIO-ECONOMIC FACTORS ON THE PROVISION OF ECOSYSTEM SERVICES IN SOUTH-WESTERN GHANA USING A STAKEHOLDER-BASED MODELLING APPROACH

Evelyn Asante-Yeboah · HongMi Koo · Christine Furst

Martin Luther University Halle-Wittenberg

Understanding the linkage between land use and land management decisions and the status of ecosystem services (ES) is important to identify how land-use/land-cover modifications can affect the supply of human benefits. However, the involvement of the people who are the direct users of land and beneficiaries of ES has not been well reflected in the ES evaluation especially in the context of West Africa. This study used a stakeholder-based modeling approach to assess the current and potential impacts of land-use/land-cover changes driven by socio-economic factors in the southwestern part of Ghana. The approach involved the selection process of legitimate stakeholders using the influence-interest matrix, site-specific selection of ES and indicators based on literature review and stakeholder surveys, and spatially explicit simulation of current land use patterns and future land use patterns influenced by land-use/land-cover change. The simulated current and future land-use patterns were integrated with potential ES values for analyzing the relationship between land-use/land-cover patterns and the provision of ES at the local level.

The result showed how land-use/land-cover changes driven by socio-economic activities can lead to a change in the capacity of the landscape to provide ES, which is visualized as trade-offs and synergies. In addition, how local perceptions can influence the landscape capacity of ES provision was identified through a stakeholder-based modeling result. The stakeholder-based modeling approach offered a context-specific evaluation of ES and its integration into site-specific ES evaluations is recommended.

## USING SOCIAL MEDIA REVIEW DATA TO ASSESS CULTURAL ECOSYSTEM SERVICES OF GREEN INFRASTRUCTURE IN METROPOLITAN AREAS OF GERMANY AND CHINA

Christin Busch<sup>1</sup> · Matthias Falke<sup>2</sup> · Katrin Bernard<sup>1</sup>

<sup>1</sup>Research Institute for Regional and Urban Development · <sup>2</sup>Ruhr University Bochum

**A**s a carrier of multiple ecosystem services (ES), green infrastructure (GI) can significantly foster the resilience of an urban area. Facing challenges such as climate change and rapid urbanization, ensuring the well-being of urban residents through protection and expansion of GI thus plays a key role in sustainable landscape management and urban planning. In contrast to regulating and provisioning ES, cultural ecosystem services (CES) comprise the non-material benefits people obtain from urban ecosystems. The intangibility and subjectivity commonly associated with CES, however, impedes mapping and assessment of CES.

Recently, the systematic analysis of social media (SM) data emerged as a promising approach for CES assessment. A large part of these studies focuses on the assessment of geotagged photos from platforms such as Instagram, Flickr or Panoramio. However, image analysis is subject to strong subjective decisions, especially when neglecting the textual comments beneath the image, that can falsify the results.

Against this background, our study explores the possibilities for assessing CES through a structured analysis of text-based comments on SM platforms. For the period of 2017-2021, we extracted more than 18,000 comments for over 15 GI types (e.g. parks, forests, community gardens, etc.) in three urban areas in the Ruhr area, Germany, and Shanghai, China. Based on all CES classes listed in the CICES 5.1 classification framework the comments were then systematically coded using qualitative data analysis software.

The results provide a sophisticated and distinct pattern of local CES demand & supply for all three cities. Overall, aesthetic experiences (CICES 3.1.2.4) accounted for the majority of the mentions in all cities, followed by passive or observing interactions (CICES 3.1.1.2) as well as active or immersive interactions (CICES 3.1.1.1). Regarding individual CES classes, there were differences both between the individual GI types and between the three cities. Moreover, we also identified information on how material and non-material GI-assets facilitate or impede the flow of CES. Such relational information on GI-assets and the flow of CES could provide relevant insights for a people-oriented landscape and GI management.

The applied method represents a grounded, cost-effective and time saving approach for a preliminary CES-assessment of GI. Due to the widespread use of SM and availability of data, the approach offers broad potential for transferability. Still, limitations arise from the socio-structural representativeness and comparability of SM data across cities. Thus, complementary desk-research and/or additional empirical survey remain a prerequisite to verify preliminary results.



## ASSESSING THE POTENTIAL OF MACHINE LEARNING FOR DEVELOPING LANDSCAPE TYPOLOGIES

Adrienne Grêt-Regamey · Maarten Van Strien

ETH Zürich

Land and system and landscape science both seek to understand land cover and land use change resulting from the actions of humans and their interactions with natural factors. While several authors have tried to identify land use change based on remotely sensed data, most current landscape typologies fail to consider complex landscape patterns and social-ecological interactions. Machine learning technologies have been promoted as opening the path to new classification approaches, but the question remains if they will better allow delineating complex landscape patterns emphasizing socio-ecological interactions.

In this contribution, we present several experiments with the creation of landscape typologies with machine learning and how they were incorporated in an iterative, participatory process. We compared the landscape typologies with available typologies and discussed them with experts. We performed our analyses based on a set of available spatial data including elevation, land use and land cover, population density, historic traffic routes and specific historical landscape elements, as well as ecosystem services. We compared indicator-based GIS fuzzy logic approach with several supervised (K-Means clustering, convolutional neural networks and self-organizing maps) and unsupervised (random forest and support vector machine) approaches. The results of several of these techniques were used in a participatory process in the canton of Schwyz, Switzerland, characterized by a high landscape heterogeneity.

Interestingly was the fact, that the machine learning algorithms identified some new typologies, which had not been identified by the experts, which led to interesting discussions about the existence of newly emerged landscape typologies. These new typologies were used as inputs for adapting the expert landscape typology. At a Switzerland-wide scale, we also investigated the use of Deep Convolutional Embedded Clustering (DCEC), which is a novel technique that has specifically been designed for the automated clustering of images. We show that DCEC successfully learned features and provided well-distinguishable clusters of images. But again, the majority of classes showed little spatial similarity with existing typologies, indicating that DCEC could only be used to inform experts about distinguishing landscape features and patterns, but not to develop comprehensive landscape typologies.

While the computer generated landscape typologies could thus not be used as a final product, the maps were highly useful as an intermediate input to support the expert-based landscape classification. Furthermore, the DCEC methodology allowed the identification of recurrent landscape patterns. In summary, the combination of qualitative and quantitative, expert-based and computer-aided methods has proved a successful approach to making landscape diversity tangible and developing its cultural-historical and identity-forming values.

## ASSESSING CLIMATE CHANGE VULNERABILITY OF MAPPED SOCIO-ECOLOGICAL SYSTEMS IN THE CENTRAL HIMALAYA

Praveen Kumar<sup>1</sup> · Christine Fürst<sup>2</sup> · PK Joshi<sup>1</sup>

<sup>1</sup>Jawaharlal Nehru University · <sup>2</sup>Martin Luther University Halle-Wittenberg

The research attempts to understand and relate the two pertinent aspects in the Himalayas, environment, and society. This research helped in understanding the complex relationship between social and ecological systems. It aimed to comprehend the vulnerability of coupled socio-ecological systems (SESs) to climate change in mountains. The work focussed on identifying and understanding SESs, and later, assessing the vulnerability of SESs to climate change in the Himalayas.

The SESs were mapped and identified through hierarchical clustering of socio-economic and ecological variables and were used as templates for the assessment. The assessment was done using the boundaries of SESs instead of administrative boundaries as the SES approach offers insights into the socio-economic and ecological determinants that contribute to high climate change vulnerability. Primary data was collected through the participatory rural appraisal (PRA) method at household levels from 14 villages in 3 different SESs. An indicator-based approach was used to assess the components of the vulnerability index for the SES. Exposure, Sensitivity and Adaptive capacity indicators were determined to calculate the socio-ecological vulnerability index (SVI).

The results showed varying patterns of vulnerability across the SESs. The outcomes helped in recognizing the vulnerable SESs to support local needs and identify gaps in existing policies and institutional arrangements for sustainable development of the Himalayas. The SES based vulnerability assessment provides a robust methodology that could be adopted in the entire Indian Himalayan region and other mountain ecosystems.

## PROBLEMS WITH SPATIAL BIG DATA PROCESSING ON THE EXAMPLE OF PHYSICO-GEOGRAPHICAL REGIONALISATION OF THE WIELKOPOLSKIE VOIVODESHIP

Witold Piniarski

Adam Mickiewicz University

Earlier studies that concern a division of the Wielkopolskie voivodeship into physico-geographical units in rank of a microregion has shown wide range of problems connected with accessible datasets (Macias et al., 2020; Piniarski, 2020). First, it was necessary to collect spatial data layers that corresponds to many and various characteristics of the environment of the study area. Secondly, all the datasets required initial preparation and unification to make it usable in desired GIS processing, to conduct multi-criteria physico-geographical regionalisation. However, it is rather noticeable that the problem with over time-consuming big data processing in GIS lies not only in the complexity of the data itself but also in specific deficiencies in performance of the software solutions. It is still quite common for GIS software to offer weak hardware support in terms of using the potential of accessible computation unit and most of all lack of support of modern hardware acceleration technologies.

The study presents encountered problems with processing large and complex geographic datasets that can be considered as Spatial Big Data. Initial research included analysis of the following environment characteristics of the study area: geological structure, landform genesis and its morphometric characteristics, as well as waters, soils and vegetation. Selected characteristics stand for criteria of the physico-geographical division. A regular net of squares with sides in size of 50 meters was written into the whole study area. This fact determines a precision of all further analyses. Ultimately, close to 12 million of 2500 m<sup>2</sup> test fields were designated within the area of the Wielkopolskie voivodeship. Furthermore, considering all 6 criteria means processing of spatial data for nearly 72 million test fields with 288 million of vertexes. In general, complicated geometries of the data with rather complex attribute tables results in lots of computation issues that could be potentially fixed with usage of more effective software and algorithms that supports hardware acceleration.

Despite the encountered limitations, researchers managed to obtain landscape contrast map for the study area. The map was a baseline for micro-regionalisation. In the Wielkopolskie voivodeship, 228 microregions have been designated, for which detailed natural characteristics have been determined and their dominant features indicated. They were the basis for the designation of 48 physico-geographical mesoregions.

Macias A. et al. (2020). *Physical and Geographical Regionalization and Environmental Management: A Case Study in Poland*. Pol. J. Environ. Stud., 29(4): 2753-2762.

Piniarski W. (2020). *Delimitation of physico-geographical microregions of the Greater Poland Voivodeship using multi-criteria environment analysis*. Poznań: Adam Mickiewicz University. (PhD thesis)

## A GIS-BASED PROCEDURE FOR PHYSICO-GEOGRAPHICAL REGIONALISATION WITH USAGE OF SPATIAL BIG DATA IN MULTI-CRITERIA ENVIRONMENT ANALYSIS

Witold Piniarski

Adam Mickiewicz University

The interest in physico-geographical regionalisation has significantly increased in recent years due to the implementation of the European Landscape Convention. One of the most important studies connected with this issue was the concept of verification and adjustment of the boundaries of physico-geographical mesoregions of Poland based on contemporary spatial data and modern GIS tools (Solon et al., 2018). The programme of identification, cataloguing and evaluation of landscapes for each voivodeship in Poland brought the necessity of correction of the commonly accepted regionalisation of Poland developed by J. Kondracki and A. Richling in 1994. The accuracy of existing physico-geographical units was insufficient for the purpose of landscape cataloguing. GIS software alongside with modern computing technologies has revolutionised the set of tools available for nowadays geographers. It not only helped with increasing details of existing regionalisation but also make it possible to introduce even more accurate units in rank of microregions for large parts of the country. One of the examples is the micro-regionalisation of the Wielkopolskie voivodeship that have been used in the work related to the landscape audit (Piniarski, 2020; Macias, Bródka eds., 2021).

The objective of the work is to present the procedure that led to the division of the area of the Wielkopolskie voivodeship into physico-geographical microregions. The concept scheme of the delimitation procedure consists of 6 essential parts that include various geometrical operations and spatial data analysis proceed with certain GIS tools. The methodological solutions adopted in the work are in accordance with the major guidelines proposed in the mid-1970s by J. Kondracki. The study tested the possibility of using statistical methods and GIS for the purposes of regionalisation. During the research, technical difficulties related to the limited performance of available computational solutions were encountered, especially in case of processing large spatial datasets (Spatial Big Data). Therefore, much effort was devoted to methodological problems and technological challenges related to the conduction of detailed divisions for vast areas. Determining the boundaries of physico-geographical units based on available source materials has proved to be an extremely complex process but thanks to GIS processing tools and developed scheme can be prepared and shown in just a few single steps.

Bródka S., Macias A. (Eds.) (2021). *Physico-geographical regions of the Wielkopolskie Voivodeship*. Poznań: Bogucki Wydawnictwo Naukowe.

Piniarski W. (2020). *Delimitation of physico-geographical microregions of the Greater Poland Voivodeship using multi-criteria environment analysis*. Poznań: AMU. (PhD thesis)

Solon J., Borzyszkowski J. (Eds.) (2018). *Physico-geographical mesoregions of Poland – modified version of J. Kondracki's regionalisation*. *Geogr. Pol.*, 91(2): 143-170.

# *Towards a dynamic assessment of habitats conservation status: from in situ data to Copernicus services*

## **Symposium organisers**

*Jose Manuel Álvarez-Martínez* (University of Cantabria), *Borja Jiménez Alfaro* (University of Oviedo)

## **Summary**

A current challenge of biodiversity and conservation relies on mapping habitat types at the landscape scale. In the absence of fine-resolution maps, predictive modelling provides a useful tool still uncommon in planning and management. The objective of this symposium will be collecting works designed for monitoring ecosystems with suitable estimates of their distribution and conservation status at different scales. Approaches will combine ground data and limiting factors, remote sensing (Copernicus) and modelling, allowing harmonizing habitat maps across space and time under Global Change scenarios.

## **Description**

There is an increasing interest in mapping the distribution and ecological status of ecosystems as an effective tool for conservation planning and management. Monitoring and reporting this conservation status requires knowledge about the distributional patterns of vegetation types to estimate regional extents, rarity and potential distribution, among other factors. However, there is a lack of long-term regional initiatives designed from the landscape to biogeographical levels. High spatial resolution maps have been mainly developed by using field surveys and visual interpretation of aerial imagery. However, these traditional surveys are resource consuming and can only be applied to small areas; therefore, vegetation maps are often not available or outdated to entire regions. Given limited resource availability and the need for continuous data allowing biodiversity estimations in a changing world, a current challenge is the complementary development of readily available maps across geographical ranges and through time. In this regard, predictive mapping based on remote sensing may provide an important opportunity for conservation, planning and management at the mesoscale.

Remote sensing techniques (i.e. Copernicus) offer a direct source of continuous data from airborne or satellite sensors, which allows the identification of the current distribution of ecosystems in the landscape. Although these methods do not replace field observations and need to be always coupled with them, they provide additional insights to traditional mapping, such as: (1) objective and continuous data, (2) faster map production, (3) insight into inaccessible terrain, (4) consistent land cover and vegetation maps at geographical scales, and (5) improved repeatability of the mapping process. Certainly, the combination of in-situ ecological information remote sensing (including satellite and UAV information, LiDAR and RADAR) has been applied to characterize specific vegetation types at a medium to local scale. Nevertheless, in spite of the long tradition of predictive mapping with remote sensing, no many studies have integrated these techniques into a generalized framework to estimate the distribution and conservation status following standardized and affordable approaches. This is especially relevant in heterogeneous and changing landscapes given the ongoing debate of defining boundaries or ecotones when modelling vegetation cover.

Following these guidelines, the objective of this symposium will be addressing two main questions: (1) Can predictive modelling based on environmental predictors and remote sensing generate suitable estimates (indicators) of the distribution and conservation status of a variety of habitat types at a regional scale? (2) Can we create unique vegetation maps by merging individual predictions for each habitat type that represents a reliable pattern of the landscape continuum that result useful for landscape planning and management?

## MODELING POTENTIAL NATURAL VEGETATION. BRINGING TO LIGHT AN OLD CONCEPT TO GUIDE NATURE CONSERVATION IN FRAGMENTED AND DEGRADED LANDSCAPES

Axel Bourdouxhe<sup>1</sup> · Lionel Wibail<sup>2</sup> · Hugues Claessens<sup>1</sup> · Marc Dufrêne<sup>1</sup>

<sup>1</sup>University of Liège · <sup>2</sup>Public Service of Wallonia

The biotope mapping is an important tool to assess and monitor the conservation status of biotopes and species associated with them. However, effective biotope surveys require significant financial and human resources and need to be repeated on a regular basis to keep it up to date. Therefore, detailed biotopes mapping is, for many countries, currently only available in some biodiversity hotspots. To overcome these limitations, the development of vegetation communities or biotope distribution models is a stimulating option. Nevertheless, modelling biotope distributions in modified landscapes such as those of Western Europe raise questions. Many biotopes identified as of Community Interest by the European Habitats Directive share similar abiotic conditions as early-stage biotopes naturally appear after a perturbation to evolve toward a climatic stage. Modelling them separately requires therefore a lot of caution.

We therefore propose in the present study an approach to model a large variety of biotopes, using the old concept of Potential Natural Vegetation (PNV). Our approach attempts to model vegetation successional stages of the same PNV together to improve modelling accuracy of scarce biotopes. Furthermore, it is interesting to identify the potential evolution of natural environments to limit human intervention for the restoration of biotopes by making better use of natural disturbances. This may help to maintain at a low cost a certain heterogeneity of the landscape that favours biodiversity and limits the fragmentation of habitats. We tested this approach in Southern Belgium. A first aggregation of biotopes into PNV was based on the long history of field expertise available in Belgium. Then Random Forest algorithm was used to predict the potential distribution of each group of biotopes using accurate environmental datasets composed of topographic, soil attributes related and climatic variables. Natura 2000 biotopes survey maps were used to calibrate the model. Resulting individual maps have a very good predictive power with a mean Producer Accuracy of 0.79 and a mean User Accuracy of 0.81. The final step was to build a unique PNV map using a Random Forest classifier combining the different predicted PNV maps. The overall accuracy of this map was calculated with a kappa value of 0.92.

The most important limitations of this study result from the quality of the input data, due in part to a potential operator effect and the way this complex dataset has been integrated in models. However, obtained maps are of great interest in identifying priority areas for restoration in the most degraded environments. They can allow saving time during field surveys in order to target areas with higher potential biological stakes. They can also be used in ecological network strategies to identify how biotopes can potentially structure the landscape and improve connectivity with a dynamic management.

## HABITAT CLASSIFICATION AND CONNECTIVITY-FUNCTIONALITY ANALYSIS ALONG THE EUROPEAN GREEN BELT USING HIGH-RESOLUTION SATELLITE IMAGERY

Stefan Fuchs · Florian Danzinger · Thomas Wrbka

University of Vienna

The European Green Belt (EGB) stretches along the former Iron Curtain from the north of Norway to the shores of the Black Sea, forming an ecological backbone across Europe that is essential for biodiversity as well as for the human well-being by providing numerous ecosystem services (ESs) and a significant contribution to the EU green infrastructure as a whole. But the EGB still suffers from a certain degree of not sufficiently connected habitats and valuable landscapes. In the course of the Interreg DTP project “DaRe to Connect” the aim to implement an EU Danube Strategy to (re)connect and strengthen the network of Natura 2000 sites and other protected areas (PA) along the EGB was pursued.

In order to find suitable habitats for networking, high-resolution Sentinel-2 satellite imagery was used to categorize the land cover classes in the project regions as Broader Habitat Types (BHT). Therefore, a machine learning approach was chosen, where the Sentinel-2 data, both spectral bands and products from it, was analyzed by an algorithm using time series of 2017 & 2018 and training data gathered by ground truthing within the pilot regions (PR). Subsequently, each pixel of the PR was classified as the BHT based on the spectral signature, resulting in detailed raster images with a resolution of 10 m.

Based on these results, two analyses could then be carried out:

- On the one hand, regarding the connectivity, where BHTs of interest (natural habitats in general, but also e.g. especially forests or grassland) were categorized using the Morphological Spatial Patter Analysis (MSPA), whereby the geometry, connectivity and spatial distribution of habitats could be represented by 7-MSPA classes (such as cores or bridges).
- On the other hand, we wanted to visualize the various ESs that are provided along the EGB. To achieve this, we combined the developed ESs capacity matrix, which consists of 5 main services comprised of 30 individual ESs that were combined as the Total Function Value (TFV; the weighted sum of all ESs as an indicator of multifunctionality), with the BHTs. In this way, their capacity to provide the respective ESs could be shown.

Finally, these analysis results were combined to the Connectivity-Functionality-Index (CFI), so potential corridors between and within the PA could be identified. Those areas have both a high functional value as well as an important role as a connecting landscape element.

These maps now serve as a tool for policy recommendations and prioritization of where to take action. Three fields of action can be differentiated: those within PA, which usually have a well-established network of ecologically valuable habitats and must, of course, be preserved and strengthened. Such areas, which are located outside PA and include corresponding corridors, which should be secured. And those where such potential connections are more or less lacking and have to be restored.

## FROM MAP TO MANAGEMENT: AN INTEGRATED MODELLING FRAMEWORK TO ASSESS THE CONSERVATION STATUS OF HABITAT TYPES AT A LARGE SCALE

Jose Manuel Álvarez Martínez<sup>1</sup> · Borja Jimenez Alfaro<sup>2</sup> · David López Trullen<sup>3</sup> · Fernando Rodriguez Montoya<sup>1</sup> · Gonzalo Hernandez Romero<sup>1</sup> · Santiago García<sup>4</sup> · Ignacio Pérez Silos<sup>1</sup> · Ana Silió Calzada<sup>1</sup> · María Recio<sup>1</sup> · Jose Barquin<sup>1</sup> · José Juanes de la Peña<sup>1</sup>

<sup>1</sup>University of Cantabria · <sup>2</sup>University of Oviedo · <sup>3</sup>ITD Medioambiente · <sup>4</sup>BIMASDE SL

**A** current challenge of biodiversity and conservation relies on the estimation of the spatial extent and conservation status of habitat types across broad territories and through time (Jiménez-Alfaro et al., 2018). In the absence of fine resolution maps, predictive modelling based on remote sensing (RS) helps in assessing the spatial distribution of vegetation cover through key indicators of community structure, function, dynamics and vulnerability. However, such approaches are still uncommon in regional planning and management.

In this work, we present a number of case studies ranging from regional (Cantabria, north of Spain) to biogeographical (Central Anatolia, Turkey) and nationwide extents (Spain) on which we map and assess the conservation status of habitat types following the framework of Article 17 of the Habitats Directive (Directive 92/43/EEC on the conservation of natural habitats and of wild flora and fauna). Data range from readily available Copernicus Land Monitoring Service products to indicators derived from different RS platforms such as Landsat 5 and 8 and Sentinel 2, LiDAR derived products and field spectroradiometry libraries. Environmental variables are also relevant for specific habitats subject to abiotic constraints. The method applies a hierarchical modelling approach that combines in-situ, expert-based data and spatial predictors allowing getting suitable estimates of forests to shrubs, pastures and wetlands at different scales and with different purposes (Álvarez-Martínez et al., 2018).

This combination of ecological modelling with remote sensing offers multiple advantages over traditional field surveys and image interpretation alone, allowing the harmonization of detailed vegetation maps across large regions and through time (Franklin, 2013). This is particularly useful for implementing conservation actions under Natura 2000 principles, assessing IUCN criteria for ecosystems and designing intelligent landscape management practices related to the development of blue and green infrastructure schemes for enhancing biodiversity and ecosystem services under the effects of Global Change.

Álvarez-Martínez J.M. et al. (2018). *Modelling the area of occupancy of habitat types with remote sensing*. *Methods Ecol. Evol.*, 9(3): 580-593.

Franklin J. (2013). *Mapping vegetation from landscape to regional scales*. In: E. van der Maarel and J. Franklin (Eds.), *Vegetation Ecology* (pp. 486-508). Hoboken, New Jersey: John Wiley & Sons.

Jiménez-Alfaro B. et al. (2018). *Modelling the distribution and compositional variation of plant communities at the continental scale*. *Divers. Distrib.*, 24(7): 978-990.



## INCORPORATING REMOTELY SENSED ECOSYSTEM FUNCTIONING INTO SPECIES DISTRIBUTION MODELS: LIMITATIONS, ADVANTAGES AND FUTURE AVENUES

Adrián Regos<sup>1</sup> · João Gonçalves<sup>2</sup> · Salvador Arenas-Castro<sup>3</sup> · Domingo Alcaraz-Segura<sup>4</sup> · Antoine Guisan<sup>5</sup> · João P. Honrado<sup>2</sup>

<sup>1</sup>Forest Science and Technology Centre of Catalonia · <sup>2</sup>University of Porto · <sup>3</sup>University of Córdoba · <sup>4</sup>University of Granada · <sup>5</sup>University of Lausanne

Species distribution models are one of the most widely used tools to appraise global change impacts on biodiversity. However, the lack of descriptors of ecosystem functioning involving key processes affecting habitat dynamics (such as primary productivity or evapotranspiration) can reduce model performance, limiting their real-world applicability for conservation and environmental management decision-making. Despite the outstanding development of remote sensing products related to ecosystem functioning, their incorporation into species distribution models remains anecdotal —neglecting a core dimension of the ecological niche of species (Regos et al., 2022).

Here we outline a variety of advantages of incorporating remotely sensed ecosystem functioning into species distribution models. Besides their global coverage and high spatiotemporal resolution, remotely sensed ecosystem functioning attributes represent additional ecological drivers of species distributions that can be efficiently assessed in time and space. We provide examples and outline future avenues for mainstreaming ecosystem functioning in cross-scale, standardized, repeatable and cost-effective global biodiversity modelling and monitoring. We will show different case studies applied a wide range of biodiversity groups, from endangered birds (Regos et al., 2019; Moreira et al., 2022) and plants (Ponce-Fontenla et al., 2021) to top predators (Regos et al., 2021), across different scales and remote sensing products (Regos et al., 2020).

Regos A. et al. (2022). *Mainstreaming remotely sensed ecosystem functioning in ecological niche models*. Remote Sens. Ecol. Conserv. (in press).

Regos A. et al. (2019). *Integrating intraseasonal grassland dynamics in cross-scale distribution modeling to support waterbird recovery plans*. Conserv. Biol., 34(2): 1-11.

Moreira F.S. et al. (2022). *Combining Citizen Science Data and Satellite Descriptors of Ecosystem Functioning to Monitor the Abundance of a Migratory Bird during the Non-Breeding Season*. Remote Sens., 14(3): 463.

Ponce-Fontenla S. et al. (2021). *Sentinel 2 images enable reliable prediction of fine-scale habitat dynamics of narrow endemic plant species in serpentine soils*. Appl. Veg. Sci., 24(4): 1-15.

Regos A. et al. (2021). *Ecosystem Functioning Influences Species Fitness at Upper Trophic Levels*. Ecosystems.

Regos A. et al. (2020). *Model-Assisted Bird Monitoring Based on Remotely Sensed Ecosystem Functioning and Atlas Data*. Remote Sens., 12(16): 2549.

## CHALLENGES OF USING THE LANDIS-II MODEL FOR BIODIVERSITY PROTECTION IN FOREST AREAS

Andris Ziemelis · Gatis Patmalnieks · Oļģerts Nikodemus

University of Latvia

**F**orests are the predominant terrestrial ecosystem on Earth and are crucial in the fight against climate change and biodiversity loss. By using the LANDIS-II model, we conclude that biodiversity in forests is affected by actions under forest management regimes (Ziemelis, 2020). Policy and legislation are important tools to take these actions. Also, we conclude that the black stork protection policy in Latvia by using a microreserves strategy is not enough for sustainable species protection (Patmalnieks, Ziemelis, 2020).

By using the LANDIS-II model, it is possible to answer every question about forest landscape changes in the future, because the LANDIS-II model (Scheller et al., 2007) is a flexible and reliable tool to simulate forest succession and disturbances using a set of predefined parameters and several specialized extensions. We tried to validate LANDIS-II simulation results (Patmalnieks, Ziemelis, 2021) and we have had a few problems.

We will present the main challenges from studies which we made earlier, including model validation. The main dataset used for our studies was the State Forest Register (SFR). SFR is a digital geospatial database that contains compartment level information on forestry related characteristics such as dominant species. Also, we used Sentinel-2 images and machine learning algorithms for mapping forest stand species in large areas. For generating future scenarios, we used forest management policy and legislation, few geospatial layers as protected areas and their management regimes, different ownership types, borders of forest stand.

First of all, from our studies we can predict how the forest landscape will change, but can't predict where exactly will be a change, because legislation and policy are too general. Secondly, we had a problem with LANDIS-II results as an indicator for biodiversity hotspots. And thirdly, a simulation starting point doesn't represent well the situation in nature, and we can't calibrate it. We are open to discuss challenges for using LANDIS-II model for biodiversity protection.

Patmalnieks G., Ziemelis A. (2020). *Forest management impact on black stork (Ciconia nigra L.) habitat landscape changes in the future scenario. Proceedings of the 62nd International Scientific Conference of Daugavpils University. Part A "Natural Sciences"* (pp. 169-178). Daugavpils: University of Latvia.

Patmalnieks G., Ziemelis A. (2021). *Meža sukcesijas modeļa LANDIS II simulācijas rezultātu validācija laika posmā no 1961-2020. gadam PSRS Limbažu mežniecības teritorijā. Latvijas Universitātes 79. Starptautiskā Zinātniskā Konference. Ģeogrāfija. Ģeoloģija. Vides Zinātne* (in press).

Scheller R.M. (2007). *Design, development, and application of LANDIS-II, a spatial landscape simulation model with flexible temporal and spatial resolution. Ecol. Modell., 201(3-4): 409-419.*

Ziemelis A. (2020). *Impact of forest management regimes on the development of forest successions in the territory of Gauja national park in the period from 2020 to 2520. University of Latvia: Latvia. (Master's Thesis)*

## *Earth Observation (EO) for ecosystem services monitoring*

### **Symposium organisers**

*Edyta Woźniak* (Space Research Centre, Polish Academy of Sciences), *Mariasilvia Giamberini* (National Research Council of Italy), *Ioannis Manakos* (Centre for Research and Technology Hellas), *Lluís Pesquer Mayos* (Centre for Research on Ecology and Forestry Applications)

### **Summary**

The symposium will be focused on the use of remote sensing for ecosystem services (ES) monitoring. The access to new kind of satellite data and on-line services, as well as, the development of advanced image-processing technologies have opened novel opportunities to track changes in ecosystems and landscapes and their impact on the provided services. During the symposium, new EO methods and applications will be presented.

### **Description**

The ecosystem service concept implies a direct link between biodiversity and human well-being. Research addressing Ecosystem Services (ES) has been rapidly increasing since 2005. However, it is still challenging to quantify and value ecosystem services. Assessing ES, like provisioning, regulation and maintenance or cultural ones, require for quantitative, spatially continuous, and timely information. The lack of such data is very often the main constrain in ES studies. As a consequence, ES are addressed using land-cover based concepts. Earth Observation (EO) can play an important role in filling in the gap. EO techniques can supply, alternatively to currently available point data, continuous surface data in a cost-effective way; allowing for studying cross-scale interactions and for the upscaling from point measurements and individual ecosystems to whole landscapes.

Currently, we are living a Remote Sensing Revolution. For the first time, there is regular access to many types of data, which vary in spatial, spectral and temporal resolutions. On the one hand, there is the Copernicus program with the fleet of Sentinel satellites. On the other hand, many constellations of CubeSats are launched (e.g. Planet, ICEYE, etc.). Also airborne and drone technologies have become more accessible. Moreover, advances in data processing possibilities occur such as cloud computing, big data solutions, artificial intelligence development, etc. All these progresses bring novel opportunities for the monitoring of habitats, landscapes, ecosystems and their services.

Despite these advances and high potentials of EO in ES assessment, its assimilation in everyday business is still quite scarce. Currently, the main applications of EO for ES monitoring are focused on CO<sub>2</sub> sequestration evaluation, biodiversity studies and yield estimation. Their limited use is due to a number of reasons – often non-technical. These can be related to training and access to information, or training resources, or policies, as well as with the accounting methodologies of ES and their perception by users. This symposium will bring together experts from fields of remote sensing, life sciences, social sciences and economy to share experiences and new ideas for the use of modern EO technologies in landscape ecology, ecosystem services and their changes' assessment, including the interactions between geodiversity and biodiversity across a range of scales. The latest applications of EO in ES evaluation will be presented. We will try to determine the possibility of filling gaps of information with the use of EO and their assimilation into novel modelling frameworks able to bridge the scale gap between climate projections, landscape dynamics and local ecosystem changes. Thanks to this symposium we will strengthen the collaboration among researches from different fields (landscape ecology, remote sensing, geoscience, economy, etc.), practitioners and decision makers for the better ES assessment using EO.

## CORRELATION OF THE FLOODING REGIME WITH THE PRESENCE OF *SOLIDAGO GIGANTEA* OVER THE VALLEY OF NAREW IN POLAND

Piotr Archiciński<sup>1</sup> · Szymon Sala<sup>1</sup> · Eleftherios Katsikis<sup>2</sup> · Marek Ruciński<sup>1</sup> · Rizos-Theodoros Chadoulis<sup>2</sup> · Afroditi Kita<sup>2</sup> · Ewa Gromny<sup>1</sup> · Edyta Woźniak<sup>1</sup> · Ioannis Manakos<sup>2</sup>

<sup>1</sup>Space Research Centre, Polish Academy of Sciences · <sup>2</sup>Centre for Research and Technology Hellas

**M**apping of habitats constitutes fundamental element in ecosystem monitoring; especially, when it comes to monitor invasive species and their impact on the ecosystem functions and biodiversity. High biodiversity plays a key role in the delivery of many ecosystem services. The expansion of invasive species into natural habitats tends to lead to a decline in biodiversity, which may negatively affect many ecosystem services. Seasonal abundance of nutrients and water presence constitute significant elements that may favour the expansion or retreat of a species.

Focusing on an invasive species (namely *Solidago gigantea*) that is recently of high concern for the Polish ecological community, this study manages to capture the fluctuation of open surface water extent over the valleys of Narew and Pilica and the degree this may correlate with its presence. This is nowadays facilitated by utilizing time series of multispectral and radar imagery, as freely offered by the Sentinel-2 and Sentinel-1 mounted sensors.

Initially, land surface phenology metrics, derived from Sentinel-2, are being exploited to the extent that they may differentiate *Solidago gigantea* from the surrounding vegetation community, reaching up to a discrimination saturation point. From that point and on machine learning techniques are being examined for their ability to increase the discrimination capacity. Together with field data from hotspots around the area they constituted the reference information for the presence of *Solidago gigantea*.

Following established workflows, inundation and hydroperiod mapping has been performed over the same area using fused information originating from Sentinel-2 and Sentinel-1 data analysis. Automated thresholding and random forest classifiers generated a series of maps. These were juxtaposed against the reference data. Phenology driven seasonal patterns have been identified in the water regime, which have a significant correlation with the apparent spatial species distribution.

Synthesis of data, means and methods generated a deeper insight about the pulsing of vegetation through time and provided new tools enhancing monitoring capacity. Limiting factors are also acknowledged, presented and discussed.

## THE ROLE OF URBAN HABITAT CONTINUITY AND LANDSCAPE STRUCTURE ON INFORMAL GREENSPACE FLORISTICAL DIVERSITY

Piotr Archiciński<sup>1</sup> · Daria Sikorska<sup>2</sup> · Piotr Sikorski<sup>2</sup> · Edyta Wozniak<sup>1</sup> · Sebastian Aleksandrowicz<sup>1</sup>

<sup>1</sup>Space Research Centre, Polish Academy of Sciences · <sup>2</sup>Warsaw University of Life Sciences

**B**iodiversity plays an important role in the functioning of ecosystems and the many services they provide. According to the TEEB report, biodiversity and ecosystem services are closely related. Including urban informal green spaces (IGS) as important for biodiversity and recreation requires a deeper knowledge of how they are developed spontaneously under various conditions. A deeper understanding of IGS and their appropriate use can improve floristical diversity in the city.

We studied IGS flora in different areas in terms of type of abandonment, habitat continuity and landscape structure. In the study area, lists of all vascular plants were made twice. On the basis of these data, we calculated: total number of species, Shannon-Wiener biodiversity index, hemeroby and urbanity, % share of species from particular ecological groups, number of ancient forest species and rare species. Habitat continuity has been traced since the beginning of the 20th century on the basis of a series of digitized aerial photos. In order to determine the influence of landscape structure on the IGS flora, we conducted spatial analyzes on the basis of vegetation patches mapped in the field and analysis of vicinity structure using LiDAR and spectral data.

Complete abandonment does not result in greater floristic diversity and total species number, but is essential for the occurrence of a group of rare species. The influence of landscape structure was also observed in vegetation species composition. IGS with a large share of the surrounding forests are clearly richer in forest species. Other types of vegetation patches in the vicinity do not have such a clear-cut effect. Habitat continuity apparently drove the development in total abandoned IGS. The IGS near forests, abandoned for several decades, are becoming important for urban biodiversity.

## THE USE OF UAV IN THE ANALYSIS OF CHANGES IN DIGITAL SURFACE MODELS FOR PEATLAND CATCHMENT AREAS

Sebastian Czapiewski · Małgorzata Szczepańska · Danuta Szumińska

Kazimierz Wielki University

Owing to rapid development and increasing availability of Unmanned Aerial Vehicles (UAV), they are frequently used for monitoring the natural environment. This paired with developments in computer analysis techniques allow the imaging performed with UAVs to be used as a basis for creating Digital Surface Models (DSM). DSMs are often employed in studies on geology, environment, engineering, and architecture. In our research, we analyzed procedures enabling the execution of a precise DSM and determined the accuracy of the obtained products in comparison with the existing DSM. Our study sets out to address two research issues. Firstly, the authors assess the plausibility of establishing a DSM based on UAV imaging carried out in unfavorable conditions and indicates whether the results obtained with this method are of sufficient quality to become an alternative to the traditional surveying techniques (LiDAR). Secondly, the article seeks to identify input parameters for a photogrammetric flight that provide the highest accuracy of a resulting DSM. The analyses indicate a strong positive correlation between the DSMs prepared based on UAV imaging with data collected using traditional methods (LiDAR). Mean correlation coefficient ranged from 0.45 to 0.75 depending on the type of land use and input parameters set for a given flight.

Peatlands constitute one of the most prominent natural wetland ecosystems in the world. They cover approx. 2-3% of Earth's land surface and store from 500 to 700 Gt of carbon. Water stored in an undisturbed peatland constitutes a major part of its volume. Therefore, the more water a peatland loses, the greater the decrease in its volume, which in turn causes peat settling, an occurrence consisting in densification and diminishment of organic matter. Available literature offers a number of estimates concerning the rate of CO<sub>2</sub> release resulting from peat settling. Khasanah and van Noordwijk (2019) argue that in the case of subtropical peatlands the peat settling rate of 4.7 cm year<sup>-1</sup> can generate up to 121 Mg CO<sub>2</sub> ha<sup>-1</sup> year<sup>-1</sup>.

UAV photogrammetric data used for performing repeated measurements of peatlands elevation may be regarded as an efficient method for monitoring the level of degradation of said objects. Thus, it may potentially aid researchers and organizations in their efforts to observe and contain threats related to greenhouse gas emissions from peatlands into the atmosphere. Admittedly, DSMs generated using this method may reflect a relatively high degree of error if the surveyed area features a thick vegetation cover, which is often the case in the context of peatlands.

Khasanah N., van Noordwijk M. (2019). *Subsidence and carbon dioxide emissions in a smallholder peatland mosaic in Sumatra, Indonesia*. *Mitig. Adapt. Strat. Gl.*, 24: 147-163.

## QUALITY CONTROL OF COPERNICUS HIGH RESOLUTION LAYERS FOR MONITORING AGRICULTURAL LANDSCAPES AND WETLANDS

Wendy Fjellstad<sup>1</sup> · Svein Olav Krøgli<sup>1</sup> · Linda Aune-Lundberg<sup>1</sup> · Aneta Lewandowska<sup>2</sup> · Agata Hościło<sup>2</sup> · Milena Chmielewska<sup>2</sup>

<sup>1</sup>Norwegian Institute of Bioeconomy Research · <sup>2</sup>Institute of Geodesy and Cartography

Europe's Earth Observation programme for climate and environmental monitoring, Copernicus, is perhaps best known for its Sentinel satellites. Among the services provided by the programme are ready-made thematic layers in the form of High Resolution Layers (HRL). These come in raster format with a resolution of 10 × 10 m or 5 × 5 m. Examples of thematic layers are *Water & Wetness* and *Small Woody Features*. In a collaborative project with Poland, we are testing the usefulness of these products for monitoring, either alone or in combination with national data. The idea of ready-made datasets, freely available and comparable across Europe is excellent – but are they of high enough quality to be useful? We have checked the accuracy of HRL *Water & Wetness* by comparing with Polish and Norwegian geographical data and conclude that the data set cannot be used for monitoring agricultural landscapes and wetlands. We will also present our latest results from quality control of HRL *Small Woody Features*.

## MAPPING ECOSYSTEM FUNCTIONAL TYPES IN CENTRAL AFRICA USING RADAR SENTINEL-1 DATA

Małgorzata Jenerowicz-Sanikowska<sup>1</sup> · Edyta Woźniak<sup>1</sup> · Ewa Gromny<sup>1</sup> · Cristina Domingo-Marimon<sup>2</sup> · Anna Foks-Ryznar<sup>1</sup> · Marek Ruciński<sup>1</sup> · Michał Krupiński<sup>1</sup> · Sebastian Aleksandrowicz<sup>1</sup> · Lluís Pesquer Mayos<sup>2</sup>

<sup>1</sup>Space Research Centre, Polish Academy of Sciences · <sup>2</sup>Centre for Research on Ecology and Forestry Applications

**E**arly detection of changes which occur in ecosystem is crucial for its accurate status monitoring, efficient protection and proper management. However, classical structural classifications of ecosystem based on attributes such as vertical vegetation structure or species composition is not sensitive enough to identify the impacts of human activities and climate changes on ecosystem. Therefore, an approach based on functional characteristics of ecosystems, which can quickly identify variations in vital processes of vegetation expressed by carbon, energy and water fluxes, is needed. Traditionally, Ecosystem Functional Types (EFT) are mapped using vegetation indices derived from optical data, mostly NDVI or EVI. However, in frequently cloudy regions, the availability of optical cloud-free data is a challenge that makes almost impossible to obtain a high accuracy annual time series vegetation profile and its derived EFT attributes productivity, seasonality, and phenology.

This study evaluates an alternative technique to map EFTs in Central Africa (north-western Tanzania, Burundi, Ruanda, eastern Democratic Republic of Congo) using images from Synthetic Aperture Radar (SAR) Sentinel-1 and Google Earth Engine platform. First, the time series of backscatter images in VH and VV polarizations are compared to time series of NDVI derived from Sentinel-2 for 5 growing seasons over the selected area of interest in order to establish the correlation between these two data sources. Results show that the VH polarization correlates better with NDVI than the VV polarization. Pearson correlation coefficient varies from 0.59 to 0.91 and 0.43 to 0.8, respectively, depending on growing season. Next, the function which correlates VH backscatter values with NDVI is established. Finally, two maps of EFTs, one based on optical Sentinel-2 and another derived from radar Sentinel-1 images are calculated for years 2020 and 2021 in order to encompass a whole growing season.

A good agreement between the EFT maps derived from optical and radar data is obtained. The proposed method is a promising solution for obtaining a continuous time series to map EFTs in cloudy tropical areas permitting the establishment of an early warning system for ecosystem degradation.

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## ECOSYSTEM INTEGRITY – SENSOR /EO-SERVICE (ESIS) FOR MONITORING BIO- AND GEODIVERSITY AND SOCIAL-ECOLOGICAL SYSTEMS BY SPECTRAL TRAITS, REMOTE SENSING AND DATA SCIENCE APPROACHES

Angela Lausch<sup>1</sup> · Jan Bumberger<sup>1</sup> · Dagmar Haase<sup>2</sup> · Tilo Wellmann<sup>2</sup> · Peter Selsam<sup>1</sup>

<sup>1</sup>Helmholtz Centre for Environmental Research · <sup>2</sup>Humboldt University of Berlin

**E**cosystems and sustainable agricultural landscapes fulfil a whole host of ecosystem functions that are essential for life on our planet. A huge number of long-standing and standardized ecosystem health and monitoring approaches of bio- and geodiversity exist and are increasingly integrating RS based monitoring approaches. Unfortunately, these approaches in monitoring, data storage, analysis, prognosis and assessment still do not satisfy the future requirements of information and digital knowledge processing of the 21st century. If we want to understand the complexity of our system, we have to apply a holistic RS monitoring approach. Traits and trait variations exist at all spatiotemporal scales. Traits are the crucial interface between different ecosystem domains, coupling of in-situ and RS monitoring approaches and are proxy indicators for ecosystem and human health interactions. RS traits can be used to quantify the genesis, structural, functional, and taxonomic geo- and biodiversity and indicators for monitoring and assessing indicators in social-ecological systems using RS technologies (Anderson et al., 2021; Lausch et al., 2018, 2019, 2020, 2022).

In this presentation, we present the development of an EcoSystem Integrity – RS/Modelling Service (ESIS). The basis of the ESIS idea is that close-range, air- and spaceborne sensors/EO sensors can monitor traits as well as trait variations in vegetation, soil, geomorphology, water quality, land-use-intensity and social-ecological systems. In the future, close-range, air- and spaceborne multisensor and multitemporal RS technologies (optical RS Data, RADAR, TIR Data) will be combined in the ESIS to make modular traits and trait variations quantifiable in a fast and standardized way in only a few steps. ESIS will implement the concepts of data science (Lausch et al., 2018).

Andersson E. et al. (2021). *What are the traits of a social-ecological system: towards a framework in support of urban sustainability*. npj Urban Sustain., 1: 14.

Lausch A. et al. (2022). *Remote Sensing of Geomorphodiversity Linked to Biodiversity – Part III: Traits, Processes and Remote Sensing Characteristics*. Remote Sens., 14: 2279.

Lausch A. et al. (2020). *Linking the Remote Sensing of Geodiversity and Traits Relevant to Biodiversity – Part II: Geomorphology, Terrain and Surfaces*. Remote Sens., 12: 3690.

Lausch A. et al. (2019). *Linking Remote Sensing and Geodiversity and Their Traits Relevant to Biodiversity – Part I: Soil Characteristics*. Remote Sens., 11: 2356.

Lausch A. et al. (2018). *Understanding Forest Health with Remote Sensing, Part III: Requirements for a Scalable Multi-Source Forest Health Monitoring Network Based on Data Science Approaches*. Remote Sens., 10: 1120.

## SPATIO-TEMPORAL ANALYSIS OF ECOSYSTEM FUNCTIONAL TYPES IN RELATION TO LAND COVER CHANGES

Lluís Pesquer Mayos<sup>1</sup> · Cristina Domingo Marimon<sup>1</sup> · Josep Maria Espelta<sup>1,2</sup> · Joan Pino Vilalta<sup>1,2</sup>

<sup>1</sup>Centre for Research on Ecology and Forestry Applications · <sup>2</sup>Autonomous University of Barcelona

**G**lobal change affects ecosystem functions and biodiversity through land-use and climate alteration. The characterization of ecosystems in functional units and the monitoring of their dynamics allows to assess the effects of climate and land cover changes (LCC). With this aim, Ecosystem Functional Types (EFTs) are defined as groups of ecosystems that share functional characteristics including the amount and timing of matter and energy exchanged between the biota and the physical environment. EFT relies on the use of seasonal dynamics of remotely-sensed vegetation indices that can provide key functional aspects of ecosystems functioning, especially those related with ecosystem responses to climatic factors or LCC. Moreover, the analysis of LC transitions and its EFT changes is essential information for the characterization of ecosystem services (ES).

We computed LCC and EFTs in Sahel and Siberia for the years 2005 and 2011. EFTs were obtained from 3 descriptors of MERIS Normalized Difference Vegetation Index (NDVI) seasonal curves (7-day composite, 300 m): productivity (NDVI-I), seasonality (sCV) and phenology (MMAX). These attributes were classified in 3 categories based on equal range percentiles for NDVI-I and sCV and the particular seasonal dynamics for MMAX. To assess LCC annual changes were obtained and relevant transitions were identified: tree loss, tree gain, urban growth and crop expansion. Then, we made a cross analysis between LCC and EFTs, according to LC and EFT invariant; LC invariant and EFT change; LC change and EFT invariant; LC and EFT change.

Siberia presented less LCC than Sahel (30.43% of its area remained LCC/EFT stable vs 11.06% of Sahel). Changes in EFTs but not in LC or vice versa demonstrate that changes in ecosystem functioning are not explained only by LCC, but also by climate change (i.e. LC invariant – EFT change: 86.95% of Sahel and 68.42% of Siberia; LC change – EFT invariant: 0.20% of Sahel and 0.21% of Siberia). Changes in LC and EFT were less frequent (1.80% of Sahel and 0.94% of Siberia).

The analysis of LC transitions showed that tree loss in Sahel involves EFT preservation/decrease NDVI-I, preservation/increase sCV, and preservation/shift MMAX. Most of tree gain area presents a decrease in NDVI-I and remains constant for sCV and MMAX. These LC transitions are related to provisioning ES (food-agriculture, fresh water, energy production) or regulating ES (flood control and prevention).

At Siberia, the most frequent transition is tree gain/loss followed by crop expansion involving EFT decrease of NDVI-I, increase of sCV and preservation of MMAX. These changes affect provisioning ES (wild land meat/non meat and timber). Affected regulating ES are mainly related to habitat protection, water treatment and flood prevention.

The EFT dynamics approach based on time series of VI collects the main LC changes plus other disturbances (climate change) that affects the vegetation functioning.

## QUANTIFICATION OF EVAPOTRANSPIRATION AND COOLING FUNCTION OF VEGETATION USING REMOTE SENSING

Tereza Nováková · Vilém Pechanec

Palacký University Olomouc

**E**vapotranspiration is one of the ongoing cycles sustaining the world hydrological cycle which illustrates water loss to the atmosphere. It is represented as a combination of evaporation (vapour from physical objects) and transpiration (vapour from vegetation). A vast number of methods has been introduced to quantify evapotranspiration and cooling functions, one of them being the Cooling Capacity Index (CCI) developed by InVEST (Sharp et al., 2020) which uses the Penman-Monteith equation (Allen, 1998). The most important influences on evapotranspiration and CCI were determined to be albedo, surface temperature and single crop coefficient. All of these influences were calculated using the Landsat 8 data and further used to measure the CCI. The calculation was done using a custom made Python script for time period from March 2020 to December 2020.

The results have shown higher cooling potential of different types of vegetation while maintaining lower range of temperatures. Whereas artificial objects, especially dumpsites and construction sites along with urban development have been found to accumulate significantly higher range of temperatures.

Sharp R. et al. (2020). *InVEST 3.10.0.post28+ug.gb377061 User's Guide*. The Natural Capital Project, Stanford University, University of Minnesota, The Nature Conservancy, and World Wildlife Fund.

Allen R.G. et al. (1998). *Crop evapotranspiration: Guidelines for computing crop water requirements*, 56. Rome: FAO – Food and Agriculture Organization of the United Nations.

## THE ROLE OF RECENT (1985-2014) PATTERNS OF LAND ABANDONMENT AND ENVIRONMENTAL FACTORS IN FOREST ESTABLISHMENT AND GROWTH OF SECONDARY FOREST THE IBERIAN PENINSULA

Joan Pino<sup>1,2</sup> · Marina Palmero-Iniesta<sup>1</sup> · Mario Padià-Iglesias<sup>2</sup> · Òscar González-Guerrero<sup>2</sup> · Lluís Pesquer<sup>1,2</sup> · Cristina Domingo-Marimon<sup>1,2</sup> · Miquel Ninyerola<sup>2</sup> · Xavier Pons<sup>2</sup> · Josep Maria Espelta<sup>1,2</sup>

<sup>1</sup>Centre for Research on Ecology and Forestry Applications · <sup>2</sup>Autonomous University of Barcelona

**F**armland abandonment has widely affected the Iberian Peninsula since the second half of the 20th century, leading to the expansion of secondary forests across the region. We aimed to evaluate changes in the recent (1985-2014) emergence patterns of these forests and examine how environmental factors affected their growth for contrasting in leaf-habit type forests.

We used a combination of Landsat-derived land-cover maps and aboveground biomass (AGB) maps from the European Space Agency to assess the secondary forest establishment and growth, respectively, in the study region. We also obtained a set of topographic, climatic and landscape variables from a set of GIS layers and used them for determining changes over time in the environmental drivers of forest establishment and AGB using general linear models.

The results indicate that secondary forest cover has still increased in recent decades in the Iberian Peninsula at a rate above the European average. Yet, they also indicate a directional change in the emergence of secondary forests towards lower and less steep regions with higher water availability (mean rainfall and SPEI) and less forest cover but are subjected to greater drought events. Moreover, these factors differentially affect the growth of forests with different leaf-habit types: thus, needleleaf secondary forests have been less favoured by high temperature and precipitation, and broadleaf deciduous forests have been most negatively affected by drought. Finally, spatial patterns of forest emergence and the contrasting responses of forest leaf-habits to environmental factors explained the major development of broadleaf evergreen compared to broadleaf deciduous forests and, especially, needleleaf secondary forests. These results will improve the knowledge of forest dynamics in the Iberian Peninsula in recent decades and provide an essential tool for understanding the potential effects of climate warming on secondary forest growth.

## DEVELOPING A SPATIALLY EXPLICIT, NATION-WIDE HABITAT MAP: CHALLENGES, DATA AND METHODS

Bronwyn Price · Nica Huber · Robert Pazur · Marius Rüetschi · Christian Ginzler

Swiss Federal Institute for Forest, Snow and Landscape Research

**H**abitat for species is considered a fundamental supporting service within the ecosystem services concept. Mapping the distribution of habitats is therefore vital for successful conservation, management and monitoring of ecosystem services and biodiversity. Within Switzerland, there is strong demand for a spatially explicit and area-wide habitat map for a range of purposes, including informing field surveys, providing base data for ecological research, ecosystem service analysis and for the management of ecological infrastructure projects. The stakeholder group for use of the data is broad including scientific researchers, government agencies, environmental advocacy groups. For such purposes, it is important for the habitat map to reflect not the potential distribution of habitats but the current distribution taking into account landscape management.

Therefore, to develop the habitat map of Switzerland, we take advantage of Earth Observation data, in particular digital aerial photography and high resolution 3D information derived from it, and high temporal resolution Sentinel-1 and Sentinel-2 satellite imagery. We map habitats according to the second level of the classification of Delarze et al. (2015), which is the most widely used in Switzerland. Within the software eCognition, airborne ortho imagery (1 m resolution) was segmented into 'image primitives' on the basis of reflectance in the RGB and NIR bands, and values of the metrics NDVI and NDWI (from the Green and NIR bands). We could then bring together information from habitat distribution models and pre-existing land use maps to assign habitat types to these segments in a rule-based approach. The habitat distribution models used in the assignment procedure were developed via machine learning approaches trained with field data available from large scale Swiss vegetation and biodiversity monitoring programmes, and spatially explicit, area-wide predictors derived from Earth Observation data from the Sentinel-1 and Sentinel-2 constellations, climate, topography, and soil data.

We undertook stakeholder consultation and workshops and implemented stakeholder feedback to ensure that the habitat map was developed to meet the stakeholder needs and will be fit for purpose for the wide variety of end-users. The approach has been developed to be semi-automated so that it can be re-applied with updates of the base data at specified time intervals, enabling use for monitoring purposes.

Delarze R. et al. (2015). *Lebensräume der Schweiz. Ökologie – Gefährdung – Kennarten*. 3rd Edition. Bern: Verlag.

## EXPLORING THE ENVIRONMENTAL DRIVERS OF HIGH-LATITUDE WILDFIRES

Antonello Provenzale<sup>1</sup> · Sebastian Aleksandrowicz<sup>2</sup> · Edyta Woźniak<sup>2</sup> · Alice Baronetti<sup>1</sup> · Anna Foks-Ryznar<sup>2</sup> · Marta Magnani<sup>1</sup> · Marta Milczarek<sup>2</sup> · Marek Ruciński<sup>2</sup> · Gabriele Vissio<sup>1</sup>

<sup>1</sup>National Research Council · <sup>2</sup>Space Research Centre, Polish Academy of Sciences

**W**ildfires play an important role in shaping landscape patterns and ecosystem structure, functions and services. Fires directly disturb the landscape by affecting vegetation and changing the physical and chemical soil properties. The increase of extent and severity of forest fires is expected to increase in the future as a consequence of climate change. High-latitudes and, in particular, Siberia are among the regions which are foreseen to be most affected by the impacts of rising temperatures. For this reason, it is crucial to identify the relationships between environmental conditions and wildfire regimes.

This study discusses empirical relationships on how climatic variables are linked with burned area and number of fires. To describe environmental variables, different sources of remote sensed and modelled data are used, such as: NOAA – snow cover presences, Copernicus – Snow Water Equivalent, MODIS – land surface temperature and droughts, ECMWF – wind, etc. The test sites are characterized by different vegetation covers: forests, grasslands and peat bogs. They were selected basing on MODIS Thermal Anomalies and Fire Product. Fire occurrence is analysed from January 2000 to the present and the areas of low, average and high fire frequency are defined as study areas within vegetation types.

Our findings can support the development of data-driven models for the prediction of wildfire regimes, landscape evolution and changes of ecosystem services.

## MONITORING OF THE DELIVERY OF RECREATIONAL ECOSYSTEM SERVICES BASED ON PARTICIPATORY AND SATELLITE OBSERVATIONS IN THE GREAT MASURIAN LAKES (POLAND)

Marek Ruciński<sup>1</sup> · Edyta Wozniak<sup>1</sup> · Sylwia Kulczyk<sup>2</sup> · Marta Derek<sup>2</sup>

<sup>1</sup>Space Research Centre, Polish Academy of Sciences · <sup>2</sup>University of Warsaw

**R**ecreational ecosystem services (RES) are crucial for human well-being and, at the same time, nature-based recreational activities often support local economies. Contrary to other ES, cultural ones (RES including) are place-based. This means that they are formed and delivered only when direct contact between people and nature occurs. However, we cannot forget the environmental threats related to outdoor leisure activities. Data on spatial patterns of the phenomenon are necessary for RES assessment and management, and consequently a foundation is necessary for long-term sustainable development of the region.

Water is one of the most important recreational assets and is used for both leisure and physical activities in multiple ways. The character of these activities is highly variable in space and time. In particular, in the temperate zone, seasonal climate diversity combined with weather dynamics influences the visitation of both sea and freshwater. Traditional methods of visitors monitoring such, official statistics or surveys offer a general insight of the phenomenon at the regional scale, but are far too general to be helpful on the local scale, where the decision on land management is usually taken. Therefore, if the tourist and recreational flow were to be included in the local planning processes, the development of new tools is urgently needed.

This study focuses on monitoring water recreation (specifically sailing). We compare the efficiency of two methods: one based on field observations and the other on satellite image analysis. We analyze the spatial and time diversity of water recreation in the Great Masurian Lakes (Poland). The spatial distribution of sailing boats for the summer seasons 2015-2021 is described. First, the on-site observations were realized and followed by GIS modeling to establish spatial distribution and daily dynamics of water-based activities (this data set is considered as the reference). Then we analyzed the sets of Sentinel-1 radar satellite images, which provide information on a regular basis (every six days), regardless of light and cloud conditions. Therefore, they are considered suitable for spatial distribution analysis.

Our method of monitoring boat traffic uses Sentinel-1 data, an algorithm based on math morphology and local backscatter analysis. Changes in recreational activity in lakes during the day are established by field observations. This interdisciplinary study conducted by ecologists, social scientists, and remote sensing specialists allowed a holistic view of water RES monitoring and can be easily applied for sustainable management of water-based recreation.

## THE USE OF HYPERSPECTRAL AND LIDAR DATA OBTAINED FROM THE AERIAL CEILING AND THE UAV PLATFORM FOR THE HYDROMORPHOLOGICAL CHARACTERIZATION OF EUROPEAN RIVERS, ON THE SCALE OF THE WATERCOURSE SECTION

Paweł Sudra · Grzegorz Wierzbicki · Luca Demarchi · Jarosław Chormański

Warsaw University of Life Sciences

**F**reshwater ecosystems are considered to be one of the most endangered ecosystems on Earth due to a significant decline in their biodiversity related to economic development, pollution and progressive climate change. In European river systems, this decline is mainly related to river partitioning, watercourse diversion, morphological modification of rivers, pollution, agricultural intensification and poor river management practices. It is necessary to improve the ecological quality and the condition of the ecosystems of river valleys and river beds. The ecological condition of river systems results from biological and chemical quality, but also from hydromorphological conditions (HYMO), defined in particular in the Water Framework Directive of the European Union, obliging the Member States to monitor them on a regular basis. In terms of operational monitoring, this is done by the River Hierarchical Network method developed in the REFORM project to assist river managers in assessing the nature of HYMO of river systems. River ecosystems can be divided into coastal and aquatic (channel) habitats. Each of them can be described with a list of HYMO key indicators controlling the processes and forms that should be monitored.

A new generation of remote sensing technologies has changed the way we look at river systems analysis, increasing our understanding of fluvial processes. Modern river monitoring and management can be optimized through the use of an unprecedented number of continuous measurements and spatial information distributed along river sections. The aim of the HyMoSense project is to define an appropriate operational methodology to characterize the HYMO state of river systems using modern remote sensing technologies. Novel, technologically advanced sensors and platforms will be tested and compared: mainly lightweight hyperspectral and LiDAR sensors, mounted on board airplanes and unmanned aerial vehicles. The project aims to provide knowledge which remote sensing method is optimal for the monitoring of the most important HYMO indicators in an automated, repeatable and cost-effective manner. HYMO indicators have been divided into coastal and aquatic habitats. For each category, both data from the airline ceiling and from the UAV platform will be used. They will be tested and compared for different, representative river systems. The first series of studies included remote sensing of the morphodynamics of the Vistula riverbed in the area of the “Ławice Kiełpińskie” reserve near Warsaw. Multispectral imaging with very high resolution (VHR) and LiDAR data allowed, i.a. to obtain a digital elevation model, digital terrain model, and a model of the height of plant cover, then juxtaposed with the orthophotomap. The research problem was the measurement of river erosion and accumulation at the ‘exit’ of the Vistula from the so-called Warsaw corset. Previously, the method was tested in the section of the Lower Vistula River transformed by the flood in 2010 (Kępa Polska-Świniary-Troszyn). Remote-sensing HYMO indicators will allow to create a geodatabase, describing the habitats that make up the natural corridor of the analyzed river.

The results of the project will have an impact on the development of the fluvial remote sensing discipline, both in the perspective of the expectations of scientists and practitioners managing rivers in the light of the requirements of the Water Framework Directive, by providing a method of periodic assessment of indicators.

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## FAST VISUALIZATION AND ANALYTICAL OPERATIONS ON THE WEB TO SUPPORT ECOSYSTEM SERVICES

Alaitz Zabala Torres<sup>1</sup> · Joan Masó<sup>2</sup>

<sup>1</sup>Autonomous University of Barcelona · <sup>2</sup>Centre for Research on Ecology and Forestry Applications

In deriving ecosystem services from remote sensing data, big data files that need to be found from different providers come in different formats and resolutions. This requires knowledge about the data providers, but also proficiency in complete GIS desktop toolsets. In this communication, we present a web map solution that offers an organized list of EO products that are shown together and can be manipulated with analytical tools that immediately presents results in the map browser.

A set of EO products are organized in a visualization and analysis map browser that lowers usage barriers and provides functionalities comparable with raster-based GIS. Normally, web map servers provide maps as pictorial representations at screen resolution. Instead, the MiraMon Map Browser takes advantage of some characteristics introduced in HTML5 (binary arrays and canvas) to transfer the real raster data to the client that is later transformed into visual 2D representations on the client side.

The modern approach provides alternative representations of the data as well as statistical analyses, time profiles, filters, layer combinations, pixel-based calculations, etc. directly in the client side without any further interaction with the server. This approach has been applied to the Horizon 2020 project ECOPotential where 20 protected areas mainly in Europe have data exposed in the browser for the benefit of the local stakeholders. In a regular sized PA of about 100-200 km wide products derived from RS high-resolution data (e.g., Sentinel 2, 10 m cell size) require a factor 10 interpolation, to fit in a regular screen.

The main difference between a traditional GIS and this approach is that each time the user pans or zooms on the map, new binary arrays at screen resolution are requested to the server while the client executes the computations, dividing the work load effort between the client and server. All operations are done in real time at pixel level, so the validity of the results of these operations are conditioned by the uncertainties generated by the server-side interpolation and the propagation of the uncertainty in the calculations. We have concluded that common statistical analyses at screen resolution are still representative of the original data: for categorical data uncertainties are commonly below 1%, as for a continuous data common statistics (e.g. mean and standard deviation) results do not vary by more than 1%.

This methodology is valid for exploratory studies, visual representation of results and overall representation of ecosystem services maps and statistical summaries of natural capital and environmental benefits. Full resolution is needed only if full detail is required. Thus, making a preliminary exploration of data at a smaller resolution gives acceptable results and saves computing power. A hypothesis can be rapidly explored and can be carefully quantified at full resolution later.

## **LiDAR, SPECTRAL AND SELF-EMPLOYED DATA FUSION FOR CULTURAL ECOSYSTEM SERVICES ASSESSMENT IN URBAN GREEN SPACES**

Edyta Wozniak<sup>1</sup> · Sylwia Kulczyk<sup>2</sup> · Marta Derek<sup>2</sup> · Tomasz Grzyb<sup>2</sup>

<sup>1</sup>Space Research Centre, Polish Academy of Sciences · <sup>2</sup>University of Warsaw

**C**ultural ecosystem services (CES) are formed as an effect of complex relations between people and natural environment. Consequently, both natural and social sciences have developed a variety of methods for ES identification and assessment. What should be perceived as a scientific richness, in many cases appears rather a battle field between social and ecological approaches. In this paper, we argue that combining both perspectives allows for a more detailed understanding of phenomena that influence CES formation and delivery.

The study aims to identify and map aesthetic CES of public green spaces in Warsaw, Poland. To describe the environmental basis of CES, LiDAR and spectral data were used. On this basis the elements of green spaces (trees, bushes, small infrastructure, etc.) and their characteristics (e.g. trees' height, bushes' density, vegetation permeability) were mapped and quantified. The obtained inventory helped to develop X-D landscape indices that describe green spaces' landscape diversity. To explore people's aesthetic evaluation on specific green spaces, self-employed mapping with users of green areas was conducted. The participants were asked to take pictures of the most attractive settings in studied green spaces and select and order 10 the most beautiful places. Finally both datasets were compared in order to verify what is the relationship between landscape indicators and social visual evaluation of the urban natural environment.

The conducted study unveils that LiDAR and spectral data are a rich source of information that can be successfully used for CES identification of visually attractive places in urban environments.

## LANDSCAPE–SEASCAPE DYNAMICS IN THE ARCTIC GEOGRAPHY AND ECOLOGY

Wiesław Ziaja

Jagiellonian University

**A**rctic – the polar (cold) climatic zone – undergoes multiannual cycles of global climate. After the Antiquity, there were three main climatic fluctuations: Medieval Warm Period, Little Ice Age, and the contemporary warming since the beginning of the 20th century. Ice ablation – visible in recession of glaciers, sea ice and permafrost – has been the first environmental reaction to the warming.

Seascape expansion at the cost of terrestrial landscape has been observed as the basic result of the warming intensification (known as so-called Arctic amplification) since the end of the 20th century. At least 44 new straits and islands appeared off the coast of Greenland, Franz Josef Land, Novaya Zemlya, Svalbard and Severnaya Zemlya due to the glaciers' recession from open depressions of bedrock. Hundreds of new fjords originated due to the glaciers' recession from valleys running to the sea. These objects are completely new from both geographical and ecological point of view. They were settled with new biota and became new ecosystems, apart from obtaining new geographical names. Thousands of old fjords were lengthened due to the same process and their environment and biota were changed. A result of this complex transformation is a significant loss of land.

Many seascapes, especially fjords and straits of Greenland and Arctic Archipelago, changed a lot due to seasonal melting of the sea land-fastened ice which covered and blocked them for centuries. Consequently, they are open both to expansion of new biota and navigation with extended human activities.

Landscapes, which survived above the sea level, has also undergone a deep geographical and ecological transformation. New terrestrial landscapes (with new landforms and deposits as well as water bodies, being undergone animal colonization, plant succession and soil formation) have been formed in the areas abandoned by glaciers. Many coastal and inland areas have been completely changed by permafrost erosion, especially if permafrost contained a lot of ice.

All these processes will continue with the climate warming, leading to increase of the landscape and ecosystem differentiation. However, all this contemporary transformation would be reversed, and the landscape and ecosystem structure would be simplified in a case of a deeper climate cooling. Such a transformation could be stopped, leading to a kind of landscape-ecological sustainability, after a long (at least a few dozen years) climate stabilizing (during a shorter period of a climate stabilizing or even small cooling, the current trend will continue due to this geosystem inertia).

These natural regularities had functioned during the aforementioned climatic fluctuations, what is known from both proxy and written or instrumental data. Hence, there is a wide field for development of the polar landscape ecology.

## 4. Learning from past landscapes

### *When history meets future – future challenges for historical landscape research*

#### **Symposium organisers**

*Stig Roar Svenningsen* (Royal Danish Library Special Collections), *Dominik Kaim* (Jagiellonian University), *Gregor Levin* (Aarhus University), *Geoff Groom* (Aarhus University), *Krzysztof Ostafin* (Jagiellonian University), *Catalina Munteanu* (Albert-Ludwigs University of Freiburg)

#### **Summary**

The session will contribute to the discussion about the main challenges of historical landscape research, applied by different disciplines. We invite geographers, ecologists, historians, but also engineers to join us to indicate the most important aspects which might be reflected and developed by closure of technological gaps, improved data availability, increased collaboration and sharing of knowledge.

#### **Description**

In recent years the availability of historical data in digital form has increased and been made more accessible, which makes the analyses of historical landscapes much easier. Obtaining scans of the maps, but also digitised machine-readable versions of map content limits time-consuming procedures and expands the analytical opportunities. This has resulted in more regional rather than just local historical landscape studies being published in the scientific journals. Many people also use advanced modelling techniques to analyse the landscape change over time. However, many research gaps and obstacles are left when obtaining and analysing historical data. During this session, we want to discuss the main challenges, addressing of which can help in future historical landscape research in the overall understanding of cultural landscapes. Are these challenges mainly connected to the difficulties in data acquisition, or are they rather a result of a lack of collaboration and communication among researchers of various disciplines incl. historians, ecologists, geographers, and engineers?

The core question of the symposium is how an interdisciplinary approach when studying historical landscapes can be moved forward and how different disciplines can contribute to the understanding of historical landscape changes? We want to present and discuss examples of techniques of automatic feature extractions, making large historical datasets easily available, but also indicate the remaining barriers of historical landscape research. So, this session will contribute to the discussion about the understanding of the evolution of historical landscapes and the main challenges of historical landscape research. Contributions from different disciplines are welcomed, focussing both on methodological issues as well as on case studies of analysis of historical/cultural landscapes.

## LANDSCAPES IN LANDSCAPE

Iztok Erjavec · Mater Gabriele Dasko · Anton Mlasko

NGO

**W**e are looking but we don't see. In Slovenia a new ethnological phenomena was recognized in the last decade (Čok, 2012; Medvešček, 2015). Pre-Christian spirituality has been preserved until present. Before recognition of this phenomena a few people were aware of it, including researchers. Its presence can be found on old buildings, everyday objects and structures as symbols, number of symbols, geometric structures in landscapes, numbers of objects, geographical names. The phenomena have opened completely new human-scale dimensions for landscape research in Slovenia based on oral tradition with material evidence in landscapes. Material evidence are hidden in material (symbols, architecture, artefacts) and non-material (stories, legends, fairy tales) ethnological heritage.

We will present our research work in the Northeast of Slovenia, in the region called Štajerska and in the landscapes named Slovenske gorice, Haloze, Kozjak and Pohorje. We are finding, especially in forests, unknown phenomena such as ditches, stone walls, stone structures, terraces, groups of stones astronomical aligned, mound and mound cemeteries. A lot of such phenomena have been determined through local ethnological heritage and geographical names associated with pre-Christian spirituality, others were found through conversations with locals, foresters, priests, public employees. Some were found through experiences and publicly available LiDAR scans of Slovenia. This involves registered and unregistered archaeological sites. Structure and purpose of these phenomena can be reconstructed with local ethnological heritage and pre-Christian spirituality which are still present but hidden in landscape. Around such places we are identifying a lot of pre-Christian symbols in traditional rural architecture and a lot of sacral objects. This is also showing the continuity of spirituality and their roots from pre-historic time. First material evidence of human presence from northeast Slovenia are from the Stone Age.

This new research dimension of landscape ecology requires development of new methods involving geographical, geometrical, and astronomical relations of recognized phenomena with their correlations to land use and land cover. There is also a need to reevaluate academic interpretations of land use and landscape structure of Slovenian landscapes due to new ethnological and human-made phenomena found in landscapes which provides additional information about land use and human relation with nature in the past. Our research work is addressing these issues, but research has just started and there is a lot of research work that needs to be done. This is also a new opportunity for landscape protection.

Medvešček P. (2015). *Iz nevidne strani neba*. Studia mythologica Slavic – Supplementa. Ljubliana: Inštitut za arheologijo ZRC SAZU.

Čok B. (2012). *V siju mesečine*. Studia mythologica Slavic – Supplementa. Ljubliana: Inštitut za arheologijo ZRC SAZU.

## KEY TECHNIQUES APPLIED IN DELIVERING MACHINE-READABLE GEODATA FROM A SCANNED SET OF LATE 1800S DANISH HISTORIC MAPS

Geoff Groom<sup>1</sup> · Gregor Levin<sup>1</sup> · Stig Roar Svenningsen<sup>2</sup> · Mads Linnet Perner<sup>3</sup>

<sup>1</sup>Aarhus University · <sup>2</sup>Royal Danish Library Special Collections · <sup>3</sup>University of Copenhagen

It is increasingly often now the case that high quality digital raster scan data are available of historic maps. However, further digital processing is required to deliver machine-readable geodata (MRG), as required for GIS-based applied research. That involves application of digital image processing (DIP) methods, which, after over five decades of development, now comprise a vast toolbox of approaches and techniques, albeit all representatives of a rather concise and constant set of core functionalities. The set of techniques applied in any specific “historic map to machine readable geodata” task is just a selective subset from that toolbox. The applied set reflects upon the map material involved, the objectives of the exercise, the applied software environment, the current trends in DIP, reported relevant work, and the predilections of those undertaking the task (possibly, DIP solutions carry a personal signature of their developer?). During 2019, the authors successfully applied DIP to produce MRG from late 1800s historic topographic maps of two areas of Denmark (ca. 300 km<sup>2</sup>) for six landuse-landcover categories (forest, heath, open water, meadow, dune-sand) (Levin et al., 2020).

This paper aims to distil out of the thousands of individual operations of that DIP solution’s workflow those functional forms that it applied repeatedly, examining their usages, and the reasoning of their application. The aim is to enable software-environment-independent transfer of the lessons learnt from this Danish exercise. It is also to broach inquiry as to whether the applied DIP is an additional factor of the discourse into the methodological and analytical perspectives of producing and using machine-readable data from historical maps in landscape ecological research.

Levin G. et al. (2020). *Automated production of spatial datasets for land categories from historical maps. Method development and results for a pilot study of Danish late-1800s topographical maps*. Scientific Report, 389. Denmark: DCE, Aarhus University.

## GEOTOURISM AND MINING TOURISM – AN IMPORTANT SOURCE OF SUSTAINABLE DEVELOPMENT OF TOURISM (GEMER REGION, SLOVAKIA)

Daniela Hutárová · Ivana Kozelová

Institute of Landscape Ecology, Slovak Academy of Sciences

The mining and processing of minerals constitute an integral part of the history of Slovakia; they are of great importance in the context of European history. The processes of extraction, transportation, and industrial production associated with woodworking, metallurgy, and forge furnaces left an indelible mark on the landscape of the Gemer region creating a traditional mining landscape reflecting its land use history. Together with valuable natural geosites, the region offers the high tourist potential. However, law in Slovakia does not protect most of the geologically significant sites and historic industrial structures and many of them have fallen into disrepair. Applying the concept of geotourism and mining tourism through the declaration of geoparks could increase the tourist interest. The geopark should be a sufficiently large area with precisely defined boundaries. Geologically important localities are situated on the territory of the geopark, divided into geological, natural, cultural-historical and recreational localities, while one locality can be a combination of several categories. The sites are systematically maintained and interconnected. The geopark should also offer technical or folk monuments, as well as elements of the intangible cultural heritage (oral traditions, language, performing arts, customs and crafts).

Based on a literature review and field studies we identified the most valuable sites with traditional agricultural landscape, cultural heritage and localities of religious and mining heritage in the Gemer region. As part of the concept of integrated rural tourism, we have elaborated the map of tourism attractions in the Gemer region with emphasis on geosites and areas with mining history. This map meets the condition for geopark declaration in the area of Gemer.

## CAN WE COMPARE 19TH CENTURY TOPOGRAPHICAL AND MODERN GEODATA WHEN ASSESSING LAND DYNAMICS? REFLECTIONS ON A DANISH CASE STUDY

Gregor Levin<sup>1</sup> · Geoffrey Brian Groom<sup>1</sup> · Stig Roar Svenningsen<sup>2</sup> · Mads Linnet Perner<sup>3</sup>

<sup>1</sup>Aarhus University · <sup>2</sup>Royal Danish Library Special Collections · <sup>3</sup>Danish National Archives

**H**istorical maps are valuable sources of past land use and land cover (LULC). Numerous studies compare historical with contemporary maps to assess LULC-dynamics. Yet, maps are not objective representations and categorisation of space. Rather, spatial categories in maps reflect the need for spatial information of the organisation or individual requesting production of the map. This also implies that definitions of categories can change over time according to changing purposes of mapmaking. Therefore, analyses of LULC dynamics must account for categorisation of space in historical maps by investigating the mapping practices of the mapmaker.

We apply results from a Danish case study (Levin et al., 2020) to reflect on how changing purposes of mapmaking affect assessed LULC-dynamics. For two study areas covering around 300 km<sup>2</sup> in northern and central Jutland, Denmark, we applied automated production techniques to extract land categories from Danish 1:20,000 topographical maps from the late 19th century. A comparison with a contemporary map shows overall dynamics, characterised by a decrease in open, non-forested habitat categories, such as heath, dune sand and wetlands at the gain of afforestation and an increasing area of agricultural land. However, a more detailed examination reveals two specific types of dynamics, which cannot be explained by this process of intensification but are, we submit, biased by changing purposes for mapmaking. First: less than 8% of the area, which in the historical maps was mapped as dune sand was in the contemporary map mapped as sand, while around 56% was mapped as grass or herb vegetation. Part of this change can be the consequence of efforts to prevent sand drift or of increased airborne nutrient loads leading to increased vegetation cover. However, this change is also the consequence of a shift from mapping for mainly military interests, where sand was mapped as a category hindering mobility, to modern mapping, focusing on nature conservation and hence vegetation types. Second: around 17% of the area of non-forested semi-natural habitat types contained in the contemporary map was not mapped in the historical maps. The majority of these areas are characterised by dry grassland habitats, which today are critical to nature conservation, but historically did not influence military mobility or visibility and consequently were not included as a category in the historical maps.

We conclude that in order to prevent misinterpretations of LULC dynamics, biases caused by changing mapping purposed between historical and contemporary maps must be addressed, not least when applying 19th century topographical maps, which predominantly where developed for military purposes.

Levin G. et al. (2020). *Automated production of spatial datasets for land categories from historical maps. Method development and results for a pilot study of Danish late-1800s topographical maps*. Scientific Report, 389. Denmark: DCE, Aarhus University.



## POTENTIAL OF AIRBORNE LIDAR DATA IN DETECTING CULTURAL LANDSCAPE FEATURES IN SLOVAKIA

Juraj Lieskovský<sup>1</sup> · Tibor Lieskovský<sup>2</sup> · Katarína Hladíková<sup>3</sup> · Dagmar Štefunková<sup>1</sup> · Natália Hurajtová<sup>4</sup>

<sup>1</sup>Institute of Landscape Ecology, Slovak Academy of Sciences · <sup>2</sup>Slovak University of Technology in Bratislava · <sup>3</sup>Comenius University · <sup>4</sup>Constantine the Philosopher University in Nitra

The potential of Light Detection and Ranging (LiDAR) scanning to identify the topographic signatures of past anthropogenic features was initially recognized in archaeology at the beginning of the 21st century. The fundamental benefits of LiDAR are the speed of data acquisition on a landscape scale, the quality of its surface data, and its ability to identify macro- and micro-topographical features undetected by terrestrial surveys. Although LiDAR initially provided data only in the 1-5 points/m<sup>2</sup> density range, technological advances now enable it to scan large areas at unprecedented point densities. The area of Slovakia is scanned from 2017 at a resolution of 20-30 points/m<sup>2</sup> and is planned to be completed by 2023.

This study aimed to examine the potential of incoming nationwide LiDAR data in detecting the cultural landscape features in Slovakia. We derived a detailed digital elevation model from LiDAR points and adopted upgraded visualization techniques based on a combination of local relief models, sky view factor, slope steepness, and color blending. We visually identified examples of different anthropogenic landforms groups and confirmed our findings with existing literature. While LiDAR can provide precise measurements of the height, length, and volume of anthropogenic features, the LiDAR images do not provide reliable information on their function, age, and origin. Additional data are therefore essential for accurate interpretation, and interdisciplinary cooperation with geomorphologists, hydrologists, geologists, and other disciplines is often needed.

Aim of the presentation is to: (1) present the examples of different anthropogenic features as they are visualized on LiDAR images, (2) present the potential of LiDAR images for historical landscape research in Slovakia, (3) demonstrate the need of interdisciplinary approach for the LiDAR images interpretation.

## COMBINING REMOTE SENSING DATA WITH LOCAL KNOWLEDGE

Franziska Mohr<sup>1,2</sup> · Robert Pazur<sup>1,3</sup> · Matthias Bürgi<sup>1,2</sup>

<sup>1</sup>Swiss Federal Institute for Forest, Snow and Landscape Research · <sup>2</sup>University of Bern · <sup>3</sup>Institute of Geography, Slovak Academy of Sciences

**H**istorical landscape research has great opportunities to benefit from recent advances in remote sensing. Artificial intelligence, for example, can contribute by enhancing the accuracy of landscape change assessments through facilitating the segmentation and classification of aerial images. This presents interesting opportunities particularly for mapping historical landscape change patterns based on a long time-span of available aerial images. Aside from technical challenges, it also remains difficult to best explain observed changes and identify its impacts on the local communities. We present here an approach that attempts to address these two challenges.

Our work aims to understand agricultural intensification and its driving forces across several European study regions during the 20th century. To study this, we adopted an interdisciplinary approach using aerial photographs, oral history interviews, and agricultural statistics as sources of evidence. In the presentation we illustrate a semi-automated approach that allowed us to identify landscape dynamics on aerial photos including changes in land cover classes and landscape elements (e.g. hedgerows, tree lines). In a second step, we lay out the plausible links between the remote sensing information and the narratives gained from oral history interviews. We hypothesized that insights from oral history interviews provide important information about the nature of farming at the time, as well as information about the background of the farm-level decisions. We identified the central driving forces for land use intensification for the individual study regions. Finally, we discuss first findings and the challenges regarding the availability of (geo)data over long time periods as well as advantages, pitfalls, and future potential of combining aerial images and oral interviews as two distinct but complementary sources of information. Combining these two data sources provides a unique opportunity to move historical landscape research ahead.

*Our work contributes to the ongoing project “Operationalizing Sustainable Agricultural Intensification Pathways in Europe” (SIPATH, <https://www.wsl.ch/en/projects/what-is-sustainable-intensification.html>).*

## HISTORICAL GEOPORTAL OF GALICIA AND AUSTRIAN SILESIA 1857-1910

Krzysztof Ostafin · Dominik Kaim

Jagiellonian University

Currently large amount of historical digital data become more and more accessible every year. However, without proper preprocessing they are not easily to be used by scholars and practitioners. For instance, georectification and further spatial data acquisition based on scanned documents can be a barrier to scientific problem solving in demography, regional development, or human-environment relations. Therefore, it is necessary not only to digitalize the collections gathered in archives or libraries but also to process them into digital spatial data, which can be used in GIS and shared with the scientific and practitioner communities. The historical geoportal of Galicia and Austrian Silesia 1857-1910 brings together processed spatial data and historical statistical data, which are combined with reconstructed administrative divisions on several levels.

In this paper, we present this geoportal, which allows viewing and downloading of digital spatial data in vector form, such as administrative divisions in very detailed scale, road network, railroad network, location of buildings. For statistical data, the geoportal offers an access to data from Austrian censuses, organized approximately every ten years. These data are available in Excel format and can be combined with the provided layers of historical administrative divisions.

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## WATER IN THE LANDSCAPE AS AN INDICATOR OF CHANGES IN THE ELBE RIVER LOWLANDS

Pavel Richter

T. G. Masaryk Water Research Institute

The focus of this paper is work to map the development of lowland landscape over last 180 years, related to pressures to use lowland areas for economic purposes including transformation of the wetland habitats, watercourse and water body parts of the landscape into arable land. The Elbe River basin was chosen as the study area because it is currently affected by a lack of water and there is an occurrence of seasonal drying up of small watercourses. This issue will probably be of greater significance in the future particularly in the context of the expected continued extreme climatic phenomena. Therefore, emphasis is placed on the analysis of changes in wetland habitats, watercourses and water bodies based on a comparison of archive maps and current data. The purpose of the study is to use the results as a proposed solution to current and future water management problems. These results can be used for example, for the restoration or revitalization of these landscape (water retention) elements in landscape planning. Moreover, there is an emphasis to highlight the importance of water retention elements in landscape in context of historical and sociocultural development.

## ANTHROPOGENIC LANDFORMS AS INDICATORS OF PAST LAND USE IN MARGINAL MOUNTAIN AREAS

Michał Sobala

University of Silesia in Katowice

In recent years, the availability of historical maps in digital form has increased, making it much easier to analyze historical landscapes. However, it must be emphasized that one of the main rules of historical analysis is that it is necessary to verify the content of archival maps based on other data sources. This is important when assessing the historical maximal human impact on landscape because the use of cartographic materials makes it possible to reconstruct the state of the landscape for a specific time period, but changes in the landscape that occurred between these time periods are often interpreted by the researcher, and this is associated with a high degree of uncertainty. The poster aims to present the possibility of using anthropogenic landforms to assess the maximal past human impact on landscape in marginal mountain areas.

The detailed study was carried out in the Silesian Beskids and Żywiec-Kysuce Beskids (the Western Carpathians). The following methods were used: analysis of historical land use based on Austrian cadastral maps from 1848 (the period when the deforestation level in the study area was the highest) and detection of landforms typical of arable fields based on LiDAR data and field studies. Afterwards, the ranges of historical arable fields and landforms were compared.

About 1700 anthropogenic landforms related to former land cultivation were identified in a total area of 260 ha. These forms were divided into point (stone mounds) and linear forms (agricultural terraces, lynchets and stone walls), and they were analyzed separately. The relationship between the location of past arable fields and landforms is varied and depends on the test area. In two test areas, the percentage of arable fields was higher among the plots with stone mounds than the percentage among the plots without them. In the third test area, the relationship was reversed. However, in this case, stone walls were detected. Therefore, it can be concluded that, in this area, the stones from the arable fields were mainly deposited in the form of walls, not mounds. Also, lynchets, terraces and stone walls sometimes occur in plots that were not arable fields in 1848.

The range of occurrence of anthropogenic landforms is greater than the range of arable fields visible on archival maps from 1848. Hence, it indicates a greater degree of anthropogenic pressure in the past than results from the content of archival maps. This research gives new insights into the land use structure in the Western Carpathians in the 19th century compared to data obtained from archival maps. It is impossible to determine the historical land use structure precisely. However, detection of landforms can be used to assess land use when historical maps have not preserved or when available maps do not present land use in detail.

## SEGMENTING HISTORICAL MAPS TO BUILD TIME-SERIES OF SETTLEMENT AND HABITAT NETWORKS ACROSS SWITZERLAND

Maarten J. van Strien<sup>1</sup> · Magnus Heitzler<sup>1</sup> · Matthias Bürgi<sup>2</sup> · Lorenz Hurni<sup>1</sup> · Adrienne Grêt-Regamey<sup>1</sup>

<sup>1</sup>ETH Zürich · <sup>2</sup>Swiss Federal Institute for Forest, Snow and Landscape Research

**A**ssessing historical landscape development can increase our understanding of the functioning of social-ecological systems. Whereas settlements and their connecting transport infrastructure (i.e. settlement networks) have grown considerably in the past century, many natural habitats and their connections (i.e. habitat networks) have shrunk over time. Although settlement and habitat networks interact in several ways, the extent and mechanisms of these interactions are not well understood. We will address this research gap in the new EMPHASES project by reconstructing time series of settlement and habitat networks to assess the evolution of these networks and their interactions. These networks will be derived from Switzerland-wide, high quality topographic maps that have been regularly produced since 1870. Although the maps are available in digital and georeferenced format, the map features (e.g. buildings, roads, forests) have not yet been segmented or vectorised, which is necessary to perform spatial and temporal analyses with these maps. To perform the segmentation, we have experimented with several machine learning approaches, which we will present here. In the first approach, we used a convolutional neural network to assign individual raster cells in historical maps to one of six classes: i.e. buildings, roads, forests, wetlands, text labels and other. With this approach, we were able to segment historical maps in several case study areas (accuracy > 94%). In the second approach, we used a fully convolutional network to segment individual buildings (accuracy > 99%), which were subsequently vectorised and geometrically corrected with GIS methods. The latter approach was successfully applied at a Switzerland-wide scale. Furthermore, we will present several challenges that we encountered during the segmentation of these historical maps as well as several examples of how we plan to use these historical maps to create time series of settlement and habitat networks. The segmented and vectorised historical maps will unlock a wealth of information about the landscape development of Switzerland over the past 150 years and about the interactions between coupled settlement and habitat networks.

## LAND AREA CATEGORIES IN LARGE-SCALE HISTORICAL TOPOGRAPHIC MAPS IN RELATION TO ANALYSING LAND USE AND LAND COVER CHANGES

Stig Roar Svenningsen<sup>1</sup> · Mads Linnet Perner<sup>2</sup> · Gregor Levin<sup>3</sup> · Geoff Groom<sup>3</sup>

<sup>1</sup>Royal Danish Library Special Collections · <sup>2</sup>Danish National Archives · <sup>3</sup>Aarhus University

Spatial information about the landscape of the past is a key data source for a range of analyses within landscape ecology, such as identifying persistent habitats or monitoring of landscapes and land use and land cover change (LULCC). Yet, such analysis of historical LULCC of pre-1950s landscapes primarily relies on cartographic documents as the source of spatially explicit information. Methodologically, most historical LULCC studies utilizing historical cartographic documents report on the geometrical precision and correctness of georeferencing and vectorization. However, often less attention is devoted to careful interpretation of land area categories. Thus, information in historical maps is taken for granted or seen as self-explanatory.

This paper presents an analysis of land area categories in Danish historical large-scale topographic maps from the second half of the 19th century in relation to a recent research project focused on the development of automated methods for vectorization of historical maps (Levin et al., 2020). Results reveal that the classification of land area categories is complex and that categories in the legend cannot necessarily stand direct comparison to modern LULC categories. Despite a similar appearance (i.e. sharing the same name as categories in current official geo-data), the categorization of land in the maps discussed here originally rested on a military oriented assessment of landscape trafficability. This result implies that thorough analysis of categories in historical maps is needed if data are to be used for LULCC studies. Thorough historical analysis of the development of the mapping and representational practices of land area categories in historical maps can reveal both a more consistent understanding of the relationship between map categories and the historical LULC, but it can also assist the development of automated methods for extracting vector data.

Levin, G., Groom, G. B., Svenningsen, S. R., & Perner, M. L. (2020). Automated production of spatial datasets for land categories from historical maps—Method development and results for a pilot study of Danish late-1800s topographical maps. (No. 389; Scientific Report from DCE – Danish Centre for Environment and Energy). Aarhus University, DCE – Danish Centre for Environment and Energy. <http://dce2.au.dk/pub/SR389.pdf>

## *The past as a source of knowledge, experience and a cause of change*

### **Symposium organisers**

*Rafał Zapłata* (Cardinal Stefan Wyszyński University), *Mariusz Lamentowicz* (Adam Mickiewicz University), *Krzysztof Stereńczak* (Forest Research Institute), *Michał Słowiński* (Institute of Geography and Spatial Organization, Polish Academy of Sciences)

### **Summary**

Symposium „The past as a source of knowledge, experience and a cause of change” within the IALE European Landscape Ecology Congress is part of the Holistic, landscape approach to the complex cultural and environmental systems, taking into account the processes and remnants of the past, in order „to better understand the diverse phenomena and processes around us and to predict and properly manage them”. We will pay special attention to formerly and now forested areas – as areas extremely valuable for today's and future environment.

### **Description**

As part of „the interdisciplinary platform linking past, present and future”, we propose to continue the discussion that will allow to build knowledge and collect data on past experiences and activities. "Making the future, learning from the past" is understood literally by analyzing, inter alia, past phenomena, as various examples of natural and human influence on the environment, and analyzing the remains of past interventions, often with long-lasting legacy effects. The symposium is inspired by the idea that knowledge about past human activities can prevent similar negative environmental impacts today and in the future. The practical dimension of knowledge and data about the past is one of the key elements of the symposium. Our understanding of the past climate, human and environmental interactions in the European landscape has made significant progress over the past decade, thanks to advances in multiproxy studies. We propose to pay special attention to the forested areas that are valuable for today and future environment.

The only palaeoecological long-term view can provide detailed understanding complexity of ecosystem processes and the landscape legacy that occur in the past. When coupled with ecology, history, archaeology and statistical modelling, such approaches potentially provide stakeholders with visualizations of past and future scenarios. We propose to look to the future, taking into account the experiences and processes of the past – from the Anthropocene and Holocene. Archaeological and historical research – in conjunction with the natural sciences – in the formula of interdisciplinary projects, constitute initiatives that allow the analysis of the above-mentioned past processes. In the context of developing methods and generated data, including remote sensing, it is current research that provides new information about the past and the current situation in a specific area. The goal of the session is to critically evaluate and improve models of anthropogenic pressure on landscape informed by the palaeoecological view and current understanding of past societies' activity, land-use, and history.

The main topics and the aims of the symposium:

- analyzing interdisciplinary projects aimed at integrated activities related to the protection of cultural and natural heritage,
- discussion on the role, meaning and possibilities of comprehensive approaches – including the sciences of the past in landscape ecology,
- discussion on the resilience and resistance of ecosystems to disturbances and their primaeval nature,
- discussing the acquisition of contemporary, archival data and validation proxies (especially remote sensing),
- analysis of the inclusion of research results and data to shape sustainable landscapes and societies of the future,
- discussion on education (including non-formal education) and the promotion and popularization of natural and cultural heritage.



## LONG-TERM, COUNTRY LEVEL ASSESSMENT OF SEMI-NATURAL AND SECONDARY FOREST COVER CHANGE IN HUNGARY

Marianna Biró<sup>1</sup> · Kinga Öllerer<sup>1,2</sup> · László Demeter<sup>1</sup> · János Bölöni<sup>1</sup> · Zsolt Molnár<sup>1</sup>

<sup>1</sup>Centre for Ecological Research · <sup>2</sup>Institute of Biology, Romanian Academy

**S**emi-natural forest areas are highly valuable for today and future nature conservation and sustainable forest management. However, the generally declining trend of semi-natural forests may be obscured by the increase of total forest area in Europe, which results mostly from new plantations and spontaneous forest expansion. This increase of forest cover in Europe is emphasized mainly in short-term time series, while long-term analyses – going back until the 18th century – generally detect that the extent of forest cover reached a minimum during the studied time period.

We assessed changes in semi-natural and secondary forest cover since the 18th century in Hungary, focusing on the continuity of semi-natural forests. Historical and recent datasets were complemented with field data to estimate forest cover change for seven time periods between the 1780s and the 2010s in 5000 randomly selected sample localities. The application of a point-based GIS analysis and the method of ‘iterative information transfer between historical sources’ made it possible to conduct a habitat-level analysis of long-term forest cover change on a national scale in Hungary (93,030 km<sup>2</sup>).

We found that semi-natural forests and secondary forests, which have substantially different histories and ecological values, showed opposing trends in their cover change. In the 18th century, 25% of Hungary was covered with forests (all semi-natural). For today, the total forest area has reached once more the forest area of the late 18th century, but today approx. 64% of the Hungarian forest cover is secondary forest. Between the two dates, forest area showed a U-shaped curve with a forest minimum of 13% in the first half of the 20th century. The most important direct driver of semi-natural forest loss was the conversion to arable land, detected in nearly half of the lost localities. Habitat-level analysis revealed the specificities of the drivers causing semi-natural forest loss. At present, 36% of forests are semi-natural and 33% are semi-natural continuous forest in Hungary. This means that 88% of the actual semi-natural forests have remained continuous forest since the 18th century.

Our results showed that when reconstructing landscape-scale historical forest cover change and continuity, the loss of semi-natural forests remains hidden if the calculations are limited to ‘total forest cover change’. We argue that it would be immensely important to distinguish between semi-natural and secondary forests and also between different kinds of forest continuity in assessments used for landscape-level conservation strategies, landscape planning and sustainable forest management. While this may be methodologically challenging, the greater availability of cartographic databases and digitized historical sources, together with more detailed recent data sources that cover larger areas, means that it is possible to make such a distinction in the majority of European countries.

## HUMAN AND CLIMATE DRIVERS OF CHANGES IN THE USE OF PEATLANDS THROUGHOUT THE 20TH CENTURY IN NORTH WESTERN POLAND (THE TUCHOLA PINEWOODS)

Sebastian Czapiewski<sup>1</sup> · Danuta Szumińska<sup>1</sup> · Piotr Sewerniak<sup>2</sup> · Tomasz Giętkowski<sup>3</sup>

<sup>1</sup>Kazimierz Wielki University · <sup>2</sup>Nicolaus Copernicus University · <sup>3</sup>Geofabryka, Toruń

Peatlands are considered exceptionally valuable on account of their communities of unique fauna and flora, which include many protected species. The main aim of this study is to identify the trends in the use of peatlands from the end of the 19th century to late 20th century. The research was conducted in the Tuchola Pinewoods (TP) (A=3550 km<sup>2</sup>, afforestation rate=70.3%) located in north western Poland (young glacial zone, moderate climate).

The analyses were performed based on 1:100,000 Prussian topographic maps from the years 1876-1879 and 1:50,000 Polish topographic maps from the years 1966-1986. The GIS database was developed with the use of GIS software and included peatland boundaries as well as several geographical features (geology, precipitation, land use of surrounding area, water network, drainage, groundwater intake stations). Additionally, the authors performed a redundancy analysis (RDA) to further supplement the results. Each peatland was classified into one of seven classes of changes (1 – no distinctive change; 2 – partial or 3 – complete change into woodland; 4 – partial or 5 – complete change into arable land; 6 – partial or 7 – complete change into water).

A total of 744 peatlands were identified in the TP, with a total area of 10,762 ha, which constitutes 3.03% of the studied region. Peatlands occur in clusters whose location is related to geomorphological (the presence of depressions and a favourable geological structure) and hydrological conditions; numerous clusters of peatlands occur in watershed zones. Small peatlands (<15 ha) are the most numerous, however, the largest share in the area of all those identified is represented by very large peatlands (>100 ha), which together account for 32% of the total area of all peatlands. As found in this study, peatlands found in the region have been largely transformed in terms of their use and hydrological conditions due to drainage – mainly for agricultural purposes. The most frequent changes included: change into arable land (53.5% of the total number, 73.4% of the total area), and change into woodland (38.8%, and 23.5% respectively). RDA analysis revealed that the most important environmental factors influencing the directions of changes in the use of peatlands are: (1) the land-use type of the surrounding area, (2) implementation of anthropogenic drainage systems, and (3) location in a lake catchment or catchments drained by rivers or streams. However, no relationship was found between the type of peatland transformations and the spatial variability of precipitation sums. Considering that 85.7% of total peatland area had been drained by 1986, the risk of greenhouse gases being released from peatlands should be assessed as high. Peatlands, due to their capacity for storage of water and organic matter, may be regarded as a part of sustainable water management and greenhouse emissions control both on a regional and global scale.

## THE USE OF THE CHOSEN SOIL CHARACTERISTICS IN GETTING TO KNOW PALAEOENVIRONMENT AND PALEOLANDSCAPE

Marek Degórski

Institute of Geography and Spatial Organization, Polish Academy of Sciences

Soil, as an integral component of geo-ecosystems, is formed and shaped by all elements of the natural system, and itself influences their properties. At the same time, soil 'stores' traces of successive phases of landscape development, including climate change and human activity. Therefore, the pedosphere can be treated as a kind of 'mirror' of multidimensional geographical space, in which the history of phenomena and processes that shape it is 'reflected' and recorded, and as a source of information enabling the tracking of changes taking place over time. The use of soil research in the interpretation of the functioning of palaeoenvironment and landscape evolution is more and more common, especially in the reconstruction of the properties of the Pleistocene and Holocene environment. In the analysis of palaeoenvironmental development, soils are used as pedostratigraphic markers of landscape evolution, and their selected physical and chemical properties as indicators of specific lithomorphological processes in which a given soil and landscape developed. Increasingly, paleo-soil analyses also support archaeological research, both in the identification and delimitation of areas of human activity in the past, as well as in determining the development time of a given material culture in the sequence of palaeoenvironmental and historical phenomena.

The aim of the paper is to present the potential possibilities of using soil research in the interpretation of the sequence of palaeoenvironment development, which may be helpful, inter alia, in determining the environmental and anthropogenic conditions for the development of a paleo-landscape. The results of selected three methods of soil research were discussed in detail, i.e. mineralogical analyses of the soil substrate, ultramorphoscopy and the relationship between different forms of iron in the soil, which the author used during many years of research carried out over the twenty years in Central and North Europe and some parts of Asia. The research was conducted in soils belonging to Spodosols and Ultisols according to USDA Soil Taxonomy. All of the presented research results are also confirmed by studies conducted by other authors, which confirms their diagnostic value. Among the features important for determining the relative age of the soils and their location in relation to each other, the content of non-resistant minerals in the substrate, the content of free, amorphous and crystalline iron as well as ultramorphic characteristics of sand grains expressed in terms of grain shape, as well as and textural features were indicated.

## LANDSCAPE MONITORING OF LARGE PROTECTED AREAS IN CZECHIA

Tomáš Janík

Silva Tarouca Research Institute for Landscape and Ornamental Gardening / Charles University

Changes of the landscape is key for understanding development of the studied ecosystem. Here, we present the results of long-term project, which is called “Landscape monitoring” and is focused on land cover and anthropogenic structures development in Czech large protected areas. This project ends this year, thus we have already analysed almost all protected areas – protected landscape areas, national parks and selected Natura 2000 sites. Protected landscape areas and national parks created 15.9% of Czechia (circa 12,540 km<sup>2</sup>) and furthermore we analysed circa 2555 km<sup>2</sup> of Natura 2000 sites and areas to potential protection.

We prepared geodatabases of land cover, anthropogenic structures (built-up and recreational areas, roads) from topographic maps and aerial imageries for four milestones in development of nature protection, society and landscape as well: (1) 1950s as the beginning of the socialist era and also the founding of the first large protected areas, (2) around the year 1990 as a transformation from socialism and communism to a free market economy, capitalism, and democracy, as well as new environmental legislation, (3) around 2004 as EU accession, together with requirements of EU legislation, and (4) 2016-2019 as the present state. Subsequently, we analysed development for each study area to stress main trends and for help to manage areas based on objective data and analyses. In this phase of the project, we can compare areas with each other and summarize our results.

Almost in all areas we can see enlarging of forested and also built-up areas, on the other hand, arable land has been replaced by permanent grassland on the vast areas. Furthermore, there are clusters of areas with similar tendencies and path dependency – for example mountainous areas are characterized by enlarging forest, low level of built-up areas in first two horizons and an increase of built-up and recreational areas especially after 1990; lowlands areas are situated often close to large cities with stable level of more intensive agricultural use during the study period and continuous and significant increase of built-up areas. Somewhere between abovementioned types we can find rural protected areas especially with replacing of arable land by permanent grassland and growth of built-up areas. Military areas are special type of protected areas almost without anthropogenic structures. Furthermore, structure of landscape was analysed and it has been becoming more homogenous during the time – mean patch size increased in the majority of the areas, on the other hand, level of landscape fragmentation by hard anthropogenic structures as roads and built-up areas increased. Our project gives a general overview of landscape development in Czech large protected areas and is a tool for appropriate management.

*Website of the project including the geoportal (in Czech): <https://www.monitoringkrajiny.cz/>.*

## SEMI-NATURAL GRASSLANDS IN THE LANDSCAPE OF KARKONOSZE NATIONAL PARK (POLAND) OVER 130 YEARS, DIFFERENCES BETWEEN MODERN AND ANCIENT GRASSLANDS

Hubert Kasprzak<sup>1</sup> · Małgorzata Raduła<sup>2</sup> · Tomasz Szymura<sup>2</sup> · Zofia Nocoń<sup>2</sup> · Filip Borkowski<sup>2</sup>

<sup>1</sup>Hirsfeld Institute of Immunology and Experimental Therapy, Polish Academy of Sciences · <sup>2</sup>University of Wrocław

Semi-natural grasslands provide a wide range of ecosystem services, however, their area and quality are still diminishing in Europe. The reason for this is the conversion of grasslands to other forms of use, abandoning or degradation in result of too intensive use. Numerous ecosystem services delivered by the grasslands are related to their biodiversity, which, in turn, is related to age of particular grasslands. It is known that grassland with long-lasting continuity in time is usually rich in more species and hosts plant species typical to grassland habitats. Therefore, by analogy to ancient forest, 'ancient' grasslands are distinguished and are considered as more valuable for nature conservation (Raatikainen et al., 2018).

Although grassy communities are of high value for nature conservation in the European Union, the possibilities of their protection are relatively small (Szymura, Szymura, 2019). Knowledge about the historical patterns of grasslands area and distribution increases our ability to predict future changes in a landscape structure. Therefore, studies on historical ecology give a reference point for nature conservation planning providing insights to the appropriate i.e. sustainable landscape management.

In this study, we reconstructed semi-natural grasslands spatial distributions in Karkonosze National Park, over the last 133 years, with four time thresholds: 1888, 1930, 1970 and 2020, using historical maps. Analysed was landscape structure in particular historical periods regarding grasslands area and spatial structure including connectivity. The patches of ancient grasslands were distinguished. In order to find differences in habitat characteristics between four groups of semi-natural grasslands (ancient, old, medium, and recent semi-natural grasslands), we established a set of 300 random sampling plots for each group. Then, to each point, we assigned measures of 13 environmental factors representing soil, topography, and climate characteristics.

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Raatikainen K.J. et al. (2018). *Contemporary spatial and environmental factors determine vascular plant species richness on highly fragmented meadows in Central Finland*. Landsc. Ecol., 33(12): 2169-2187.

## IDENTIFICATION OF DRIVING FORCES BEHIND LANDSCAPE CHANGES: CASE STUDY OF SOBÓTKA COMMUNE IN POLAND

Piotr Krajewski · Joanna Karpiel · Iga Kołodyńska

Wrocław University of Environmental and Life Sciences

The landscape is the combination of many factors and interactions, for which specific driving forces of change within the landscape are responsible. The method of studying the driving forces of landscape change is based on a study of the history of the landscape by using different kind of research methods.

The main aim of the study was to identify main driving forces of landscape change in Sobótka commune by combination of quantitative data obtained from analyses of cartographic resources and conclusions derived from qualitative data obtained through social research, including face-to-face interviews. The study area was selected due to the relatively high diversity of land cover and landscape type – it is an agricultural commune, mostly lowland, with almost all villages having rural character, and a large area of forest cover in the south, where the magnificent Ślęza Massif is located, at the foot of which the town of Sobótka is situated.

The study period was 1905-2020. Map analyses consisted of analysis of land cover changes on cartographic materials from 1938, 1983, and 2020. An equal part of the work was to conduct face-to-face interviews with witnesses of landscape changes. Seven interviewees of different ages were asked what changes in different types of landscape took place in Sobótka municipality over the time period specified for this study. The interviews revealed that cultural forces were the most significant drivers of landscape change. Until the beginning of the Second World War, the local culture was responsible for the shape of the landscape. A number of other driving forces for minor changes resulted from the strong rootedness of the residents in the area. After the war, the area was shaped mainly by political forces, which strongly influenced cultural changes, and technological forces, associated with the development of technical infrastructure. The last analysed period was dominated by political forces associated with political transformations and Poland's accession to the European Union, as well as economic forces associated with changes in the employment structure of the rural population.

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## LANDSCAPES OF THE MIDDLE DNIESTER RIVER VALLEY DURING THE GRAVETTIAN AND EPIGRAVETTIAN OCCUPATION – FINDINGS FROM THE DOROSHIVTSI III CAMP (UKRAINE)

Maria Łanczont<sup>1</sup> · Przemysław Mroczek<sup>1</sup> · Dariusz Bobak<sup>2</sup> · Larissa Kulakovska<sup>3</sup> · Marta Połtowicz-Bobak<sup>4</sup> · Laëtitia Demay<sup>5</sup> · Olesia Kononenko<sup>6</sup> · Anna Lemanik<sup>7</sup> · Adam Nadachowski<sup>7</sup> · Vitaly Usik<sup>3</sup>

<sup>1</sup>Maria Curie-Skłodowska University · <sup>2</sup>Foundation for Rzeszów Archaeological Centre · <sup>3</sup>Institute of Archaeology, National Academy of Sciences of Ukraine · <sup>4</sup>University of Rzeszów · <sup>5</sup>National Museum of Natural History · <sup>6</sup>Institute of Archaeology, National Academy of Sciences of Ukraine · <sup>7</sup>Institute of Systematics and Evolution of Animals, Polish Academy of Sciences

Settlement processes in Europe during the LGM period are a hotly debated issue. In Eastern Europe we observe several major settlement centres including the camp at Doroshivtsy III located in the Middle Dniester valley. It is one of the very important sites to understand the settlement processes at LGM and the importance of refugia, as well as studies of Palaeolithic landscape changes.

The 2019 excavation season at the Doroshivtsy III site is a continuation of the work carried out in 2007-2010, directed by Larissa Kulakovska, the results of which showed significant differences between the area studied earlier and in above-mentioned year. These differences concern both geological record, the data determining the absolute chronology and also palaeontological and archaeological artefacts. Therefore it was not possible to closely correlate the geological layers and cultural levels delineated during the earlier and current investigations. These may be due to both post-settlement geological processes and, in the case of archaeological and palaeontological data, functional variation of the site.

The section at site is a sequence of calcareous, layered deposits, with admixtures of fine debris of local rocks, of aeolian and solifluction/colluvial origin. Among the faunal remains identified were those of reindeer, horse, mammoth, wolf and vulpine, and also a crow was. The representation of mammoth was higher than expected with individuals dead in situ. The small archaeological inventories, containing, for the most layers with artefacts, mainly blades and flakes, are analogous to those known from cultural layers identified in 2007-2010, but far scarcer.

OSL dates from this sequence provide grounds to assume that a major part of this profile may be correlated with MIS 2, more specifically with LGM-b. Most of the calibrated radiocarbon dates obtained from cultural layers during the 2019 season specify the time of settlement to the Heinrich Stadial (HS-2) corresponding to the cold GS-3 stage within LGM-b. The results from chronological modelling point to a relatively short period of occupancy of the site but an open question is the length of individual settlement horizons. The LGM was the period when the Palaeolithic people, who until then had settled in the uplands surrounding the Dniester valley, moved from their very cold, windy and open landscapes into the narrow and deep canyon of this river. Most of the archaeological finds were associated with soil cover composed of gleysols or cambisols, which was formed under steppe or tundra vegetation, with the presence of trees. The environmental conditions of the site area were favourable for the primary settlement – a place was sheltered from winds, with access to flint raw materials, water, and game.

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## SIGNALS FROM THE PAST: PRELIMINARY EVIDENCE ON THE ROLE OF ANCIENT AND HISTORICAL LANDSCAPE CHANGES ON POPULATION GENETIC STRUCTURE OF MACEDONIAN OAK (*QUERCUS TROJANA* WEBB) IN PUGLIA (ITALY)

Paola Mairota<sup>1</sup> · Alessio Pollice<sup>1</sup> · Claudia Mattioni<sup>2</sup> · Luca Mangiacapra<sup>1</sup> · Mattia Labella<sup>1</sup> · Nicola Difonzo<sup>1</sup> · Marcello Tropeano<sup>1</sup> · Antonella Marsico<sup>1</sup>

<sup>1</sup>University of Bari Aldo Moro · <sup>2</sup>National Research Council - Research Institute on Terrestrial Ecosystems

The study aimed at investigating the possible environmental factors that have led to the presence of three genetic pools, defined in previous population genetics analysis (Carabeo et al., 2017), in Macedonian oak germplasm (*Quercus trojana* Webb) of a disjunct part of the species distribution range (Puglia, Italy). A paleogeographic analysis and a landscape genetics approach, based on specific methods for multivariate spatial data analysis (Dray et al., 2006; Borcard et al., 2011; Legendre, Legendre, 2012), were applied. These allowed to verify the isolation by distance hypothesis and to generate other hypotheses likely to underlie different evolutionary processes (gene selection and gene flow). The results confirm the population genetic structure previously observed and suggest its very ancient origin, probably due to geodynamic and phytogeographic events as from at least late Miocene times (Tropeano et al., 2002; Bache et al., 2012), only subsequently influenced by land use changes that in historical times have led to the fragmentation of forests and of Macedonian oak habitat (Francini Corti, 1966). These are preliminary, yet important, findings relevant to strategies aimed at the conservation and the adaptive forest/landscape management, of this endemic species, in the context of climate change.

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## SOIL CHANGES WITHIN THE MODERN FOREST-STEPPE ZONE OF UKRAINE AS A REFLECTION OF THE EVOLUTION OF LANDSCAPES IN THE PLEISTOCENE AND HOLOCENE

Zhanna Matviishyna · Serhii Doroshkevych · Anatolii Kushnir

Institute of Geography, National Academy of Sciences of Ukraine

The study of the history of nature development in the past has an important theoretical and applied significance. Our work is devoted to the study of fossil Pleistocene and Holocene soils within the modern forest-steppe zone of Ukraine. The methodological foundation for the paleogeographic reconstructions based on paleosoil research is taking into account the fact that soil is an integral part of the landscape, and morphogenetic differences of different soils in each section reflect the evolution of landscapes due to changes in physical-geographic conditions.

The research is based on the results of a comprehensive paleopedological method using micromorphological analysis. It involves the study of the soil at the micro level and the diagnosis of elementary soil-forming processes in Pleistocene and Holocene soils within different key areas of the modern forest-steppe zone of Ukraine (Middle Pobuzhye, Dnieper Left-bank and others). Diagnosed micromorphological features of different soil formation processes in Pleistocene and Holocene soils made it possible to identify genetic types of fossil soils and, accordingly, to trace the evolution of natural changes over time.

For the paleogeographic reconstructions of the Holocene, within certain areas, we also used a geoarchaeological approach, the essence of which is to study the buried ('preserved') soil under a certain dated archaeological site and compare its features with modern soil background. In particular, the buried Holocene soils within the Bilsk hillfort (2600-2400 BP), Storozhove mound complex (4100 BP, 3800 BP, 1600 BP, 300 BP) (Poltava region), Trypillia settlement near the village of Likareve (5800-5300 BP) (Kirovohrad region), Voitsekhivka mound complex (3600-3400 BP, 5500-5100 BP) (Zhytomyr region) and others were studied.

The reproduction of the evolutionary features of soil development is based on the results of our own field and laboratory research, as well as the analysis of materials of other researchers. The obtained results are also reflected in the form of maps of soil cover of some key areas within the modern forest-steppe zone of Ukraine for different stages of the Pleistocene (Middle Pobuzhye) (Doroshkevych, 2018) and in separate Holocene chrono intervals (forest-steppe Dnieper Left-bank) (Matviishyna, Kushnir, 2018).

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## PLEISTOCENE LANDSCAPE HISTORY OF THE MIDDLE DNEIPER RIVER VALLEY (UKRAINE) BASED ON LOESS COVER STUDIES

Przemysław Mroczek<sup>1</sup> · Maria Łanczont<sup>1</sup> · Maryna Komar<sup>2</sup> · Jerzy Nawrocki<sup>1</sup> · Karol Standzikowski<sup>1</sup> · Beata Hołub<sup>1</sup> · Oleksyi Krokhmal<sup>3</sup> · Kateryna Derevska<sup>4</sup>

<sup>1</sup>Maria Curie-Skłodowska University · <sup>2</sup>National Museum of Natural History · <sup>3</sup>Institute of Geological Sciences, National Academy of Sciences of Ukraine · <sup>4</sup>Taras Shevchenko National University of Kyiv

The contemporary landscape of the Middle Dnieper Valley is characterized by pronounced asymmetry on both sides of a wide flood plain now occupied by dam reservoirs. The high and steep right bank – the edge of the hilly plateau of the Dnieper Upland, contrasts with the left bank – gently sloping and low of the Dnieper Terraced Plain. In this area, loess-soil sequences with thicknesses up to 50 m are widespread. The role of the stratigraphic marker horizon is played by the moraine of the Dnieper glaciation (Saalian). Loess and loess-glacial sequences constitute an important record of paleoenvironmental dynamics and valuable long-term archives of Pleistocene landscape development in the area, the record continuity has great potential for correlation on a continental scale.

Here we discuss the sedimentary record exposed in several sites located on both sides of the river using multi-proxy tools. The greatest dynamics of landscape changes in the Middle Dnieper Valley was characterized by the period of advance, stagnation and recession of the glacial lobe. The different morphological-dynamic situation of the ice sheet of the marginal zone on both sides of the river is the reason for the different altitude of the glacial till exceeding 100 m. This situation reflected locally different accumulation conditions of loess sediments east and west of the river accumulated before, during, and after glaciation of the area. The complete cycle of events accompanying the entry of the glacial lobe into the lower Sula River valley, left Dnieper tributary, is recorded in the Klishchintsi section, where the phases of transformation of the aeolian/loess landscape into the glacial one and vice versa can be precisely distinguished.

The post-recession loess-soil sequences are characterized by a complex layering, with locally discontinuous soil horizons that wedge out in the elevated areas. They represent successive stages of transformation of the original glacial landscape by erosional processes and aeolian sedimentation, which took place after the period of stabilization and formation of soil cover. The Pleistocene landscape after deglaciation was characterized by a mosaic of steppe and subordinately tundra with small patches of cold-tolerant trees and shrubs in sheltered areas; the vegetation cover diversified at the end of the glacial period. Interglacial periods were characterized by the lack of complete forestation; rich grassland communities played a significant role in the vegetation cover, but in the right bank of the Middle Dnieper Area the occurrence of deciduous trees was greater.

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## LANDSCAPE CHANGE EXPERIENCES IN AN INNER-GERMAN BORDER AREA (EICHSFELD) USING HISTORICAL MAPS – BETWEEN DIVISION AND REUNIFICATION AND FUTURE TASKS

Marco Neubert

Leibniz Institute of Ecological Urban and Regional Development

The inner-German border area is characterized by an eventful history, which resulted in extensive land use changes. After the Second World War, the division of Germany and the development of massive, almost impassable border fortifications with additional, frontier zones with restrictions took place from 1945 onwards. The main driver of changes in land use during the socialist GDR period was agriculture (collectivization, intensification, mechanization, chemization, melioration, etc.) (URANIA-Bildungsgesellschaft Eichsfeld, 2003), e.g. leading to an almost complete loss of wetland areas.

With the opening of the inner-German border on November 9, 1989, and reunification on October 3, 1990, new processes became spatially effective. The previously peripheral region was suddenly of central importance and many developments were caught up. This concerned in particular the restoration of the previously interrupted, connecting technical infrastructure (especially road and highway connections). The border fortifications were almost completely dismantled and these areas now form the 'Green Belt' nature conservation project in the area formerly known as the 'Death Strip' (BUND, 2021). The agricultural structures, on the other hand, remained almost unchanged.

The research is exemplified by the rural Eichsfeld region in the heart of Germany, the tri-border area of Thuringia, Hesse and Lower Saxony. To picture the development of division and reunification including the resulting and accompanying land-use changes historical maps and digital data in scale of 1:25,000 in five stages from 1939 till 2014 have been analyzed using GIS (Kim, Neubert, 2018, 2019). The backward editing method (Kienast et al., 1991) was used to digitalize land use features (polygons and lines) by respective overlaying and editing. Thus, the changes can easily being located and quantified.

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## LIVESTOCK GRAZING IN TEMPERATE FORESTS REVISITED – WHAT DOES SCIENCE KNOW AND WHAT CAN BE LEARNT FROM HISTORICAL LITERATURE?

Kinga Öllerer<sup>1,2</sup> · Zsolt Molnár<sup>1</sup> · László Demeter<sup>1</sup> · Anna Varga<sup>3</sup> · Andrea Dénes<sup>4</sup> · Alexander Fehér<sup>5</sup> · Alen Kiš<sup>6</sup> · Klára Szabados<sup>6</sup> · Marianna Biró<sup>1</sup>

<sup>1</sup>Centre for Ecological Research · <sup>2</sup>Institute of Biology, Romanian Academy · <sup>3</sup>University of Pécs · <sup>4</sup>Janus Pannonius Múzeum · <sup>5</sup>Slovak University of Agriculture in Nitra · <sup>6</sup>Institute for Nature Conservation of Vojvodina Province

**M**ultifunctionality is an important aspect of historical forest use and included livestock grazing for centuries. Still, highly increased stocking rates, development of forestry and reduction of forested areas have led to overall restriction and even total ban of forest grazing in many European countries from the mid-19th century onward. While our knowledge on the traditional practice of this land-use is limited, there is an increasing recognition that it can be more finely tuned between the extremes of intensive grazing and total ban of livestock. Properly managed, targeted livestock grazing has been shown to benefit forest management and biodiversity, maintaining a cultural practice generating income for local communities.

Our objective was to review the current scientific literature and historical knowledge on livestock grazing in forests in order to assess the contemporary relevance of traditional silvopastoral practices to biodiversity management. We conducted a broad literature review, addressing both recent (Web of Science) and historical publications (prior to mid-20th century), in this second category focusing on the Carpathian Basin.

We identified 71 recent and over 160 relevant historical publications, covering mainly the 17th century–present period. Both source types concur that livestock can cause significant damage to tree seedlings, but provide examples that if done with care, under the surveillance of a competent herder, grazing can also support forest management. We found over 960 historical records mentioning effects of grazing by livestock in forests. These records present cases of cattle and sheep grazing applied for weed control in plantations, facilitating the regeneration of target tree species, by favouring seed germination through trampling and grazing out competitors. Pig grazing was used to prepare the soil for acorns, thus favouring oak regeneration. Reported effects varied greatly depending on forest type and stocking levels, livestock species and age, availability of alternative forage, grazing season, herder attitude and other activities taking place in the forest.

We argue that considerate livestock grazing can contribute to increased patchiness and habitat diversity resulting from a reduction in the cover of monodominant shrubs and pioneer vegetation, leading to higher diversity of herbaceous vegetation. While recent experiments mainly focus on intensive grazing vs. non-grazing situations, several historical sources provide recommendations for the practice of careful forest grazing. We thus urge the use of historical literature as a complementary source for developing tradition-based innovative nature conservation management methods. Widening the temporal scale of our understanding on the benefits and dis-benefits of livestock grazing in forests would support their multifunctional use.

## FORESTS OF THE EEMIAN INTERGLACIAL AND THEIR CLIMATE-DRIVEN CHANGES WITH NO HUMAN INTERFERENCE

Irena Agnieszka Pidek<sup>1</sup> · Anneli Poska<sup>2,3</sup> · Anna Hrynowiecka<sup>4</sup> · Dorota Brzozowicz<sup>5</sup> · Marcin Żarski<sup>4</sup>

<sup>1</sup>Maria Curie-Skłodowska University · <sup>2</sup>Tallin University of Technology · <sup>3</sup>Lund University · <sup>4</sup>Polish Geological Institute – National Research Institute · <sup>5</sup>University of Lodz

The aim of the study was to estimate the range of forest cover variability in Central Poland during the Eemian Interglacial (Marine Isotope Stage 5e; dated to ca. 127,200-109,500 BP acc. to Brauer et al., 2007). High resolution pollen records are available for several profiles of the fossil lakes in the region of the Garwolin Plain, which allowed for a detailed reconstruction of changes in forest composition through 17 thousand years without any anthropogenic influence. The combination of the plant indicator method and the modern analogue technique helped to estimate also several climate variables. Special attention was paid to the interglacial optimum consisting of three phases: oak-, hazel- and hornbeam-dominated forests (acc. to Mamakowa, 1989) and to the transition between Middle- and Late-Eemian. The latter is characterized by the drastic fall of deciduous trees and the predominance of conifers: fir, spruce, and finally pine.

The results suggest that highest total precipitation was observed in the hazel phase, and this was followed by a decrease in temperature in the Late Eemian together with a significant drop in precipitation. It coincided with a marked lowering of the water level in lakes and their transformation into different types of marshlands. The last part of the Eemian is characterized by a further decreasing temperature, particularly during the coldest month. Rising water levels due to a combination of lower evaporation and higher air humidity was noted.

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## IDENTIFICATION OF TOURISTIC ROUTES AND CREATION OF HERITAGE MAPS FOR THE ENHANCEMENT OF THE HISTORICAL LANDSCAPE. THE HISTORICAL LANDSCAPE OF THE LEONARDO DA VINCI'S GIOCONDA

Francesco Piras · Beatrice Fiore · Mauro Agnoletti

University of Florence

**W**ith the growing attention to historical landscapes, it becomes necessary to study and promote rural areas neglected in the recent past and considered less important or disadvantaged due to their reduced economic performance, but that still preserve peculiar features that be crucial for the valorization of these areas.

This study deals with the enhancement of one of these landscapes, the Valmarecchia. This valley, located in central Italy, is characterized by pastures and forest in the upper part and by agricultural areas divided by hedgerows in the central part. Traditional agricultural activities, which due to the local territory morphology are necessarily non-intensive, are unable to support the local economy. However, these practices have contributed to the formation of an extremely varied and unique landscape. Moreover, the widespread presence of castles and historical towns, together with a peculiar morphology, creates a landscape of significant historical and cultural importance, that some researchers identify with the one represented in the background of Leonardo da Vinci's Gioconda.

The study has been commissioned by the Local Action Group with the aim of promoting rural tourism and to strengthen the links between the historical built heritage (villages and castles) and the historical rural landscape. The research is based on the VASA (Historical and Environmental Approach) methodology, that is the official methodology chosen by the Italian Ministry for Agricultural Policies for the inscription in the National Register of Historical Rural Landscapes. This methodology, based on the multitemporal analysis of the landscape, allows to identify the historical features of the territory, their evolution and the measurement of the level of integrity of the historical landscape, representing a fundamental tool for landscape planning at local level.

The results of the comparison between 1976 and 2019, allowed to identify the territory portions that still preserve the traditional landscape structures more intact, in order to enhance the touristic sector through the identification of specific routes. The applied methodology, based on open source resources, led to the production of Heritage Maps, cartographic representations of the territory, that highlights both the cultural and rural heritage of the valley, promoting the knowledge of the close relationship existing between historic villages, castles, museums and the agricultural, forest and pastoral features. Moreover, specific touristic routes have been identified, in order to facilitate the access and the fruition of the most significant parts of the rural territory.

## EXPLORING HOW SOCIOECONOMIC SYSTEMS AFFECT VEGETATION: THE CASE OF THE SUMMIT FOREST OF GRAN CANARIA (SPAIN) DURING THE 20TH CENTURY

Aarón M. Santana-Cordero

University of Las Palmas de Gran Canaria

Landscapes evolve over time according to regional/local socioeconomic and environmental settings. During the 20th century, the agrarian-based socioeconomic system of the Canary Islands (Spain) was replaced with one based fundamentally on tourism. Under the former system, natural and rural countryside landscapes were exploited through an agrarian economy which most notably involved intensive deforestation, while under the latter (from the 1960s onwards) the main economic activities were progressively relocated to coastal zones. This triggered a reevaluation of the coasts and the progressive abandonment of crop cultivation in other parts of the island. Additionally, in the 1987 the Canary Government increased the protection of natural and rural environments and the trajectory of landscapes changed course. The aim of this work is to study the changes in vegetation cover associated to land uses of the landscape of the summit of Gran Canaria (Spain), which has an extension of 2224 ha and is about 1550 m above sea level. The main data, derived from vegetation maps from the 1998 and cultural heritage elements (CHEs) of the 20th century, were used to model land uses through the Voronoi method.

A nearest neighbour analysis that was calculated over CHE points yielded a value of 0.45, indicating that the variable displays a strong spatial concentration. Land use intensity (LUI) was calculated by counting the number of CHEs per km<sup>2</sup>. Results showed that high LUI values were concentrated in the north and south-east sectors of the study area. No patterns were detected when relating LUI and vegetation structure (grassland, shrubland and trees). Approximately, half of each LUI degree is constituted by trees. No patterns were also detected when relating land use types and vegetation structure. Finally, a comparison of current and potential vegetation in terms of structure showed that trees were the dominant vegetation (53.85% and 98.95%, respectively). Apart from natural recolonisation, other drivers in the evolution of the vegetation need to be taken into account, including the protected status of the area since 1987 and reforestation tasks.

The findings of this research demonstrate that land uses strongly modify vegetation dynamics. The most important findings are the non-existence of spatial patterns in vegetation and the significant differences between current and potential vegetation.

The main conclusions are that human activities have not resulted in defined spatial patterns in vegetation structure and that, in this case, an anthropized landscape shows more biodiversity than a natural one (potential vegetation).

## DIVERSITY OF HISTORICAL LANDSCAPE STRUCTURES AND WAYS OF THEIR IDENTIFICATION

Marketa Santruckova

Silva Tarouca Research Institute for Landscape and Ornamental Gardening

**H**istorical landscape structures play very important role for biodiversity conservation and we could find great variety of these structures in landscapes. Origin of the historical landscape structures is in traditional agriculture, forestry, small scale industry, water management, landscape designing, etc. We can assume that human activities in the landscape in past produced many landscape structures. When these historical landscape structures are still function or visible in the landscape and are not destroyed by modern intensive human activities, we could identify historical cultural landscapes based on the preserved landscape structures.

The paper presents two main points. First, sources and methods how to identify historical landscape structures on the national level will be present. We suggest how to excerpt different geographical databases, such as CORINE Land Cover or the fundamental base of geographic data (of the Czech Republic) that are available on national or European level and which features are important for identification of historical cultural landscapes. Our method is proposed for the first identification historical cultural landscapes on national level and gives us preliminary results about existence of the historical landscape structures. It is relatively easy for data preparation and processing.

Second, diversity of the historical cultural landscapes based on the cluster analysis of historical landscape structures will be present in the paper. We propose several general categories for methodological framing historical cultural landscape studies. These general categories are useful for both, nature and heritage conservation because different historical landscape structures and landscapes need different (intensity of) management.



## CHARCOAL PRODUCTION IN MEDIEVAL CENTRAL EUROPE AND ITS ENVIRONMENTAL CONSEQUENCES

Michał Słowiński<sup>1</sup> · Krzysztof Szewczyk<sup>1</sup> · Agnieszka Halaś<sup>1</sup> · Jerzy Jonczak<sup>2</sup> · Agnieszka Mroczkowska<sup>1</sup> · Dominika Łuców<sup>1</sup> · Sandra Słowińska<sup>1</sup> · Sebastian Tyszkowski<sup>1</sup> · Anna Kowalska<sup>1</sup> · Ewa Kołaczowska<sup>1</sup> · Paweł Swoboda<sup>3</sup> · Aleksandra Chojancka<sup>4</sup> · Tomasz Ważny<sup>4</sup> · Barbara Gumińska-Nowak<sup>4</sup> · Mateusz Kramkowski<sup>1</sup> · Cezary Kardasz<sup>4</sup> · Vincenzo Barbarino<sup>5</sup> · Agnieszka M. Noryśkiewicz<sup>4</sup> · Bogusława Kruczkowska<sup>5</sup> · Dariusz Brykała<sup>1</sup> · Tomasz Związek<sup>1</sup>

<sup>1</sup>Institute of Geography and Spatial Organization, Polish Academy of Sciences · <sup>2</sup>Warsaw University of Life Sciences · <sup>3</sup>Institute of Polish Language, Polish Academy of Sciences · <sup>4</sup>Nicolaus Copernicus University · <sup>5</sup>Warsaw University of Life Sciences

Charcoal in the Middle Ages and early modern was an important economic resource in Central and Eastern European countries. Charcoal production causes severe consequences of the vegetation compositions, soil properties, microclimate, hydrology and finally erosion that, in turn, affects adjacent lakes and peatlands ecosystems. Our goal is to provide a comprehensive understanding of how charcoal hearths functioned and what role they played in the evolution of medieval and early modern landscapes. Therefore, for this purpose we have combined historical, paleoecological, onomastics, phytosociological, microclimatic, dendrological and soil science data. Our preliminary results show intermediate disturbance connected with charcoal hearths operation affected the short-term and long-term changes in the ecosystems, which had a cascading nature. This research addresses the emerging issue of the impact of charcoal hearths legacies of past human activity and the impact of shaping trajectory of landscape transformation during medieval and early modern period.

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## INDICATORS AND DRIVERS OF CHANGES IN SLOVAK AGRICULTURAL LANDSCAPE

Jana Špulerová · Zita Izakovičová

Institute of Landscape Ecology, Slovak Academy of Sciences

The current land use is the result of a long-term historical development and represents the real use of the landscape by human society. Various socio-economic, technical or political drivers have caused land use changes. The aim of the paper is to evaluate land use changes in the Slovak republic over the last 100 years, to identify key periods of land-management practices and prevailing drivers, based on the various indicators.

We organized a workshop with guided brainstorming to identify individual eras of agricultural development and their impacts, as well as selection of the most important indicators reflecting the land use changes. The workshop was attended by 25 experts and stakeholders in agriculture, who were representatives of scientific organizations, department organizations in the scope of agriculture, NGOs as well as representatives of the Ministry of Agriculture and Rural Development.

In total, we identified five main periods of agricultural landscape development and specified the characteristic landscape structure. Indicators for measuring changes in the agricultural landscape and its effects on the landscape, biodiversity, agriculture, socio-economic environment and rural life were used for characterization of main development trends.

Knowledge of the basic drivers of land use change as well as knowledge of impacts is important to develop effective policies and to ensure effective protection of the values of a traditional agricultural landscape.

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## FROM FLOODPLAIN TO REPETITIVE FLOOD AREA: LANDSCAPE CHANGE OF THE FLOODPLAIN IN THE LOWER YOM RIVER BASIN IN KONG SUB-DISTRICT, THAILAND

Pakkasem Tongchai<sup>1</sup> · Danai Thaitakoo<sup>2,3</sup> · Ignacio Ortinez<sup>1</sup> · Asan Suwanarit<sup>3</sup>

<sup>1</sup>Urban Climate Resilient Infrastructure + Strategic Planning (UCRISP) · <sup>2</sup>Chulalongkorn University · <sup>3</sup>Thammasat University

The floodplain in the Lower Yom River Basin has been misidentified by a number of governmental agencies as a “repetitive flood area”. This misrecognition leads to ecological mismanagement of the floodplain. To recognize aptly the floodplain, we need to understand its ecological history. This research uses a historical ecology approach to study the structure, function, and changes, from both natural and human, in the floodplain of the Lower Yom River, specifically in the Kong sub-district.

This research use data from geographic information systems, such as geomorphological maps, past and present topographic maps, high-resolution digital terrain map, and satellite images, combined with information from research on the landscape’s physical geography, flora and fauna, and local community, to understand the structure, function, and changes in the floodplain. We also interviewed a sample of the local population.

The floodplain in the Lower Yom River Basin is situated at the bottom of Thailand’s Upper Central Plain. This characteristic leads to annual inundation during raining season. In this period, the floodplain becomes the natural habitat for aquatic fauna which are essential to the livelihood of locals in Kong sub-district for many generations. However, the floodplain habitats in the floodplain including brushwood, grasslands, shrublands, and swamps have decreased significantly, from 64% in 1959 to 2% percent in 2011. This change occurs in conjunction with a decrease in water surface area and an increase in rice fields, roads, dikes, and levees.

Rice Intensification Program implemented by the government leads to the transformation of forest areas into off-season rice fields. With the rice fields expanding extensively, the natural inundation events turned into a “flood disaster” and the floodplain becomes the “repetitive flood area”. Being categorized as such, the management of the floodplain by the government focuses heavily on creating flood control infrastructure. These changes are the cause of the decrease in water surface area and so disrupt the dynamic process in the floodplain. This may harm the flora and fauna depending on the ecosystem services provided by the process, which could lead to further negatively affect the livelihoods of the local population in Kong sub-district.

The development policies implemented by the government, especially the Rice Intensification Program, lead to the expansion of irrigation and flood control infrastructure. The natural process within the floodplain becomes a problem with a solution that ends up deteriorating the natural abundance of the floodplain. The management without understanding leads to the decrease in water surface area and the disruption of the floodplain’s dynamic processes. Ecosystem services, which are the process’ products, are then also disrupted. Lives dependent upon the services could in turn be harmed by this management.

## A POLICY ANALYSIS ON SECURING TENURIAL RIGHTS OVER ANCESTRAL DOMAIN: CASE OF AGTA-DUMAGAT TRIBE OF POLILLO ISLANDS

Leajim Villanueva · Merlyne Paunlagui

University of the Philippines

The importance of the issue of tenure is associated with the bundle of rights it accorded to holders ranging from access and use rights to management, exclusion, and alienation (Larson et al., 2010). In the absence of it, Indigenous People (IP) are without the legal right to access, withdraw, manage, exclude and alienate. Therefore, the issue of tenure towards their ancestral domain is central to the IP's struggle to be recognized and to have their rights respected (Erasga, 2008).

The study was conducted to do the following: (1) describe the implementation of Indigenous People's Rights Act (IPRA) relative to Certificate of Ancestral Domain Title (CADT) application of Agta Dumagat Tribe within Polillo Islands, 2) determine the Institutional, Political and Social influences to policy reform, and (3) identify the strategic responses based from the analysis. The macro and meso level analysis of the policy reform on the tenurial instrument for the ancestral domain of the IP communities using the case of Polillo had been helpful in understanding the intricacies of the political, social, and economic environment of the country which influences how policy perform at the ground level. While IPRA law was hailed as a 'landmark legislation' which challenged for the first time, the western conception of land ownership, however, the implementation arm, the NCIP, had been wanting, resources wise, to fully promote the recognition on the rights of the IPs to their ancestral domain. In the case of Polillo, assistance from other institutions had been helpful to facilitate the application. However, the limitations of these kinds of support and their sustainability remain a cause of the struggle.

Further, the result shows that support from civil society organizations and the local government unit helped with completing 15 steps of the CADT process. The challenge has been negotiating with other mandated agencies the extent and scope of the Ancestral Domain given that there is already existing tenure in the area. NCIP provincial officer pointed out that the bottleneck in the application has always been this part of the process, the issue of common projection. Based on the analysis, there are recommended strategic responses relating to social inclusion, empowerment, accessing funding opportunities, advocacy, and increase of NCIP visibility with the Local Government Unit to ensure sustained support all throughout the process of application.

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## RECONSTRUCTION OF THE HYDROGRAPHIC NETWORK IN JELENIA GÓRA BASIN (SW POLAND) AS A TOOL OF GEOHAZARDS PREDICTION AND PROPER SPATIAL PLANNING

Iwo Wieczorek · Agnieszka Latocha-Wites

University of Wrocław

**R**econstruction of historical landscape based on archival maps provides us with important information about location and usage of various landscape elements by humans in the past. Especially the analysis of past hydrographic network gives us an opportunity to study how humans dealt with geohazards such as floods, and how they used water resources in the past. The aim of the study was to reconstruct the changes in hydrography in the Jelenia Góra basin in the Sudetes Mountains since the 18th century, and to assess the importance of these findings for prediction of potential geohazards and for proper spatial planning.

In our research we used maps made by Ludwig Regler in scale ca. 1:24,000 (1764-1770), topographic maps Messtischblatt 1:25,000 (1919-1944), topographic maps 1965 1:25,000 (1975-1986), The National Database of Topographic Objects 1:10,000 (2015) and a Digital Terrain Model (DTM) of 1 m resolution (2015). By digitalising the hydrographic network presented in each set of maps we acquired a quantitative data of an area, length and location of different hydrographic objects. Next they were compared with the database from 2015 and with the theoretical hydrological model based on the DTM.

Results of the cartographic analysis has been additionally checked during field work which allowed us to verify the information about usage of different parts of Jelenia Góra basin nowadays and also to identify the possible marks of past exploitation of water resources. The largest area covered by ponds was observed at the end of the 18th century what is connected with well-developed fish farming. At the beginning of the 20th century the situation has diametrically changed – the area of ponds has decreased measurably but the total length of rivers has increased. Till nowadays, number of ponds and total length of rivers has increased again. All of these changes are strictly related to human activity in different times.

The study area was subject to changing human impact on the environment in the last 250 years, which is well presented by the changes in the hydrography. The knowledge on past usage and management of water resources, for example the assessment of the location of historical ponds or old riverbeds, can help us to indicate places which are under risk of geohazards, such as floods or ground subsidence, which is an important information for future spatial planning. Additionally, the understanding of past functioning of the water system can help to better adapt to the current environmental challenges, such as flash floods or droughts, by re-using the historic water infrastructure or to reconstruct the former one, for example by extending the number of water bodies.

## 5. Planning future landscapes

### *Future landscape development: forecast, visions and scenarios*

#### **Symposium organisers**

*Michał Sobala* (University of Silesia in Katowice), *Krzysztof Badora* (Opole University), *Urszula Myga-Piątek* (University of Silesia in Katowice), *Katarzyna Pukowiec-Kurda* (University of Silesia in Katowice), *Anna Żemła-Siesicka* (University of Silesia in Katowice)

#### **Summary**

Contemporary global processes are the factors that have consequences in landscape transformation. They can be analysed at various spatial levels: local, regional and global, which determines the accuracy and probability of predictions. Predicting landscape changes is challenging. Despite some difficulties concerning that issue, it seems obvious to try to predict what the landscape in the future will be. This session focuses on presenting the results of research on that issue – the prognosis for landscape development.

#### **Description**

Global demographic, social, cultural, political and economic changes that are developing ever more quickly, and also the disturbing effects of climate change are the factors that are likely to have consequences for dynamic landscapes' transformation in the immediate future. These transformations will take place at a different rate in many parts of the world. Therefore, determining them should take place at various spatial levels: local, regional and global. These spatial scales will determine the accuracy and probability of the predictions that are made.

A detailed study of the effects of driving forces determines the high probability of an accurate assessment of future landscape effects. What is more, it makes distinguishing between visions and high-precision scenarios possible.

Predicting landscape changes is challenging and has so far been undertaken very rarely in research. Nevertheless, it is a vital element of theoretical scientific research. There are many difficulties arising primarily from the need to take into account a large number of variables. These variables are often difficult to determine. The magnitude and direction of future driving forces that determine the dynamics and pace of landscape changes are unknown. Furthermore, it is also impossible to predict all the future driving forces in accordance with the current state of knowledge. Nevertheless, these difficulties do not exempt scientists from attempting to create scenarios for the development of future landscapes. It seems obvious to develop the prognosis for landscape development and to try to predict what the landscape in the future will be.

This subject area includes:

- analysing the driving forces that will affect landscape changes at various spatial levels (local, regional and global),
- analysing possible directions of the transformation of cultural landscapes – case studies,
- estimating the pace and dynamics of landscape changes.

## IMPACTS OF CLIMATE CHANGE ON EXTENT OF TREE CROP PLANTATIONS IN SOUTHEAST ASIA

Jonas Appelt<sup>1</sup> · Thatheva Saphangthong<sup>2</sup> · Žiga Malek<sup>1</sup> · Jasper van Vliet<sup>1</sup> · Peter Verburg<sup>1</sup>

<sup>1</sup>Vrije Universiteit Amsterdam · <sup>2</sup>Lao Ministry of Agriculture and Forestry

**P**erennial tree crop plantations are some of the dominating landscape types in Southeast Asia. Together, coconut, oil palm and rubber plantations take up 8% of the total land area and 31% of the existing cropland in the region, while they contribute to agricultural livelihoods of millions of people. Expansion of tree crop plantations has been a significant driver of ecological transformation in recent decades, causing loss of natural areas and biodiversity across the region. At the same time, they are an integral part of the national and local economies, contributing to the livelihood of local households. Climate change has the potential to drastically affect local agricultural landscapes and hence the societies relying on these, for better or for worse, through their impact on the conditions for crop cultivation and yields.

In this study, we use a modified EcoCrop model to create a 1 km resolution map of crop suitability for coconut, oil palm and rubber in Southeast Asia under current and future conditions, based on projected climate data from a suite of Generalized Circulation Models. This mapping is used to assess how changes in climate variables will impact their suitability under different climate scenarios, as well as the agricultural landscapes they are part of.

We find that projected increases to temperature and rainfall in the insular parts of Southeast Asia will decrease the suitability of the existing production areas of coconut and oil palms, while increasing temperature in the mainland parts of the region will improve suitability for many existing rubber areas. Loss of suitability for existing coconut areas can be expected in Indonesia and to a lesser extent in the Philippines, which may cause a move of production northward, to parts of Thailand, Vietnam, and Myanmar. Areas with existing oil palm plantations will generally see decreasing suitability, in particular in southern Sumatra, but with little increase in suitability on the mainland. Climate change may therefore further exacerbate the pressure on natural landscapes in the insular parts of Southeast Asia, with large oil palm producers looking to move production to frontier areas in Borneo and New Guinea. In the mainland parts of the region, improvement in rubber suitability may be advantageous for both smallholder and larger plantation producers in Cambodia, Lao PDR, and Thailand. However, it is not clear if increasing suitability of rubber in these areas will keep up with increasing demand. Based on these data we can project that climate will increasingly be a limiting factor for perennial tree crops in certain parts of Southeast Asia, and this may induce significant movement of production towards other landscapes in the region that are currently predominantly natural.

## THE GEOGRAPHY OF MEGATRENDS AFFECTING EUROPEAN AGRICULTURE

Niels Debonne<sup>1</sup> · Matthias Bürgi<sup>2</sup> · Vasco Diogo<sup>2</sup> · Julian Helfenstein<sup>3</sup> · Felix Herzog<sup>3</sup> · Christian Levers<sup>1</sup> · Franziska Mohr<sup>2</sup> · Rebecca Swart<sup>1</sup> · Peter Verburg<sup>1</sup> · Tim Williams<sup>1</sup>

<sup>1</sup>Vrije Universiteit Amsterdam · <sup>2</sup>Swiss Federal Institute for Forest, Snow and Landscape Research · <sup>3</sup>Agroscope

**T**he future of European rural regions is highly dynamic and contested. Megatrends – long-term driving forces that are observable today and will likely have transformational potential in the future – are building up pressure towards transformational change. However, Europe is highly diverse, and different sets and intensities of megatrends are present in different regions. Additionally, the likely impacts of these megatrends can range from reinforcing a systemic lock-in, to driving desirable or undesirable transformations.

Climate change, demographic changes, (post-) productivism shifts, and the decreasing environmental action space are four megatrends that we identified to be relevant and highly variable across Europe. The megatrend direction and intensity differs by region. In our research, we map these megatrends, analyze where they coincide, and explore the potential system responses. We find that in most European regions, megatrends are converging towards instability, meaning that the current status-quo is being undermined by megatrends. In other regions, megatrends combine to reinforce the current system (persistence), or to make it unviable (marginalization).

This study is a novel approach towards continental-scale explorations of the future of landscapes because we explicitly look at drivers of change that have a less well understood theory of change but which are expected to become engines of systemic change in the future nonetheless. For example, it is still speculative what the exact impacts of climate change could be on rural regions, but we can assume that these trends will be among the most impactful dynamics in the future. This study is currently under review in *Global Environmental Change*.

An already visible outcome of demographic change is that a shrinking supply of farm labor is being supplanted by migrant labor in a process that we call the ‘Californisation’ of European agriculture. In a study, we use COVID-19 related newspaper articles on labor shortages due to border closures, in combination with existing data, to map californisation across Europe, establish its trends, and analyze the role of Californisation as a force of landscape change. We find that, in most countries, the use of migrant labor is increasing, and this can lead to very rapid intensification processes that would not be possible without californisation.

Lastly, environmental actions space denotes the increasing stringency of environmental regulations and the increasing difficulty for farmers to meet these regulations. This research is ongoing, and will map, for Europe, where and to what extent regions are overshooting a range of sustainability targets. In discussing the various sustainability targets that are being proposed by different actors, this research moves from forecasts and scenarios to visions.



## FILLING A GAP IN DOURO PROTECTED AREAS NETWORK. AN OPPORTUNITY FOR THE CREATION OF THE LOWER SABOR NATURAL REGIONAL PARK

Cláudia Fernandes · Margarida Medeiros · Rita Raposo · Paulo Farinha Marques · Pedro Beja · Nuno Ferrand

University of Porto

The Douro is a unique region of deep valleys and Mediterranean character, nestled between two important Portuguese mountains and the Iberian plateau. The original geological, morphological, and climatic characteristics allow for the survival of an extraordinary diversity of plants and animals, which is why this territory has been occupied, since prehistoric times, by successive waves of people who have gradually left their mark creating today a unique and valuable landscape.

The originality of this territory and richness of natural and cultural values have led to an impressive extension of various protected areas. Douro region currently encompasses, wholly or in part: (1) the Alto Douro Wine Region (ADV), a UNESCO Evolutive and Living cultural landscape, (2) the Côa Valley Archaeological Park, also a UNESCO world heritage protected landscape, (3) the Tua Valley Natural Park, (4) several Natura 2000 sites, (5) the Faia Brava, the first Portuguese private protected area, and also a pilot area for the European Project Rewilding Europe, (6) the Douro International Nature Park, and (6) the Meseta Ibérica Transfrontier Biosphere Reserve.

These protected areas face distinct challenges and have conservation strategies, governance tools, and development goals that are not always convergent. Managing facing such complexity demands a holistic and integrated vision and the definition of a framework to enable best practices in sustainable landscape planning and management. Here we propose the design of a connectivity corridor on the east-west axis in which all the tributaries of the Douro river are included. This system of connectivity routes, internally and with neighbouring landscapes, brings together the best-preserved continuums of each protected area and allows gaps identification in that connection.

The methodology involved identifying and mapping using ArcGIS the biophysical characteristics of each protected area and natural and cultural heritage attributes. The territorial management instruments in force for each protected area were also analysed and compared. It was thus possible to demarcate a connected network of protected areas – the Douro Valleys Park and identify a critical gap between the lower Sabor and Côa with the Douro river that should be filled with the creation of a regional natural park similar to the one existing for the Tua river.

The proposed network of protected landscapes confirms the need for this landscape to have a unique identity, with the conviction that this will contribute to reducing the asymmetries that have been seen in the Douro region concerning the various conservation statutes and protected areas classifications and management models.

## LANDSCAPE CHANGES AND ITS DRIVING FORCES IN THREE LOWER SILESIA COMMUNES – JELENIA GÓRA, MYŚLAKOWICE AND KĄTY WROCŁAWSKIE IN POLAND – CURRENT TRENDS AND FUTURE PROJECTIONS

Piotr Krajewski · Iga Kołodyńska · Monika Lebedzińska · Karolina Birnbaum

Wrocław University of Environmental and Life Sciences

**A** crucial element in the analysis of the driving forces of landscape change is the collection of data on the physical transformations of landscapes, as well as information on the causes of these changes as indicated by the public. Only having full knowledge of the types of transformations and their perception by the residents allows to competently plan changes in the following years. Combining social research with analysis of the history of landscape transformation is now the basis for identifying the driving forces of landscape change.

The main objective of the study was to characterize landscape transformation in the period 2005-2020, which includes the time after Poland's accession to the European Union, and to identify its current and possible future driving forces through social research – surveys and face-to-face interviews. Three communes from Lower Silesia in Poland were selected as study areas: the city of Jelenia Góra, the rural commune of Myślakowice and the urban-rural commune of Kąty Wrocławskie. Research areas were selected because of the diversity of landscape types existing within their borders. Landscape changes were characterized for the periods 2005-2010, 2010-2015 and 2015-2020 in terms of the number and size of changes and types of transformations. The landscape change index (LCI) was also determined, which showed in the case of Jelenia Góra city and Myślakowice commune, a systematic increase in the level of landscape changes in consecutive periods. The opposite situation occurred in the municipality of Kąty Wrocławskie, where the highest index was recorded for the years 2005-2010. The spatial policy of individual study areas contained in planning documents was also analyzed and the main areas of future landscape transformations were identified. Using an online survey made available to volunteers through social media and organizations associated with the study areas, proximate and underlying driving forces behind landscape change were identified and planned landscape changes were assessed. The surveys were supplemented by face-to-face interviews with local leaders, which provided a broader perspective on the identified and planned landscape changes. The research resulted in the development of a list of driving forces identified by residents as the main drivers of transformation, along with an attempt to identify forces that may affect the landscape in future years.

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## COMBINING MODELS WITH SOCIO-ECOLOGICAL STUDIES FOR UNDERSTANDING THE FUTURE OF AGRICULTURAL LANDSCAPES IN CENTRAL EUROPE, AND OPTIONS FOR NBS IMPLEMENTATIONS

Kinga Krauze<sup>1</sup> · Renata Włodarczyk-Marciniak<sup>1</sup> · Katarzyna Izydorczyk<sup>1</sup> · Wojciech Frątczak<sup>2</sup>

<sup>1</sup>European Regional Centre for Ecohydrology, Polish Academy of Sciences · <sup>2</sup>Marshall Office of Łódź Voivodeship

**A**gricultural lands in Poland have served for centuries as refuges of biodiversity, simultaneously preserving numerous supporting and regulatory ecosystem services. This has been a consequence of the land use structure favouring diversified mosaic of cultivations, rooted in local tradition and empowered by market-dismantled socialist economy.

Almost two decades after Poland's accession to European Union, we applied a cascading thresholds model by Kinzig et al. (2006) to define the regime shifts over social, economic and ecological domains and to derive the scenarios of agricultural landscape development together with the key drivers of change. The model was fed with the results of extensive socio-ecological study carried among the farmers of the Pilica River catchment (Central Poland). The additional aim of the study was to understand their attitudes towards traditional landscape elements and their decisions over future land use practices which will impact the provision of ecohydrological regulatory services. Additionally we analysed the hot-spots of nutrient leakages in the catchment applying the SWAT model, and collaboratively identified agricultural practices feasible to serve as preventive measures.

Kinzig A.P. et al. (2006). *Resilience and regime shifts: assessing cascading effects*. Ecology and Society, 11(1): 20.

## ECO-REVITALIZATION – INNOVATIVE AND ECOLOGICAL ASPECTS OF REVITALIZATION PROJECTS ON THE EXAMPLE OF ŁÓDŹ

Rafał Michaś

University of Lodz

The subject of the article concerns the introduction of innovative ecological solutions in implemented urban regeneration projects. The aim of the presentation is to present such practical solutions that can adapt the revitalized areas of cities to current and future climate problems, etc., to the principles of sustainable development. Presentation of the standards of design and implementation of revitalization projects on the example of Łódź in the context of preparing cities for drastically changing climatic conditions (droughts, floods, etc.) and improving the conditions for the development of the existing urban greenery and defining methods for increasing the amount of greenery in cities and most urbanized zones. Selected revitalization projects implemented in Łódź will be subject to a detailed analysis in terms of the applied ecological solutions and implementation of projects in accordance with the principles of sustainable development. Topics of the paper concerning the implementation of innovative ecological solutions in implemented urban regeneration projects. The currently used solutions aimed at adapting the renovated urban spaces to the current and future climate problems, etc.

The results of the research determine the possibilities of adapting modern cities to climate change, and the implementation of regeneration projects based on the principles of sustainable development. The results of the work will determine the types of innovative ecological solutions that can be used by local governments and other entities as part of revitalization and a catalog of ecological solutions that should be used as part of urban revitalization. The conducted literature research and analysis of implemented projects confirm the need and the possibility of using ecological solutions in revitalization projects. Thanks to the preparation and implementation of revitalization in accordance with the principles of sustainable development, projects of this type respond to the current and future needs of cities in terms of adapting to climate change, increasing biodiversity or increasing the biologically active area. The results of the research confirm the need for sustainable preparation of revitalization projects, taking into account the broadly understood ecological aspect and impact on the environment.

## FORECAST CULTURAL LANDSCAPE DEVELOPMENT. THEORETICAL CONSIDERATIONS BETWEEN VISIONS AND SCENARIOS

Urszula Myga-Piątek

University of Silesia in Katowice

The evolutionary approach is quite frequently presented in cultural landscape research carried out by geographers. This makes it possible to explain the current condition of the landscape as a result of changes that took place over previous centuries. Based on historical and iconographic resources, but mainly on archive cartographic materials, it is possible to recognize differences in landscape structure over a period of time and, consequently, to identify critical events that determine the time ranges of clearly distinct stages of landscape development. Landscape forecasting is one of the aspects of the evolutionary approach and an essential element of theoretical geographical research. Such research has been highly attractive in scientific terms, especially in recent decades, when it has been supported by modern computer-aided technologies and methods, as well as GIS tools. That is why the evolutionary approach to landscape analysis is dominated by research on changes, mainly in land cover and land use in various space and time ranges.

Many practical actions, including land use and landscape protection, are based on forecasts. The landscape approach to forecasting is synthetic and holistic but also difficult. The difficulties result mainly from a number of unknown variables: the intensity of the future impact of each landscape-shaping factor that determines the dynamics and pace of landscape changes is unknown, as is the vector return in direction of their impact. The observation of a change itself, although obvious and necessary in this analysis, is not enough to fully research landscape evolution. It is very important to understand the historical contexts of the landscape as well. Analysis is only an approximate vision, not a specific and detailed development scenario. Consequently, the following question seems to be justified: is it possible to forecast landscape changes at all and is it scientifically reasonable? These basic unknowns do not stop geographers from taking up studies in the creation of possible development scenarios for future landscapes. The aim of this presentation is to outline matters related to the forecasting of cultural landscape development by defining its preconditions. It also aims to define the factors which should be taken into consideration – as highly probable – because of pre-existing detailed analytical forecasts, including climatic, demographic and economic ones. Most forecasts regarding changes in landscape-forming factors are qualitative rather than quantitative.

The important stages in forecast development involve setting explanatory variables and estimating how they will affect the components of the current landscape structure in the analyzed period, and how they will modify current processes occurring in the geosystem and social system.

## EVOLUTION OF ARCHAEOLOGICAL LANDSCAPE IN POLAND – THE PAST, PRESENT AND FUTURE CHANGE

Anna Żemła-Siesicka

University of Silesia in Katowice

The archaeological landscape is a sub-type of cultural landscape. It can be defined as a landscape in which archaeological sites of their own landform are the dominant element. The term refers to current landscapes which, historically, were transformed and which have a specific contemporary form, function, and physiognomy.

The archaeological landscapes in Poland are preserved in varying conditions, depending on the history of their discovery and the method of research carried out upon them (invasive or non-invasive). Some structures have been reconstructed after excavations, some preserved in their current condition, or not protected at all. Many of these sites are currently adapted for tourism and equipped with tourist facilities. In order to protect and correctly plan the development of these sites, it is necessary to identify the past changes that have occurred in them and to analyze both the current conditions and the directions of transformation that may happen in the future.

The aim of this research was to identify models of the evolution of archaeological landscapes based on an analysis of current landscapes and their past changes. The study was conducted on several sites with legible landscape forms – barrows and cromlechs located in different regions of Poland (dating from the Neolithic, Bronze, and Iron Ages). Changes in land cover, as well as the main processes and threats were identified based on an analysis of historical and contemporary topographic maps and a literature review. Inventories of current developments were also taken during field visits.

Two main groups of changes were distinguished: those induced by humans and natural ones. In the first group, three models of evolution were identified, depending on the activities undertaken in relation to archaeological landforms: A. conservation of an existing form (A1. conservation of an unexcavated form, A2. conservation of an already excavated site without reconstruction), B. reconstruction of an archaeological landform (B1. partial reconstruction, B2. total reconstruction), C. abandonment (C1. abandonment of a protected form leading to its slow destruction and a possible change of land use, C2. abandonment of the tourist function – in the case of sites already adapted for tourists), D. development of tourism (D1. sustainable development – a limited number of facilities well integrated into the landscape, D2. intensive tourist infrastructure related to the site, D3. intensive tourist infrastructure with other tourist attractions, producing negative landscape effects). Two models were identified in the changes due to natural factors: E. changes related to natural hazards, e.g. storms, and F. slow, natural changes, such as climate change.

These models allowed us to determine the current stage of development of a particular archeological landscape and to identify possible scenarios of future changes. The presented results will be helpful in future landscape planning and protection.

## ***Planning and policy approaches for future landscapes: learning from past experiences to develop novel pathways***

### **Symposium organisers**

*Simona R. Grădinaru* (University of Bucharest), *Anna M. Hersperger* (Swiss Federal Institute for Forest, Snow and Landscape Research), *Ana Beatriz Pierrri-Daunt* (Swiss Federal Institute for Forest, Snow and Landscape Research)

### **Summary**

Worldwide, land transformations have contributed to amplifying environmental challenges such as depletion of food providing areas, climate change effects, or soil degradation. Efforts need to be put in improving the capacity of governments and authorities to formulate and implement policies which tackle these challenges. This symposium aims to assemble talks that discuss innovative approaches for integrating landscape ecology principles, concepts, methods into planning and policy for better addressing these challenges. We encourage papers which address all steps of the planning cycle.

### **Description**

Worldwide, we experience fast and profound alteration of our human and natural environment. Arguably one of the most important processes therein are land transformations and their associated impacts on the landscapes. The resulting challenges, including rapid global urbanization, depletion of green spaces and food providing areas, climate change, and soil degradation, among others, are critical in our time. It is in this context that great effort needs to be put in understanding how to improve the capacity of the worldwide governments and authorities to formulate, adopt and implement policies that tackle these challenges.

Spatial planning and policy, in its various forms ranging from integrated strategic approaches for setting long term visions to targeted policies, has been proven to influence patterns of land transformations. Thus, current environmental challenges need to be integrated into the planning agendas.

We welcome presentations which follow the general congress theme – making the future, learning from the past, and present:

- evidence on the role of planning in landscape transformations,
- lessons learned from participative/collaborative planning processes,
- novel methods through which landscape ecology could support addressing current challenges during the planning process,
- integration of landscape ecology concepts into planning and policy,
- approaches for mainstreaming ongoing challenges such as landscape changes, and food security, into planning documents,
- developing scenarios of future landscapes.

We invite papers that address various steps of the planning cycle, from goal setting to implementation and evaluation procedures. Presentations can address, for example, the role of the actors during the planning process, the efficacy of the planning instruments, or the impact of plans and policies on the landscapes. A focus on urban landscapes and the use of new tools for integrating the ecological and human dimensions within a spatial framework (e.g. digital plans) are particularly welcomed. We encourage contributions that present both theoretical endeavours and empirical results.

## TOWARDS TRANSFORMATIVE LANDSCAPE PLANNING FOR PEOPLE AND NATURE: A CRITICAL REFLECTION

Christian Albert<sup>1</sup> · Christopher M. Raymond<sup>2,3</sup> · Marleen Buizer<sup>4</sup> · Claudia Bieling<sup>5</sup> · Tobias Plieninger<sup>6,7</sup> · Blal Adem Esmail<sup>1</sup> · Thomas Beery<sup>8</sup> · Nora Fagerholm<sup>9</sup> · Natalie Gulsrud<sup>10</sup> · Maria Garcia-Martin<sup>11</sup> · Silviya Korpilo<sup>2</sup> · Anton Stahl Olafsson<sup>10</sup> · Stefan Schmidt<sup>1</sup> · Mario Torralba<sup>5</sup> · Jingxia Wang<sup>1</sup> · Esther Turnhout<sup>4,12</sup>

<sup>1</sup>Ruhr University Bochum · <sup>2</sup>University of Helsinki · <sup>3</sup>Swedish University of Agricultural Sciences · <sup>4</sup>Wageningen University & Research · <sup>5</sup>University of Hohenheim · <sup>6</sup>University of Kassel · <sup>7</sup>University of Göttingen · <sup>8</sup>Kristianstad University · <sup>9</sup>University of Turku · <sup>10</sup>University of Copenhagen · <sup>11</sup>Swiss Federal Institute for Forest, Snow and Landscape Research · <sup>12</sup>University of Twente

In recent decades, many landscapes in Europe and elsewhere have suffered substantial degradation that leads to loss of biodiversity and undermines the capacity of landscapes to provide essential contributions to people. It is increasingly recognized that fundamental, transformative change is required to halt these trends, and to develop landscapes towards more sustainable pathways. Landscape planning, as a forward-looking action to enhance, restore or create landscapes, could arguably take a leading position in these efforts, but must itself be re-thought to effectively support the needed transformations. This contribution aims to explore how landscape planning might be advanced to better support transformative change for nature and people.

Our starting point is a well-known transdisciplinary framework that identifies planning's contributions to systems, target, and transformation knowledge, but may promote hindering, technocratic approaches. We recommend that landscape planning moves away from the ambition to develop comprehensive system knowledge and instead aims at fostering a constructive dialogue around people-place relations. Second, we suggest target knowledge to ensure equity and justice by aiming at provisional visions and avoiding premature consensus. Third, we propose that transformation knowledge should link visions and people-place relations with actions, while still allowing for disagreement and differences. We conclude that if landscape planning succeeds in focusing on people-place relations, justice, and contestations, it can foster the connections between knowledge and action that support transformative change.



## MAKING CONNECTIONS – GREEN SPACE ACCESSIBILITY AS AN INDICATOR OF WEALTH DISTRIBUTION

Tereza Aubrechtová · Ondřej Slach · Lenka Paszová · Vojtěch Bosák · Alexandr Nováček

University of Ostrava

New trends in urbanisation show on one side depopulation of the countryside, and on the other hand depopulation of city centres driven by suburbanization or peri-urbanisation. It has a negative impact either on the economic or on the social and environmental dimensions of urban areas. To avoid these negative effects, nature and its ecosystem services should be considered as a very important aspect of city attractiveness. But policy statements relating to landscape planning and urban nature restoration are rather formal or vague. Robust environmental data expressing inhabitants' quality of life are needed as a database for evidence-based strategic and further urban plans.

In our research, we focus on the accessibility of public green space as a potential donor of benefits increasing the quality of life with a special emphasis on social justice. The availability of green spaces, especially for people with low adaptation capacity (low income, elderly people), is supposed to be the main input for strategic planning and further investment plans, setting the maintenance priority. Our study aims to provide a quantitative approach to detect areas with worsened accessibility of green spaces and lower quality of life. To do so, we are using three categories of green spaces: (1) public parks in current good condition, (2) public parks in current weak condition, and (3) private greenery with a potential use.

The case study area is a central part of Ostrava city (Czechia), facing shrinkage and depopulation of the city centre. The three steps network analysis of green space (1-3) accessibility was calculated. The data of good (< 300 m), worsen (300-500 m) and bad (> 500 m) accessibility zones are combined with socio-demographic data, considering especially the number of elderly people in each zone and proportion of residential and non-residential buildings.

Based on the data, we can spatially express the wealth distribution and potential of each green space to improve the quality of life. The research method creates an analytical governance approach to sets priorities for spatial planning and creates a specific dataset connecting human benefits from nature, which may result in informed and data-based landscape and urban planning incorporating aspects of ecosystem services.

## MAPPING ECOSYSTEM SERVICES IN THE AREA OF PLANNED TURNICKI NATIONAL PARK

Mariusz Boćkowski · Marcin Rechciński · Joanna Tusznió · Małgorzata Grodzińska-Jurczak

Jagiellonian University

**N**ational parks (NPs) are considered core areas of ecological networks. Since 2001 there has been not created a new national park in Poland and they still cover no more than 1% of the area of the country. Mainly, this is a result of (1) legal environment (local municipalities can veto the creation of NP) and (2) negative attitudes of local inhabitants towards national parks. These two factors correspond both with the alleged conflict of interests between Polish conservationists and the forestry sector as well as with the current global debate on paradigms of nature conservation. The area of long-time planned Turnicki NP is a round-up of ongoing problems with Polish NPs and a very relevant case for studying their future perspectives.

Using the lens of ecosystem services concept, we tried to explore how: (1) various groups of local stakeholders perceive the spatial distribution of ecosystem services relevant for the quality of life of local inhabitants, (2) local stakeholders understand relationships between delivery of ecosystem services from ecosystems to human and management of local resources, and (3) the use of the concept of ecosystem services may help plan a protected area.

To assess the spatial distribution of ecosystem services according to the perceptions and knowledge of stakeholders we organized five exploratory, structured participatory mapping workshops. The results revealed a set of top five priority ecosystem services perceived by specialists of nature conservation, foresters, and three groups of local community leaders. Stakeholders brought an array of perspectives to the table. They varied in: perception of map/space, knowledge understanding of services, seeing relationships of nature and development. All participants appreciated the value of forest ecosystems as service providers. However, they differed in how those ecosystems should be utilized. The participatory mapping proved to serve very well as an introductory and exploratory stage of research on social and economic aspects of the management of natural resources. Also, the workshops showed the importance of the use of proper language and making common definitions when communicating with various groups of stakeholders on nature-related issues. The survey informed the ongoing process of research on relations between humans and nature in the area of planned Turnicki NP.

## MAPPING AND CLASSIFYING PERVIOUS SURFACES AND CANOPY COVER THROUGH NDVI TO SHIFT TOWARDS SUSTAINABLE URBAN PLANNING

Anna Codemo · Angelica Pianegonda · Sara Favargiotti · Rossano Albatici

University of Trento

**U**rban green infrastructure (UGI) has a key role in improving human and environmental health in cities. Vegetation contributes to climate adaptation and mitigation in the urban environment by providing microclimate regulation, sustainable water management and energy sustainability. An accurate UGI assessment is envisaged to manage sustainable land-use transformations and to integrate climate strategies into urban planning practices. Technological advancement and simplification of data gathering facilitate urban green areas assessment, management, and planning. Therefore, geospatial data-driven approaches may highlight potential gaps in the current urban system and address new project opportunities. Particularly, it can be a useful tool to shift from the common prescriptive approaches based on traditional zoning towards more flexible and effective urban development, by introducing ecological quality indicators and standards supporting planning decisions. The aim of the study is to contribute to the integration of UGI in current urban planning practices, by mapping and assessing urban green areas and by highlighting potential applications in the policy cycle.

Specifically, a simple process to assess and map permeability and canopy cover in urban areas is developed by using the Normalized Difference Vegetation Index (NDVI) from high spatial resolution (0.20 m) digital colour-infrared aerial imagery, and Digital Elevation Models. Spatial analyses are performed to classify urban cover, according to land use classes. Moreover, by using a sample area, the use of NDVI is tested to implement a performance-based approach. The approach is tested in the city of Trento, an alpine city in the North of Italy, characterized by an increase of soil sealing in the valley floor. The proposed method is part of the framework of the Trento Urban Transformation research project, aiming to introduce innovative and adaptive tools into current planning practices and to shift towards a performance-based planning approach.

By performing remote sensing and GIS analyses, the study provides high resolution maps of permeability and canopy cover for the Municipality of Trento; quantification of permeability and canopy cover by land use; experimentation of alternative scenarios with different mitigation strategies. Pervious surfaces and canopy cover maps are useful to geovisualize critical areas at a very detailed level and to enable further analyses, for example related to property, distribution pro capita or to temperature regulation and sustainable water management. Hence, their use is a valuable tool for policy makers to manage urban transformations and to integrate climate strategies in planning practices. In conclusion, the contribution provides a case study to enrich the debate about management and implementation of UGI and to give scientific support for sustainable urban planning.

## THE ROLE OF THE NATIONAL URBAN AGENDA IN BRAZILIAN STATE CAPITALS: A SOCIOECONOMIC AND LAND CHANGE ASSESSMENT

Beatriz Pierri Daunt<sup>1</sup> · Dario Domingo<sup>2,3</sup> · He Zichao<sup>4</sup> · Anna M. Hersperger<sup>1</sup>

<sup>1</sup>Swiss Federal Institute for Forest, Snow and Landscape Research · <sup>2</sup>University of Zaragoza · <sup>3</sup>University of Valladolid · <sup>4</sup>Martin Luther University Halle-Wittenberg

**N**ational urban policies play a crucial role to guide urban growth towards more sustainable and efficient cities. However, the comparison of policy goals and outcomes in terms of an effective land-use change and socio-economic transformation remains a challenge. This study aims to understand the role of the national urban agenda in driving land-use and socio-economic changes in 27 Brazil State capitals from 1990 to 2020. We carried out content analyses to identify five main goals addressed by both the 1988 Federal Constitution (FC) and 2001 City Statute (CS): (1) Economic development, (2) Basic services provision, (3) Housing, (4) Urban Compactness development, and (5) Green and sustainable cities. We calculated socio-economic, demographic and landscape change indicators from 1990 to 2000 and from 2000 to 2020. To assess the link between the policy goals with change indicators, we classified the intended behaviour of the indicators and the observed values into increase (+1), decrease (-1) or no changes (0). To compare the intended and observed changes for each variable and city, we calculated the absolute difference to identify whether an observed change was in full conformance (absolute difference = 0), nonconformance (absolute difference = 1) or strong nonconformance (absolute difference = 2) with the intended change. Finally, we computed the mean score per goal and policy for each city, standardizing the results on a scale from 0% (no conformance) to 100% (full conformance).

Overall, land-use change, and socio-economic transformations conform better with CS (68%) than with FC (59%). After the implementation of CS in 2001, conformance with Goal 1 increased from 22% to 83%, and from 67% to 75% with Goal 5. Land-use change and socio-economic transformation in all cities conformed roughly 85% with Goal 3 in both periods. However, conformance with Goal 2 was better from 1990 to 2000 (90%) than after 2000 (70%). These findings suggest that most studied cities in Brazil have grown economically after 2000, but access to basic services has not followed the same trend. Urban growth was dominated by edge-expansion (>50%) and infill (ca. 40%) while outlining growth was scarce (ca. 8%) in both periods. The cities showed an increase in urban compactness after 2000 and thus higher conformance with Goal 4, while the value stayed rather low (30%). Indeed, we found that fast urban growth occurred mainly at the edge of the studied cities. We argue that further policies should focus on improving urban development, by regulating land prices, changing land taxation systems, improving services provision and accessibility.

## IS 3D URBAN MORPHOLOGY EVOLUTION ASSOCIATED WITH SOCIO-SPATIAL PATTERNS? EVIDENCE FROM SPANISH URBAN AREAS FOR THE PAST DECADES

Dario Domingo<sup>1,2,3</sup> · Jasper van Vliet<sup>4</sup> · Anna M. Hersperger<sup>1</sup>

<sup>1</sup>Swiss Federal Institute for Forest, Snow and Landscape Research · <sup>2</sup>University of Zaragoza · <sup>3</sup>University of Valladolid · <sup>4</sup>Vrije Universiteit Amsterdam

Urbanization is leading to major changes in urban form and socio-spatial patterns around the world, while urban planning aims to shape the built environment for human health and well-being. The increasing availability of three-dimensional (3D) information have become indispensable for the assessment of urbanization trajectories, and therefore for evidence-based urban planning. This study aims to reveal the potential of 3D datasets to characterize change in horizontal and vertical patterns of urban development and to analyse the association of urban form with certain socio-spatial patterns over time in Madrid, Barcelona, Valencia and Zaragoza.

Firstly, we developed an efficient methodology to depict current and past 3D urban forms based on a unique combination of cadastral data and LiDAR point clouds, which we use to characterize building footprint, height, and volume, at decadal intervals between 1965 and 2015. Subsequently, we characterize urban expansion and densification processes using building volume and Urban Morphological Types. Secondly, we analyse the associations between urban form and socio-spatial patterns using graphical and statistical analysis at census section resolution for the available years 2001 and 2011.

The built-up volume has considerably increased by roughly 350% since 1965, with the highest rates 1975-1985 and 1995-2005. The new developments are often located at the city outskirts or in new urban clusters, characterized by sparsely built-up morphologies which contain a small proportion of the total building volume. At the same time, city-cores have become denser and compact over time and overall, the height of new buildings has remained the same. Preliminary results show that urban form is consistently associated with marital status, the age of inhabitants and the level of education. The study demonstrates the usefulness of cadastral and LiDAR datasets to comprehensively characterize the evolution of urban morphology over time and shows how data on the evolution of urban morphology can help to understand changes in socio-spatial patterns.

## AN INTEGRATED ASSESSMENT OF ECOLOGICAL INTEGRITY AND ECOSYSTEM SERVICES IN AGRO-FORESTRY LANDSCAPES

Cristian Echeverria<sup>1</sup> · Rodrigo Fuentes<sup>1</sup> · Christine Fürst<sup>2</sup> · Luis Morales<sup>3</sup> · Roberto Jara<sup>4</sup>

<sup>1</sup>University of Concepción · <sup>2</sup>Martin Luther University Halle-Wittenberg · <sup>3</sup>Universidad de Chile · <sup>4</sup>University of Talca

Land change associated with loss and degradation of natural forests have led to negative impacts on ecological integrity (EI) and diverse ecosystem services (ES). Spatially explicit large scale modelling studies can inform spatial targeting of policies to maximise synergies and minimise trade-offs between ES under future scenarios. Significant challenges remain in developing integrated modelling approaches that adequately include comprehensive cross-scale on ES and their associated uncertainties, while addressing multiple drivers. The aim of this study was to assess the impact of land-use and land-cover change on the EI and the provision of multiple ES in south-central Chile through a spatially explicit integrated assessment approach.

Changes in the study area resulted in a greater homogenization of its land cover/land use in the period 1979-2017, mainly due to the replacement of native forests and afforestation on agricultural land and shrubland for the expansion of forest plantations of exotic species. Native forest fragmentation, mainly due to the substitution of native forests for forest plantations and fuel wood extraction, caused a severe decrease in the core areas of native forests. Over the last three decades, land cover/land use change reduced the landscape's capacity to provide thermal regulating ES by 6%. A similar trend was experienced in the capacity to provide water ES for flow regulation and drinking water quality, which decreased by 12% and 7% respectively. Restoration with native species in headwaters and riparian zones of rivers, lakes and wetlands proved to be the most favorable scenario for the provision of multiple ES, as by 2050 there would be no trade-off between the ES studied. Greenhouse gas regulation would increase by 34%, thermal regulation would increase by 11%, erosion rate control would increase by 9%. In addition, this scenario would improve the landscape's capacity to provide water regulation ES.

## VALUES OF LARGE-VERSUS-SMALL URBAN GREENSPACES AND THEIR ARRANGEMENT

Richard T.T. Forman

Harvard University

**D**oes one large park provide more, or less, value than many small parks of the same total area? Using some empirical data plus ecological principles, I compared one large park (greenspace) versus 16 small ones for air cooling, biodiversity, flood reduction, and recreation.

Based on cooling within and surrounding different-sized parks (in this case in Berlin), one large park cools the area of >70 small ones and lowers the temperature much more. For biodiversity, small parks serve as steppingstones for movement, but large ones support some interior and specialist species, provide a 'species rain' for the surrounding area, and are a food-and-rest stop for migrating birds. So, one large park is better than many small ones for cooling and biodiversity. In contrast, while a large park may have more water infiltration into the soil, many small ones have a much longer upslope edge intercepting more water runoff (which may be channelled into basins in parks). Similarly, although a large park may contain a trail network, many small parks normally have a wider range of recreation resources and are closer to and used by more urban residents. Thus, many small parks are better than one large one for flood reduction and recreation.

Furthermore, a collection of small parks may be converted into a park system, by increasing flows and movements among them. Green corridors, a row of small steppingstones, a cluster of steppingstones, a row of trees, and similar land uses on facing sides of adjacent parks facilitate interconnections.

To compare the values of large and medium-size greenspaces, adjacent to or within the urban area, major values were qualitatively recorded for parks in 27 urban areas: 9 large adjacent (or close-by) edge parks, 9 medium-size adjacent parks, and 9 medium within-city parks. The large adjacent parks had a total of 19 values (mean 4.6), medium adjacent 23 (mean 3.8), and medium within 6 total (mean 2.6). Within-city parks overwhelmingly provide recreation, tourism, and socio-cultural values. Medium and large edge parks adjoining the urban area also provide a wide range of additional values.

In brief, one large park and many small parks both provide important, but different, values. An optimum design or arrangement maintains one large park and many small ones in a small-to-medium-sized city, and in each major section of a large city. Several designs encourage flow among parks, converting a collection into a park system. Medium/large parks within a city provide the same few values in different cities, whereas medium/large parks by the urban edge provide many more values, and differ greatly from city to city.

## LANDSCAPE MANAGEMENT PLANNING IN PROTECTED AREAS OF LITHUANIA: PRESENT CHALLENGES AND LEARNING FROM THE PAST

Zenonas Gulbinas

Nature Heritage Fund, Vilnius

Lithuania has experienced enormous and rapid social and economic changes in the last 30 years. The following processes have had the most impact on the state of protected areas (PAs): land reform and related processes, the development of constructions, intensified use of forests, growth in recreational use, previous landscape damages. The aim of this study is to present experience of more than 20 years of landscape planning in PAs within changing environment and new cycle of updating of territorial planning documents for PAs in Lithuania. Questions addressed:

1. What kind of planning instruments could be used in PAs to achieve sustainable landscape management?
2. Could landscape management planning and implementation of approved management plans for PAs be one of the key issues for land management governance strategies?
3. How land use conflicts among diverse institutional actors, different stakeholders, and local people acting in PAs be solved?

Two methodological approaches – functional zoning and landscape management zoning – are used in preparation of planning documents for PAs in Lithuania. Delineation of functional priority zones for territorial complexes is used in preparation of plans of boundaries of PAs and their zones while designation of landscape management zones intended for regulation of landscape protection and use and their regulations, define directions of and measures for the protection and management of landscape territorial complexes and objects, also landscape formation, development of recreational infrastructure and other management measures. Designation of landscape management zones in PAs could serve as specific spatial typologies with some similarities and differences in preparation of management plans for PAs.

After the restoration of the Lithuanian independence, in 1991-1992 the establishment of a system of national and regional parks was completed, in 1993 the functional zoning schemes for state parks were prepared and approved. Nevertheless, preparation of management plans for PAs took longer period and the last management plan was approved only in 2013. Now a new cycle of updating of territorial planning documents for PAs is ongoing. Stages of the process of special planning: public awareness and collection of planning conditions; analysis of current situation; preparation of draft plan; assessment of impact of solutions; public discussion and approval. No changes have occurred in the planning stages but planning process itself experienced new challenges so main influencing factors could be distinguished: changes in land use and ownership, also in public information and participation process, integration of ecological network Natura 2000 and cultural heritage issues to the landscape planning, harmonization of planning documents at various levels. The last current challenge is the development of the network of PAs of Lithuania through the landscape planning in the context of European Green Deal.



## RURAL FIRE PREVENTION: AN INTEGRATED LANDSCAPE PLANNING SOLUTION

Manuela Magalhães · Selma B. Pena · Natália Cunha · Ana Müller · Inês Adagói · Luísa Franco

University of Lisbon

The transformation of the Portuguese landscape since the 20th century led to the increased presence of rural fires. The traditional multifunction landscape that integrates agriculture, extensive shrublands, and forestlands (*ager-saltus-silva*) is disappearing. Consequently, and together with the increase of fire risk, there is a loss of different fundamental ecosystem services. Therefore, it is urgent to create an integrated landscape planning solution to deal with rural fire and ecological sustainability.

This work aims to present the FIRELAN model, an ecological-based planning model developed in a Geographic Information System that articulates the ecological and cultural components with a suitable and multifunction land-use plan. The model was developed considering the river basin as a spatial land use planning unit. It is constituted by the FIRELAN Network (FIRELAN N) and the Complementary Areas (FIRELAN CA). According to the ecological land suitability, the FIRELAN N defines a network of native species and agriculture areas, providing a multifunctional landscape and restoring the concept of familiar agriculture near the settlements. This network will ensure the effectiveness of discontinuities in the landscape with less combustible land-uses. On the other side, the FIRELAN CA includes the remaining areas for a wide variety of land-uses, including fast-growing species, such as eucalyptus or maritime pine.

The FIRELAN model is applied to five case studies from the Centre region of Portugal: Leiria, Pampilhosa da Serra, Figueiró dos Vinhos, Pedrógão Grande, and Castanheira de Pêra. Comparing the FIRELAN model application with the current land use and land cover allowed the conclusion that the landscape needs to change drastically to achieve resilience. This tendency is even higher when steep slopes and dominance of eucalyptus and maritime pine are combined characteristics.

The results contribute to the discussion of landscape transformation through policy change and restoration actions, in which ecological landscape planning can provide meaningful contributions.

## BUILDING ON THE PAST PLANNING CONCEPTS AND EXPERIENCES – MAKING THE FUTURE OF RESILIENT CITY. GREEN INFRASTRUCTURE IMPLEMENTATION IN WARSAW

Gabriela Maksymiuk · Renata Giedych · Agata Cieszewska

Warsaw University of Life Sciences

**E**volution of discourses and shifting paradigms result in changing planning concepts or management in cities. These processes are true irrespectively from planning traditions and systems worldwide. In recent years, several planning concepts aimed at maintaining and enhancing green spaces in cities have been applied, e.g. ecological networks, ecological land use complementation, or green infrastructure (GI). The concept of green infrastructure is now considered as one of the key notions in regards to sustainable development at regional and city/local scale and in shaping urban environments through the delivery of ecological services. It is worldwide recognized as an important urban planning instrument.

The aim of presented research is to review and evaluate how the past planning concepts and ideas paved the way for the GI concept implementation in Warsaw. Basing on the review of literature and planning documents, we identified and analyzed various concepts, instruments and measures relevant to green infrastructure. In our study we focused on concepts that mattered for the quality of life in cities, and which related to enhancement of urban areas functioning. The studied concepts and measures in a broader sense followed GI principles.

The performed study allowed us to identify two main approaches / ways of classifying the concepts and measures: (1) those, which are not applied anymore, but their results are still evident in urban fabric, e.g. the green wedges concept, or application of green spaces development standards, and (2) those that are still present in planning practice, e.g. urban natural system, or application of Ratio of Biologically Vital Area (RBVA). On the canvas of identified concepts and ideas, we also studied planning documents, urban studies and policies that can advance GI implementation in Warsaw. The study included mainly Warsaw Study of Conditions and Directions of Spatial Development (2006, amended several times till 2021), environmental study elaborated in a form of Eco-physiographic Atlas (2018) and a project assumptions for a new Warsaw Study of Conditions and Directions of Spatial Development (2021).

Our studies let us point out that the rich traditions in regards to ecological networks and green spaces planning concepts advanced the GI concept implementation in Warsaw.

## ACTORS' INVOLVEMENT FOR ECOSYSTEM-BASED COASTAL PROTECTION: A DIGITAL APPROACH TO SOCIAL NETWORK ANALYSIS

Evke Schulte-Guestenberg · Leena Karrasch

University of Oldenburg

**F**acing impacts of climate change, innovative approaches are needed to analyze governance processes and the socio-ecological system of coastal areas. Ecosystem services are rarely integrated in coastal protection management, even though the approach provides opportunities to strengthen coastal protection. By analyzing relationships in social networks, awareness can be promoted to develop innovative ecosystem-based coastal protection measures. Our research question is, how the actor constellation influences decision making processes and which actors are important in coastal protection management to facilitate integration of ecosystem services into planning processes?

We conducted an egocentric qualitative social network analysis using an adapted and digitalized Net-Map approach. Together with actors from different fields of action, including coastal and environmental protection, tourism, and local and regional planning, the networks were drawn on a digital whiteboard. Simultaneously, we conducted semi-structured interviews to examine their role in coastal protection management. Furthermore, we analyzed the actor constellation, including their interests and influence, synergies and conflicts as well as formal and informal connections to understand decision-making structures. 17 egocentric social network maps were consolidated to show the overall coastal protection management network.

Our results show that coastal protection is a traditional field and governance structures evolved over centuries. Innovative approaches such as ecosystem-based coastal protection receive little attention. The network analysis indicates that beside formal cooperation, informal collaboration on local and regional level is fundamental in coastal protection management. The implementation and maintenance of measures is often concentrated on local level. Actors belonging to different fields of action are more often incorporated in coastal zone planning to find a joint solution and their involvement is perceived as first step to deal with climate change effects. These actors from other fields of action perceive their incorporation as insufficient in order to develop innovative approaches. Understanding the actor constellation makes it possible to better comprehend decision making processes. Even if the involvement of actors from other fields of action and cooperation processes become more common, coastal protection is still locked in traditional thinking. Actors' involvement is crucial to develop innovative approaches incorporating ecosystem services in coastal protection management. The network analysis shows which actors are relevant and need to be involved to consider ecosystem-based coastal protection in planning processes and lead to acceptance by civil society. In a next step, the actors' perceptions of ecosystem services are identified to ascertain how the ecosystem service approach can be incorporated to establish an ecosystem-based coastal protection.

## WIND ENERGY AND LANDSCAPES – CHALLENGES IN APPLYING MULTI-CRITERIA ANALYSIS FOR PLANNING SUPPORT

Deepa Manolan Kandy · Ulla Mörtberg · Vincent Wretling · Berit Balfors

KTH Royal Institute of Technology

**W**ind energy plays a vital role to meet growing energy needs and to replace non-renewable energy sources to reduce greenhouse gas emissions. Sweden has set the goal of 100% renewable electricity by 2040 with a major share coming from wind energy. In this context, Sweden has a national strategy for sustainable wind power development, with suggested development shares for each region. However, wind power comes with a multitude of environmental impacts, not at least in a landscape perspective, affecting, among other, social and biodiversity aspects. Residential areas and outdoor recreation areas may be affected by noise and visual impacts, and biodiversity-related impacts concern e.g., collision risk for certain bird and bat species, and risk for loss and fragmentation of habitat such as old forest and wetlands. Therefore, wind power planning face major challenges and there is a need for systematic planning support, integrating scientific knowledge and stakeholder valuation. The REWIND project aims to develop GIS-based methods based on multicriteria analysis (MCA) for sustainable wind power planning. We focus on capturing and integrating tools like green infrastructure and viewshed analyses, among ordinary more technical or legal analyses and constraints.

In the case study of Västernorrland, stakeholders are engaged in the main MCA steps, the design step with factor selection, treatment, and aggregation, as well as weighing, and the evaluation step. Preparing this, to gain credibility, we analyse not only scientific literature but also existing planning documents and legal judgments in order to find relevant factors and their treatment and valuation. In the process of factor modelling, we build the REWIND-GIS model in Python for ArcGIS where factor parameters can be easily altered so that a wide array of uncertainties can be tested, such as graded safety distances to breeding sites of sensitive bird species. Another type of uncertainties is introduced in the weighing process. From the model testing of all these versions, we arrive at several scenarios for suitable sites, to be evaluated. Remaining conflicts that are inevitable also in the most suitable sites are quantified and mapped. The evaluation and ranking of alternatives can then use the original factors and conflicts, while adding also new emerging that are spatial or non-spatial. The treatment of green infrastructure analyses in this process is highly uncertain and several approaches was tested.

Through the systematic and transparent approach, planners have various options to choose from the decision space with improved understanding about the trade-offs in a quantified manner. REWIND bridges the knowledge gap in treatment of diverse factors and their performances spatially, through development of the transferable REWIND-GIS tool. The results will be a method for sustainable wind power planning on regional level, considering main sustainability aspects.

## A LANDSCAPE ASSESSMENT IN A RURAL – NATURAL REGION OF NATURA 2000 PROTECTED AREAS IN PELOPONNISOS (GREECE)

Ioannis P. Kokkoris<sup>1</sup> · Danae Androulidaki<sup>1</sup> · Eleni S. Bekri<sup>1</sup> · Maria Stefanidou<sup>1</sup> · Giorgos Mallinis<sup>2</sup> · Panayotis Dimopoulos<sup>1</sup>

<sup>1</sup>University of Patras · <sup>2</sup>Aristotle University of Thessaloniki

Rural and natural areas' alteration form unique landscapes in terms of biodiversity, aesthetics, and socio-economic activity. Protected areas, designated for biodiversity conservation, include also rural, agricultural and agroforestry units, especially in countries where the landscape approach has been followed when designing their boundaries. In this case, cultural and natural elements have been intentionally included to impose conservation management measures and actions on both human use and natural capital. This type of approach has been followed in the designation of the Natura 2000 sites in Greece. The present study deals with the landscape diversity inside Natura 2000 protected areas in Peloponnisos, Greece, where significant land use and land cover transformations occurred during the last decades, mainly due to the post-Second World War development approach, especially for agriculture, rural development, and tourism. This study aims to: (1) map natural and human induced areas for the year 1945 and present day, (2) assess structural characteristics of habitat types of community importance that are severely degraded (i.e., wetlands, floodplain forests, coastal habitats), (3) assess the ecosystem condition, and (4) provide recommendations to support management and policy decisions for protected areas, in order to protect biodiversity and ecosystem services, under the complex socio-cultural, rural environment.

Earth observation (EO) data were used to assess ecosystems extent in 1945 and present day and identify: (a) changes in ecosystem extent, (b) changes in structural characteristics, (c) spatial diversity of land use / ecosystem types, (d) land use patterns, and (e) land use trends. A GIS-based analysis is used to provide spatially correlated results and to create relevant thematic maps. The guidelines for the Mapping and Assessment of Ecosystems and their Services implementation in Greece, as drafted by the LIFE-IP 4 Natura project, have been followed to develop relevant indicators for ecosystem condition and ecosystem services assessment, while the System Of Environmental Economic Accounting – Experimental Ecosystem Accounting approach is used to provide a baseline for natural capital accounting, under the consultation and lessons learned from the MAIA Horizon 2020 project.

Main results highlight the severe degradation of the coastal wetlands and the riparian ecosystems, and their transformation to agricultural land. Significant changes are also identified in the river route of the area's major river and its delta. Tourism seems to be the prevailing trend on land use change at the coastal area. These results are supported by structural degradation findings provided via the EO data analysis. An accounting table for ecosystems' extent and condition has been drafted based on 1945 and present-day results. Study outcomes provide an evident based support to management and policy decisions and suggest an integrated management approach that will consider management and climatic scenarios, to develop resilience on both natural ecosystems, rural areas and the socio-economic environment.

## GREEN CITY OF THE FUTURE – INTEGRATING CLIMATE-ORIENTED MEASURES INTO PLANNING PROCESSES

Simone Linke<sup>1</sup> · Andreas Putz<sup>2</sup>

<sup>1</sup>Technical University of Munich · <sup>2</sup>City of Munich, Planning Department

**G**reen infrastructure is crucial in the adaptation of cities to climate change. Through various ecosystem services, it contributes to a regulating effect during periods of heat and heavy rainfall events. However, especially in growing cities, securing and further developing green infrastructure is a difficult task: housing needs and transport infrastructure are just two of the many land competitions in dense cities. The research project “Green City of the Future – Climate-Resilient Neighbourhoods in a Growing City” aims, among other objectives, to examine instruments and processes for possible windows of opportunity for climate adaptation and mitigation measures in cities with enormous land pressure and to analyse obstacles. For this purpose, administrative staff from the city of Munich as well as other experts from various disciplines were interviewed, workshops were held, and the methodological procedure of the living labs approach was followed.

The selected living labs are urban neighbourhoods of the City of Munich that differ in their urban location, building structure and density, type of use and sociodemographic characteristics, and are each undergoing different planning processes. Thus, the planning steps could be supported scientifically, and first implementations could be carried out through newly acquired knowledge.

In the context of the surveys conducted, concrete windows of opportunity for integrating green infrastructure into the various planning instruments were identified. In summary, it can be stated that climate-oriented frameworks are crucial, especially in early planning phases. Furthermore, a holistic, interdisciplinary approach as well as consistent implementation throughout the individual phases in the planning process are of great importance. The results show that many barriers to the implementation of green infrastructure can be overcome by incorporating climate adaptation and mitigation aspects into urban planning processes at an early stage.

The work in the living labs was optimized through the scientific support and cooperation of the various research partners. Extensive findings were created and implemented in ongoing planning processes, e.g., in planning competitions. Here, competition texts were adapted to the requirements of climate change, suggestions for possible planning participants with climate competence were considered, and the participation of scientists in the preliminary discussion with the jury, the preliminary examination, and the colloquium of questions was made possible. Even though the research project could only be active in selected living labs, integrated and transferable recommendations for action in planning practice were developed, which can accelerate further transformation processes in urban and open space planning beyond the living labs – entirely in the sense of mainstreaming.

## TOWARDS A 'GLORIOUS MOMENT' POLICY APPROACH? WHAT WE CAN LEARN FROM THE MULTIPLE STREAMS FRAMEWORK FOR ACHIEVING SUSTAINABLE LANDSCAPES

Gerd Lintz

Leibniz Institute of Ecological Urban and Regional Development

**G**iven the negative development of landscapes and the continuous decline in green open space, innovative approaches for integrating landscape concerns into policy and planning are needed. So far, however, approaches from political science have not been widely adopted in the landscape policy and planning domain. The Multiple Streams Framework (MSF), one of the leading policy analysis approaches, may provide a bigger picture of why policies have often failed as well as of how policies to protect landscapes and to stop open space consumption could be improved.

The MSF postulates that a significant policy change (here: in favour of open space protection) can only happen when three streams, which show their own dynamics, converge in a policy window: the problem stream, the politics stream, and the policy stream. Problems are real states or developments perceived as deviating from the desired states or developments. They compete for the policymakers' attention, e.g., through indicators or focusing events (disasters etc.). The politics stream reflects the predisposition of the current competitively elected decision-makers regarding green space policies, the influence of interest groups and the mood of the population. The policy stream consists of competing ideas about how to solve problems. The ideas and measures are developed in policy communities which includes landscape and spatial planners.

So, according to the MSF, a significant change towards more effective open space policies can only be expected, when (1) there is a strong problem pressure regarding green space, (2) policymakers have a favourable propensity for open space policies, are positively lobbied by environmental interest groups and perceive a favourable public mood, and (3) an open space policy exists which the policymakers find promising. Kingdon also highlights the role of the policy entrepreneur who tries to convince policymakers to adopt a specific policy to solve a specific problem. In contrast to the still significant idea of rational policymaking, the MSF may appear frightening because there is room for individual (bounded) rational behaviour, but in the end, policymaking is highly dependent on chance, on the occurrence of – as it could be called – a 'glorious moment'.

The presentation introduces the MSF and derives first thoughts about possible actions and measures which may improve landscape and open space protection. On one hand the analysis of policymaking based on the MSF is quite sobering for all engaged in transition to sustainable development. But on the other hand, a more realistic picture might help to better endure slow progress. Furthermore, it can encourage all willing actors to strive to achieve improvements in all the three streams and support the coupling of these streams. Then, provided the required bit of good fortune, glorious moments for sustainable landscapes may be witnessed.

## MULTIPLE ECOSYSTEM SERVICES MODELLING AND MAPPING FOR FRIULI VENEZIA GIULIA REGION (NE ITALY) PLANNING

Valentina Olmo<sup>1,2</sup> · Giovanni Bacaro<sup>1</sup> · Erika Kosuta<sup>3</sup> · Maurizia Sigura<sup>2</sup>

<sup>1</sup>University of Trieste · <sup>2</sup>University of Udine · <sup>3</sup>Region Friuli Venezia Giulia

**E**cosystem services (ESs) mapping and quantification is considered a key resource for policy support and decision making. Friuli Venezia Giulia Region (NE Italy) has recently expressed the interest to evaluate its natural capital from a ESs point of view to address novel planning strategies. In this light, we developed a pilot framework for integrating ES concept in the regional planning. In the first phase we presented the ES concept to regional decision makers and starting from the available information on nature-based potential two ESs were selected for quantification. Secondly, we quantified and mapped the selected ESs through transferable modelling frameworks. In the third phase (in progress), the developed contents, integrated to show synergies and trade-offs, were discussed in relation to land management and environmental strategies.

In this study we present the second step of the framework, which correspond to the quantification and mapping of the two ESs, namely carbon stock and recreation, in Friuli Venezia Giulia Region (NE Italy). Carbon storage and recreation ESs were chosen to address territorial strategies for climate change mitigation and support of societal values provided by ecosystems in terms of life-quality and wellness. The InVEST carbon model was used to spatialize literature and regional data of carbon stocked in four pools (aboveground, belowground, in soil and in litter) using as a reference layer the Corine Biotopes map. ARIES recreation model functions and data were customized and employed to model nature-based recreation: supply was computed through a multiplicative function of naturalness and the distance-driven accessibility of natural elements, and demand was computed through an additive function of population density and recreation-driven mobility. The abovementioned layers were aggregated to highlight synergies and trade-offs.

Carbon stocked in biomass was associated to the northern forested area of the region, with highest values occurring in silver fir and spruce forests, while soil C maxima were found in plain plantations where active management facilitate C retention. Recreation supply was high along plain riverbeds, in the Alps, in lagoon wetlands and in the karst, while demand was high in the surroundings of provincial capitals

In conclusion, this framework is triggering ES concept integration in the next regional planning programs. The presented research provided for the first time an advanced, intuitive and reproducible informative content to open a discussion about land management and environmental strategies, associated to an agreed key to understanding.



## IDENTIFICATION OF DIFFERENT PATHWAYS BASED ON FLOOD-RELATED CHALLENGES AT DIFFERENT WATERSHED SCALES IN GERMANY

Pinar Pamukcu-Albers · Mariele Evers · Katharina Höreth

University of Bonn

The UNESCO Chair Human-Water Systems at the University of Bonn focuses on both, the complexity of the impact of anthropogenic and climatic changes on hydrological processes and consequences as well as on the impact of flood-related challenges on human well-being and quality of life. In this context, it is essential to identify interlinkages, coupled systems, feedback loops and sensitivity parameters of the human-water systems and to understand and explain past changes to assess future expectations.

There have been changes in climate and land use along with increasing hydrological challenges (water demands, flooding, and flash floods) at different scales. To better understand these challenges in human-water systems and the approaches implemented at different scales the watersheds of Elbe river and Mehlem creek with its flood-related challenges were determined. Elbe river provides insides on management approaches of a whole watershed, while Mehlem creek watershed is part of Rhein river watershed and therefore gives insides on a smaller scale. In order to find out 'past' and 'current' short-middle-long term- challenges and solutions as well as to identify different pathways for the future, in Elbe river watershed, flood-prone areas as hotspots were determined, while in Mehlem creek watershed, flash floods and structural measures in flood management were considered.

The results from this preliminary study showed that an integrated approach which social, economic, and ecological aspects were taken into account is important to define 'flood vulnerability' at both scales. In the later stages of the study, abovementioned actions will give us the opportunity to see the impacts of floods on environment and human particularly who are living in flood-prone areas using interconnections and nodes between Sustainable Development Goals (SDGs) and ecosystem services (ESs). This will let us to contribute SDGs and improve ESs within the frame of climate change mitigation actions/measures, while we can identify different pathways that can be taken to achieve sustainable human well-being and natural environment and tackle climate change based on current (and future) flood (risks).

## FRAMING HOW A MOUNTAIN LANDSCAPE CHANGES IN THE LONG TERM BY FOCUSING ON LAYERED SOCIAL PROCESSES AND DEEPER CAUSES

Margherita Pasquali · Rocco Scolozzi

University of Trento

**T**he Anthropocene is a geological epoch where the human-induced impacts can be traced in the Earth's geology. In this actual context, we should reconsider human economies and technologies as hybrid phenomena interlacing biophysical resources, cultural perceptions, and global power structures. Economy, technology, perception, power structure are all social processes affecting the landscapes, which are complex, interdependent, and layered.

Causal Layered Analysis (CLA) is a theory of knowledge and a methodology CLA that works at several levels, delving deeper than the data level of reality (called 'litany level') to reach a systemic-level understanding of its root causes. Below that level, CLA goes further, searching for the 'worldviews level' or stakeholder views on studied issues. Finally, it unpacks the deepest levels of social reality ('metaphors and myths'). Each subsequent level below reveals a deeper cause. The layers are not simply analysed separately but explored by a movement back and forth between them. CLA, by creating scenarios from changes at deeper levels, can be used for support strategies and visions of alternative futures. We propose to combine this paradigm with landscape ecology tools in the study of peculiar landscapes, 'extreme territories': marginal hinterlands, where the natural and anthropogenic resources and risks are maximal.

The abstract presents a preliminary CLA analysis to the applicative case of Val di Rabbi, an 'extreme territory', in the Italian Alps. Images of the future are divided into the four levels of the CLA. Two variables are chosen to test CLA on the applicative case: population (P) and local tourism (LT).

The litany level identifies declining for P; unstable tourism flows for LT. The system/social causes level identifies ageing and remoteness for P; whereas lack of public services and an oscillating demand for LT. At worldview level, technological needs and distance from urban services (P); and, cultural identity within changes from long-stay tourism to 'fast and consumerism experience' (LT).

A set of plausible scenarios are depicted by framing changes within the deeper levels: considering at the worldview a prevalence of 'balance of wireless working and offline' in the way of living in mountain areas (P) and 'slow and sustainable tourism' in the nature-based tourism (LT). These would imply changes at higher levels, for example: at the system/social causes higher demand for digitalization of public services (P) and for diversified creative experiences and services (LT).

Overall CLA is not predictive model but rather a speculative tool that helps to investigate the changes in a territory more explicitly future-oriented. In addition, framing landscape change by CLA can help a community to better specify desirable futures, reliable with deeper cause of changes. This can be crucial to design Planning and Policies that act on the social-ecological system.

## A COMPARATIVE ANALYSIS OF THE EVOLUTION OF LANDSCAPE PROTECTION SYSTEM IN APULIA (IT) AND WALLONIA (BE)

Lauriano Pepe · Serge Schmitz

University of Liège

In response to the numerous and rapid changes that our landscapes are undergoing, a growth of protected areas, diversified in number, size, and type, has appeared over the last decades, so that today, landscape protection relies on a multitude of protection tools (Brown et al., 2005). Based on a mixed method including analysis of legislative and strategic documents and semi-directed interviews with active landscape stakeholders, our communication proposes a comparative study of the evolution of the landscape protection systems implemented in Apulia (Italy) and Wallonia (Belgium) – two regions where the word ‘landscape’ has the same root (pay-), but whose cultural traditions and the processes of territorialization and anthropization that have affected these regions have led to development of different policies and instruments to protect the landscape. The analysis aims to better understand how the landscape is defined and taken into account in these laws and protection tools.

In both regions, landscapes are protected through several national and regional laws that were created in particular historical contexts. These various laws reflect the richness of meanings that have been given to landscapes. First, the aesthetic interest of landscapes was promoted in the laws defined in the first half of the 20th century. Then, the protection was extended to exceptional natural goods, leading to the designation of landscapes to be protected for their aesthetic, natural, and even historically exceptional values. At the beginning of the 21st century, the European Landscape Convention led the different signatory countries to broaden their own definition of landscape and to adapt landscape policies (notably their protection policies).

Our comparative analysis shows that, despite somewhat different regional protection systems, both in Apulia and in Wallonia, we observe a growing interest in overcoming the protectionist and static vision of the landscape (characterized by a passive regulation of constraints) that has shown strong weaknesses. Tools such as ‘Piano Paesaggistico Territoriale’, ‘Parco Agricolo Multifunzionale’ in Puglia, ‘Charte Paysagère des Parcs Naturels’ or ‘Grand Site Paysager’ in Wallonia reflect a more integrated approach for these landscapes of regional concern. However, due to diverse and sometimes divergent interests, changing the perceptions of local populations, politicians, landowners, and the private sector on protected areas remains a major challenge. This lack of awareness leads to a dominant restrictive vision of the landscape and, finally, to a weak implementation of actions or projects that could draw a series of benefits from the protected landscapes.

Brown J. et al. (Eds.) (2005). *The protected landscape approach: linking nature, culture and community*. Gland, Switzerland and Cambridge, UK: IUCN.

## COLLABORATIVE PLANNING AS A LANDSCAPE APPROACH. EXPERIENCES AND INSIGHTS FROM EXPERIMENTAL RURAL LANDSCAPE PROJECTS IN DENMARK

Jørgen Primdahl · Lone Søderkvist Kristensen

University of Copenhagen

The notion of applying a 'landscape approach' to integrate different policy domains through collaborative processes has been outlined and discussed in recent papers. Although there is no single definition of a landscape approach it is often associated with interventions trying to balance competing land use demands to satisfy both ecological and human demands. A landscape approach therefore focusses on creating solutions, including different objectives e.g, livelihood, food production, nature restoration, climate changes, protection of natural resources and rural developments goals. In this paper, we present our experiences and insight gained through more than 20 experimental projects with landscape strategy making and shows how landscape strategy making represent a useful way to bring the different dimensions of a landscape approach together. We present a framework for locating landscape strategy making in an institutional context, for organizing the process, and for structuring the strategy.

With references to the literature and specific examples from these projects, we focus on three key aspects of landscape strategy making: (1) The landscape as a socio-ecological entity: how to bring the landscape in question in place as the pivotal point of strategy making. This requires a common understanding of the landscape and an interest in its future among a broad range of stakeholders. (2) Collaboration: how to organize collaboration between the key stakeholders. This aspect concerns considerations about which persons and organisations to include, how to create fora for and facilitate dialogues, debates, and meditations, and how to use the landscape as an arena for discussions and collaboration. (3) Solutions: how to frame the strategy into a coherent and convincing document which includes visions and goals for the future landscape, spatial principles to guide land use decisions, and a handful of strategic projects to initiate agreed developments.

In all these three aspects knowledge and expertise are crucial issues to consider. What and who's knowledge and expertise are needed? How may difficulties of working across disciplinary boundaries be overcome and how are systematised knowledge (expert knowledge) and experiential knowledge (local and practical knowledge) brought together and eventually linked to action?

We close the paper by discussing the potential role of rural landscape strategy making may have as a pathway to realize a landscape approach in a European context. This discussion will incorporate reflections on how sectoral policy implementation concerning climate change, biodiversity conservation, outdoor recreation, and rural development may be joined with local and regional stakeholders' interests including owners and users of the landscape in question.

## GAPS IN MINE CLOSURE POLICIES IN INDIA AS PER PILLARS OF JUST TRANSITION

Amrita Kaur Slatch

RWTH Aachen University

**M**ining is a temporary use of the land (Robertson et al., 1998). Stockholm Environment Institute (SEI) has noted that mining and its closure leaves behind degraded land and environmental contamination of the surrounding region. It is therefore suggested that coal mining regions across the world require careful mitigation of its impacts post closure. Because the global coal mine industry has shifted from West to East, the report highlights that in the future, coal mine closures and associated job losses will be concentrated in Asia. China, India, and Indonesia the top three coal producers will be affected the most by these closures. In India the coal industry is associated with significant social and environmental impacts due to open-cast large scale mining. Issues relating to displacement, rehabilitation and resettlement have been a consistent problem for the coal industry. Also, coal reserves in India are located in heavily forested parts of the country which were primarily inhabited by tribal communities. Thus, the displaced local communities surrounding the projects suffer from local environmental impacts of mining activities including – water scarcity, water pollution, air pollution, deforestation and impact on agriculture, human health etc. leading to loss of livelihood (Chikkatur, Sagar, 2007). A common theme for most mines is that landscape performance goals are poorly defined. There are few broad policies which are not specific enough to provide enough direction and there are numerous undeclared goals (Mc Kenna, Dawson, 1997). The World Bank's global initiative Support to Energy Transition in Coal Regions, considers broad energy, economic, social, and environmental objectives. World Bank lessons learned: (1) greater emphasis should be placed on re-skilling, retooling and repurposing human/ natural and physical capital that has built up over decades in coal regions, and (2) greater need for private sector investments within public-private partnerships and stand-alone project financing. The paper investigates the gaps in Mine closure policies in a developing country India as per pillars of Just Transition as suggested by the World Bank.

Chikkatur A.P., Sagar A.D. (2007). *Developing better policies for the sustainable development of the Indian Coal Sector*. PAPER – Energy Technology Innovation Policy Project, Belfer Center.

Mc Kenna G., Dawson R. (1997). *Closure planning practice and Landscape Performance at 57 Canadian and U.S. Mines*. British Columbia Mine Reclamation Symposium. Vancouver: University of British Columbia Library.

Robertson A.M. et al. (1998). *Post Mining Sustainable Use Plans vs Closure Plans*. British Columbia Mine Reclamation Symposium. Vancouver: University of British Columbia Library.

## INTEGRATING HUMAN-ECOLOGICAL DIMENSIONS INTO URBAN GREEN INFRASTRUCTURE PLANNING

Catarina Patoilo Teixeira<sup>1</sup> · Cláudia Fernandes<sup>1</sup> · Jack Ahern<sup>2</sup> · João Honrado<sup>1</sup> · Paulo Farinha-Marques<sup>1</sup>

<sup>1</sup>University of Porto · <sup>2</sup>University of Massachusetts

**R**apid and profound shifts in urban ecosystem patterns and configurations can threaten cities' livelihood and originate multiple challenges that demand urgent response and action. Urban landscape transformations have also contributed to the emergence of unprecedented plant species assemblages (mixtures of native and non-native species) resulting from complex and prevailing interactions between human and ecological dimensions in urban environments. There is a growing interest in studying novel ecosystems, their origin, dynamics, and societal roles, particularly in urban contexts. This way, we argue that the assessment of urban ecological novelty and the integration of this concept into urban green infrastructure planning and management is pertinent and necessary. This research aims to present a new working methodology to assess and map ecological novelty in urban areas and to reflect on the role that urban green spaces with distinct degrees of urban ecological novelty can play in the urban green infrastructure regarding current challenges that urgently need to be addressed (e.g., urban green infrastructure connectivity, climate change adaptation, and mitigation, biodiversity conservation, social cohesion).

In this methodology, the human dimension is explicitly considered a fundamental component in the measurement of novelty, alongside the biotic dimension of the concept. Thus, we evoke an innovative, holistic, and integrative vision of the urban environment by exploring both human and ecological spheres. The new methodology was tested in the city of Porto, Portugal, considering study sites from three types of urban green spaces: urban woodlands, parks and gardens, and vacant lands. The application of the methodology allowed positioning the green spaces in a continuum of urban ecological novelty.

In general, vacant lands showed higher urban ecological novelty, parks and gardens occupied more intermediate positions in the continuum, and urban woodlands showed lower urban ecological novelty. Nevertheless, it was also possible to verify that the degree of novelty does not always depend on the type of urban green space under evaluation. The presence of urban green spaces with different degrees of ecological novelty contributes to the diversity, multifunctionality, and resilience of the urban green infrastructure. In addition, the degree of urban ecological novelty may entail different planning and management goals that will determine the urban green infrastructure's social-ecological resilience and how prepared it will be to respond to adverse environmental impacts. Novel combinations of species are already thriving under the cities' harsh conditions, suggesting that they may be better prepared to face change in its various forms. Ultimately, the assessment of urban ecological novelty will be useful to inform decision-makers and assist the integration of uncertain and intricate environmental challenges into the planning and management agendas.

## HIDDEN INCENTIVES AND IMPACTS OF LAND POLICIES – THE CASE OF THE CZECH LAND VALUE CAPTURE MODEL

Eliška Vejchodská

J.E. Purkyně University in Ústí nad Labem

The Czech land use planning system has recently taken a brand-new approach to land value capture, i.e., utilising a part of the increments in land value external to the landowner's efforts for public purposes. Two new instruments have been adopted. One of them allows municipalities to condition new development by planning contracts with developers, the second one to charge landowners for land value increments generated by the change of land use plan. With these instruments, the Czech planning undertook a big step towards more robust opportunities for land value capture.

Nevertheless, the authors of the new law did not sufficiently consider the hidden incentives of actors in land development these new instruments bring. Therefore, they did not consider adverse side effects that the new instruments might cause in terms of the effectiveness of land value capture or the effects of these instruments on land conversion.

This contribution aims to bring attention to the possible incentives and side effects resulting from the hidden incentives created by land policies. It conceptualises a possible approach of policymakers for the search of potential incentives to consider them when designing a policy. Methodologically, it builds on the Institutional Analysis and Development framework developed by Elinor Ostrom, relevant parts of which will be applied to the new Czech land value capture instruments.

# *Green infrastructure as socio-ecological systems: governance for the common good*

## **Symposium organisers**

*Isabel Loupa-Ramos* (University of Lisbon), *Werner Rolf* (Technical University of Munich)

## **Summary**

This symposium aims to reflect on research and practice about green infrastructure (GI) planning with a focus on governance arrangements and how it contributes to transformative action towards sustainable development of cities and beyond. Building on the concept that humans are part of nature, addressing GI as a socio-ecological system enables to explore a broader set of relationships between pattern and processes and people and action. We expect to follow up sound science-based evidence on the GI concept, highlighting linkages and knowledge gaps, and to shape the research agenda further to enhance GI planning.

## **Description**

Since the EU GI Strategy as adopted in 2013, GI planning has gained attention on the policy agenda. Further momentum is given by the European Green Deal by envisioning transition towards sustainability. Also, the Territorial Agenda 2030 and the reviewed Leipzig Charter call for novel approaches to multi-level governance that can promote territorial coherence and cohesion.

Understanding that besides 'government' and public policies, there is also 'governance' as the interactions through which government, other public bodies, private sector, and civil society participate, aiming at solving societal problems and creating societal opportunities. Therefore, gathering experiences from regions with different planning cultures provides valuable insights and enables exploring alternative governance arrangements.

Building on the concept that humans are part of nature, addressing GI as a socio-ecological system enables to explore a broader set of relationships between pattern and processes and people and action. In this regard sound science-based evidence is required to inform GI planning promoting inclusive planning processes and address the question on how the common good can be equally available to all, both in space and time, promoting better ecological livelihoods.

We expect to follow up on the gained knowledge and experience on the GI concept of the past years in this regard, to highlight linkages and knowledge gaps, to shape the research agenda further to enhance GI planning.

The following questions are of interest in this regard:

- Who are the stakeholders? What are their interests in GI?
- How does landscape stewardship effect/impact GI planning?
- What policy framework across sectors is suitable for GI planning?
- What is the role of regulations and funding structures?
- How can GI contribute to bridging the 'urban/rural divide'?
- Which governance arrangement are effective to trigger transformative action?



## GOVERNANCE OF DENSIFICATION AND CLIMATE CHANGE ADAPTATION: HOW TO SOLVE CONFLICTING DEMANDS FOR DENSIFICATION AND GREEN SPACE?

Sabrina Erlwein · Juliane Meister

Technical University of Munich

**G**rowing municipalities face conflicting demands for densification and urban green space. On the one hand, green infrastructure is recognized as a nature based solution for climate change adaptation: urban green spaces reduce urban heat loads and promote human well-being. On the other hand, increasing housing demand and built densification exert pressure on green spaces. Municipalities face the challenge of addressing both the housing shortage and the need for climate change adaptation on limited space. For climate resilient urban development and a balance between densification and green space preservation, policy action is needed. Based on a case study approach, we investigated how growing municipalities respond to this challenge. Four municipalities were selected for in-depth analysis of policy documents and nine semi-structured expert interviews with senior officers from the city planning and green space planning departments. The policy arrangement approach (PAA) (Arts et al., 2006) is employed to analyse the interrelations between involved stakeholders, distribution of power and resources, the existing regulations and prevailing discourses connected with urban development and green space integration.

We identified several decisive conditions: (1) cooperation between urban and green planning departments, but also between administration and politics, (2) supporting discourses in public and among municipal staff, (3) existing internal working routines for cooperation, clearly communicated rules, and (4) access to knowledge and resources. Transparent communication of the regulations in force, development of rules and resolutions with public participation to foster public acceptance and employment of external resources through funding and involvement in model projects constitute main policy recommendations. Templates for legally compliant determinations in binding land use plans or urban planning competitions that consider climate change adaptation and urban green space would further help municipalities with limited financial and personal resources. Increased awareness for the importance of urban green spaces through the [Corona](#) pandemic should be used to stimulate public discourse about integration of urban green space in urban development.

Arts B. et al. (2006). *Political Modernisation and Policy Arrangements: A Framework for Understanding Environmental Policy Change*. *Public Organ. Rev.*, 6(2): 93-106.

## TO ALLY TECHNOLOGY, NATURE AND SOCIETY FOR INTEGRATED URBAN WATER MANAGEMENT – ATENAS

Kinga Krauze<sup>1</sup> · Renata Włodarczyk-Marciniak<sup>1</sup> · Pascal Breil<sup>2</sup> · Antti Rehunen<sup>3</sup> · Kati Vierikko<sup>3</sup>

<sup>1</sup>European Regional Centre for Ecohydrology, Polish Academy of Sciences · <sup>2</sup>INRAE · <sup>3</sup>Finnish Environment Institute

Cities are increasingly in the focus of water related challenges because of the increasing number of inhabitants, and in consequence the pressure on land, caused by people's aspirations, environment misuse and poor planning both spatial and socio-economic. Additionally, aging of urban population, poverty of the proportion of society, and high accumulation of assets, make cities vulnerable to many aspects of water cycle disruption, including flooding and droughts and urban heat island. Decades of conventional urban water management, targeted ultimately at water provision and draining led to the land – water – climate nexus situation. Untangling the nexus requires innovative thinking within the field of technology and engineering, built upon flexible approaches and behavioural change among decision-makers and citizens. It also calls for resilient, self-adapting measures featured for synergistic provision of multiple benefits.

Project ATENAS (<https://atenasjpi.eu>) has been launched within the framework of JPI Water programme on “Water Challenges in the Changing World” (<http://www.waterjpi.eu>) and built on the basis of three demonstration cities Łódź (Poland), Vantaa (Finland) and Lyon (France). ATENAS aims to contribute to closing the water cycle gap through securing water cycling with nature-based solutions (NBS). It took the challenge to merge three action lines:

1. to develop scenarios for implementation of NBS in demonstration cities, based on running pilot projects through the whole cycle of planning, legal challenges, stakeholder interplay and technical co-design;
2. to understand the multiple barriers – from legal through cultural to biophysical to NBS and best-practices to overcome them;
3. to secure the continuation of the approach beyond ATENAS lifetime by identifying, supporting and building the capacity of local leaders in mutual learning process.

All three action lines are to empower transfer of ecosystem services from areas of high natural capital to areas where demand exceeds supply (Krauze, Wagner, 2019), which emerges from the general approach to the city as socio-ecological entity (long-term socio-ecological platform sensu LTER <https://www.lter-europe.net>). Thus, they comprise establishing blue-green infrastructure as a core of urban fabrics, building relationship between society and nature, and creation a public-private partnership in nature governance.

Krauze K., Wagner I. (2019). *From classical water-ecosystem theories to nature-based solutions – Contextualizing nature-based solutions for sustainable city*. *Sci. Total Environ.*, 655: 697-706.

## GOVERNANCE OF GREEN INFRASTRUCTURES ACROSS ADMINISTRATIVE BOUNDARIES IN LISBON METROPOLITAN AREA

Isabel Loupa-Ramos · Pedro Pinto

University of Lisbon

**G**overnance of green infrastructure (GI) in Metropolitan Area of Lisbon's (MAL) has significantly evolved over time. Pitfalls become notably visible when it comes to transposing the metropolitan GI into municipal land use plans. Through document analysis and interviews with experts involved in GI planning over the last three decades we assessed government using an adapted tool based on Bressers' (2016) Governance Assessment Scorecard considering aspects as extent, coherence, flexibility and intensity of the governance regime according to scales, actors, strategies and resources. We analyzed situations where the metropolitan GI strategy spans the border between adjoining municipalities to understand how/if the governance model in place dealt with the issue of preserving continuity across jurisdictions and across scales.

As a result, we identified what type of gaps can be found in the planning process and institutional framework that contribute to this. Multilevel and cross-boundary coordination may be hindered by a lack of tradition in horizontal coordination at the local level and an intermittent and resource-deprived leadership, hindering multilevel cooperation. GI is perceived by municipalities as yet another element in the ever-more complex and lengthy municipal land-use plan and possible land development restrictions increase the complexity and political sensitivity of the local GI's delimitation. This has resulted in an incomplete transposition of the regional GI to the local scale, spatial discontinuities across municipal boundaries, and poorly defined objectives and management strategies for GI, limiting its benefits.

Bressers H. et al. (2016). *The Governance Assessment Tool and Its Use*. In: H. Bressers et al. (Eds.), *Governance for Drought Resilience* (pp. 45-65). Cham: Springer.

## EQUITABLE USE OF URBAN GREEN INFRASTRUCTURE. INSIGHTS FOR THE CO-DESIGN OF URBAN PARKS

Diana Andreea Onose · Simona Grădinaru · Cristian Ioja · Athanasios Alexandru Gavrilidis · Ana Maria Popa

University of Bucharest

**T**he creation of sustainable urban settlements is a principle promoted by United Nations both through the Sustainable Development Goals and the Habitat Agenda. In this context, green infrastructure represents a key component of urban areas increasing the quality of life and ensuring a healthy environment. However, the availability of urban green doesn't always guarantee equity of access or inclusion, their design and facilities often causing problems related with segregation.

Urban parks represent a main component of urban green infrastructure, a very important provider of ecosystem services and the most visited natural areas inside cities. Therefore, planning and designing urban parks should better acknowledge the needs, demands and desires of all main visitor groups. Our aim was to understand the position of different visitor groups (elders, visitors with children, adults, persons with animals etc.) in order to integrate them in solutions for co-designing urban parks. We used Bucharest (over 2 million inhabitants) as a case study and based our analysis on over 5000 questionnaires applied between 2012-2019 in the main parks of the city. Our research focused both on the elements these groups find attractive inside urban parks and on the problems they perceive. We also analyzed the duration and frequency of visits considering that parks should better accommodate those spending the most time there. We used statistical tests for differences and multiple correspondence analysis in order to identify the differences between studied groups.

Our results highlighted the needs and desires of visitors in relation with the design of urban parks. We used the visitors input to identify solutions which best answer to their needs and ensure equitable access to green spaces and inclusion. Co-design of urban parks can contribute to the quality of time spent outdoors and can represent a solution for continuously improving the quality of green areas in direct relation with the changes in society's consumption patterns.

## GOVERNANCE ANALYSIS OF PRODUCTIVE GREEN INFRASTRUCTURE WITH MULTIPLE BENEFITS LINKING URBAN AND RURAL AREAS

Werner Rolf<sup>1</sup> · Rico Hübner<sup>1</sup> · Linda Schrapp<sup>2</sup> · Maren Buschhaus<sup>1</sup> · Sara Salgado<sup>1</sup> · Katalin Czippán<sup>2</sup> · Anika Sebastian<sup>2</sup> · Peter Blum<sup>2</sup>

<sup>1</sup>Technical University of Munich · <sup>2</sup>Weihenstephan-Triesdorf University of Applied Sciences

The talk will present outcomes of the Interreg Project LUIGI – Linking Urban and Inner-Alpine Green Infrastructure-Multifunctional ecosystem services for more liveable territories (2019-2022). The project aims at shaping a transalpine GI-network with multiple ecological, economic and cultural benefits linking rural and urban areas, while looking at representative food-tree-based land use systems (such as orchards) and other semi natural farming systems, their value-chains for goods and services, related business models, financial and policy instruments. As part of the project working package three investigates participatory and governance approaches of good practice examples, which will be focus of this presentation. Therefore, an in-depth analysis was conducted comprising 11 case study regions in six different countries. In each case study area representatives of six different stakeholder groups have been interviewed, leading to 69 interviews in total. Finally, more than 1000 transcript pages have extracted from these interviews building the data set for analyses. The network structure has been analyzed using social network analysis (Wasserman, Faust, 1999). Furthermore, qualitative content analysis helped to analyze the network structures with regard to the governance arrangement based on the actors involved, their discourses, available resources, and applied formal and informal rules (Arts et al., 2006; Liefferink, 2006). Finally, a number of different governance approaches have been identified (adapting Arnouts et al., 2012; Ambrose-Oji et al., 2017), namely Government led, Market oriented, Closed Co-Governance, Open Co-governance, Green hubs, and Grassroots initiatives.

Ambrose-Oji B. et al. (2017). *Innovative governance for urban green infrastructure: A guide for practitioners*. Work Package 6: Innovative Governance for Urban Green Infrastructure Planning and Implementation GREEN SURGE Deliverable 6.3.

Arnouts R. et al. (2012). *Analysing governance modes and shifts – Governance arrangements in Dutch nature policy*. *Forest Policy Econ.*, 16: 43-50.

Arts B. et al. (2006). *Political Modernisation and Policy Arrangements: A Framework for Understanding Environmental Policy Change*. *Public Organ. Rev.*, 6: 93-106.

Liefferink D. (2006). *The dynamics of policy arrangements: turning round the tetrahedron*. In: B. Arts and P. Leroy (Eds.), *Institutional Dynamics in Environmental Governance* (pp. 45-68). Springer: Dordrecht.

Wasserman S., Faust K. (1999). *Social network analysis: methods and applications*. Cambridge: Cambridge Univ. Press.

## INSTIGATING GREEN INFRASTRUCTURE PLANNING – ADVOCATING A ‘MULTI-FACETED’ AND ‘MIDDLE-UP’ APPROACH – THE CASE OF MALTA

Sarah Scheiber

University of Malta

In Malta, both the National Environmental Policy (NEP) and the Strategic Plan for Environment and Development (SPED) identify the need to move towards sustainable development. However, factors such as traffic congestion, pedestrian safety, air and noise pollution, have reduced the amenity and quality of life. This has led to the gradual erosion of the degree of social integration within communities. Additionally, the low provision of urban green spaces does not encourage healthy lifestyles.

As a result, research was conducted which aimed to investigate the planning and design of urban open spaces in Malta and use the outcomes to develop proposals for improving their contribution to sustainable development. The planning of open space has long played an important role in facilitating the potential of urban open spaces to add value to the built environment. This can be seen through the various planning models which have emerged since the 18th century. In considering the potential contribution of urban open spaces to sustainable development, the concept of planning for green infrastructure is being recognised as one of the more relevant planning approaches in moving towards sustainable and resilient urban areas.

A mixed method two phased approach (Scheiber, 2020a) using Malta’s urban conurbation as a case study was adopted. The first phase gathered substantial data with the aim of developing proposals. Using international best practices, the second phase developed proposals in response to the first set of results. Focus groups were then held with mixed stakeholders and authorities, to provide a platform for discussion and explore potential barriers to implementing such proposals.

The results identify gaps in the planning of urban open spaces in Malta as well as various governance related challenges (Scheiber, 2020b). Through the focus group discussions three main themes emerge with respect to the barriers: socio-cultural tendencies, lack of resources, and inadequacies in planning and governance systems. The talk will discuss these barriers and their implications. An attempt is made to understand the potential role which spatial planning systems can play in transforming urban open spaces such that they can function as green infrastructure.

Ultimately the importance and need for good governance or co-governance emerges. International research presents various forms of governance (Ambrose-Oji et al., 2017). However, can these provide a response to the barriers which the case of Malta experiences? The research concludes by advocating that a ‘multi-faceted’ approach together with collaborations of a ‘middle-up’ nature which bring together various institutions and entities, both public and private to adopt the concept of ‘urban learning labs’ or ‘urban green labs’, could be a means of instigating change in contexts such as Malta’s.

Ambrose-Oji B. et al. (2017). *Innovative governance for urban green infrastructure: A guide for practitioners*. Work Package 6: Innovative Governance for Urban Green Infrastructure Planning and Implementation GREEN SURGE Deliverable 6.3.

Scheiber S. (2020a). *A Mixed Method Approach to develop proposals for Malta's Urban Open Spaces to act as Green Infrastructure*. In: K. Hannes et al. (Eds.), *Qualitative Inquiry towards Sustainability*. Malta: European Congress of Qualitative Inquiry Proceeding.

Scheiber S. (2020b). *The Potential for Malta's Urban Open Spaces to act as Green Infrastructure: Considerations for Planning and Governance. The City and Complexity – Life, Design and Commerce in the Built Environment*. London: University of London.

## SOCIO-ECOLOGICAL ARCHETYPES FOR MANAGING ECOLOGICAL INFRASTRUCTURE

Sergio Wicki · Manuel Kurmann · Sven-Erik Rabe · Benjamin Black · Adrienne Grêt-Regamey

ETH Zürich

**A**n intact network of core area habitats and habitat corridors is a key factor to ensure the functioning of ecosystems. The existence of such networks is expected to gain significance in the future, with ongoing global processes such as climate and land use change, as well as the degradation of biodiversity, resulting in further deterioration of the integrity of ecosystems. The link between habitat networks and ecosystem functioning has been codified in the concept of Ecological Infrastructure (EI). Switzerland is one of the first countries to formally adopt measures to strengthen its EI in the Swiss Biodiversity Strategy and Action Plan.

In order to understand the mechanisms of EI, we define Socio-Ecological Systems (SESs) for EI by applying a tiered approach of Ostrom's framework using indicators of Natures Contribution to People (NCP), biodiversity and socio-economic conditions. By analyzing the spatial patterns of these indicators using machine learning and clustering algorithms, we identify areas defined by similar characteristics. The identification of similar configurations and their spatial distribution enables us to delineate archetypes of EI. A refinement and validation of these archetypes is achieved through a combination of machine learning and expert knowledge in an iterative participatory process with stakeholders. By applying the Institutional Resource Regime (IRR) – framework on the refined archetypes of EI alongside a detailed habitat map of Switzerland, we can link existing governance mechanisms and policy instruments to specific archetypes. This will provide insights into the interactions between current policies, management strategies and the state of EI within the boundaries of archetypes and highlight synergies between NCP management and biodiversity conservation. Such synergies are attractive given that conservation interventions typically incur high costs, and as such the potential to manage biodiversity hotspots through economic 'free-riding' on the management of NCPs represents a 'win-win' situation.

Together with stakeholders, archetypes of EI and their corresponding policy instruments support the co-production of management scenarios that aim towards consolidating the continued provision of NCPs and biodiversity. We utilize archetypes of EI to formulate policy interventions in Switzerland and discuss their contribution to transformative action towards securing a functioning EI for the present and the future. Finally, we discuss how the development of archetypes in an iterative participatory process, combining qualitative and quantitative data as well as expert-knowledge and machine learning methods, can support decision makers in planning for a functioning EI.

## *Integrating landscape science into development, conservation and natural resources planning*

### **Symposium organisers**

*Samuel Cushman* (United States Forest Service), *Zaneta Kaszta* (University of Oxford)

### **Summary**

Combining ecological modelling and analysis with policy and management decisions is deeply challenging. In this symposium we focus on welcoming methods, tools, models, and approaches to link management and science.

### **Description**

Management, conservation, policy and scientific research are inextricably linked. However, in practice, there is typically a large gap between science and management, and decisions are often made with poor support from available scientific knowledge. In this symposium, we particularly focus on decision support and scenario optimization tools to combine projections of future landscape change, policy and management goals, species distribution models, connectivity models and population and genetic models. We present examples of landscape ecology and methods that are most applicable to management planning, including landscape pattern analysis, decision support and scenario optimization tools, and we present several examples of successful application of these tools to important conservation design and landscape management problems both in Europe and around the world.



## REGULATING ECOSYSTEM SERVICES OF URBAN GREEN SPACE IN WARSAW: ASSESSING AND MAPPING POTENTIAL, USE AND UNMET DEMAND

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

Institute of Geography and Spatial Organization, Polish Academy of Sciences

The quality of life in cities depends on many different factors. In addition to the technical infrastructure and organization of social life in the city, an increasingly important role is attributed to the quality of the urban environment and its impact on the well-being of residents. Large cities are areas where the highest values of atmospheric pollution from anthropogenic sources are recorded. Atmospheric pollution is a serious problem from a human health perspective. Increased production of carbon dioxide, one of the gases responsible for the greenhouse effect, is also considered pollution. Among the recently accelerating climatic processes is the increase in global air temperature. From the point of view of the quality of life in the city, high air temperatures during summer days and nights, are particularly dangerous. The temperature is further increased by the urban heat island effect. Furthermore, urban development is related to the expansion of impervious surfaces, and the decline in the area of biologically active land (soil sealing). The effect of these changes is a deterioration of the infiltration properties of the substrate, and thus an intensification of surface runoff, which in addition to a greater threat of urban flooding and waterlogging can lead to increased erosion on permeable soils. Water erosion, especially surface erosion, is one of the main causes of soil degradation in Europe. This process is particularly important in agricultural areas, but also in urban areas it often affects the usability of certain areas. The control and regulation of these processes within large cities depends largely on the deployment and operation of green urban space.

Our aim was to present five indicators of key regulating services relevant to the role of green urban space: (1) control of erosion rates by vegetation, (2) prevention of flash floods, (3) regulation of chemical composition of atmosphere, (4) regulation of temperature and humidity, and (5) reduction of particulate matter air pollution from anthropogenic sources. The indicators refer to potential, use or unmet demand and were calculated for all 18 districts and for 143 sub-districts of Warsaw. Although all the indicators are based on the distribution of urban green, the values of each of them have their own specific spatial pattern, only partly relating to the degree of urbanization of the Warsaw area, while preserving the clear distinctiveness of the central part of the city, corresponding to Warsaw within its pre-1951 borders.

## EVALUATION OF EQUITABLE ACCESS TO URBAN GREEN SPACES IN SANTIAGO, CHILE

Víctor Alegría · Emilio Martínez · Alexis Vásquez · Paola Velásquez · Elizabeth Galdámez

Universidad de Chile

**E**quitable access to green spaces has become a crucial issue for urban planning to achieve fairer, healthier, and more resilient cities, as well as an opportunity to reduce the socio spatial segregation of most deprived communities. However, green spaces accessibility analysis in urban planning mostly focuses on the area of public greenspace per number of inhabitants of a given administrative unit, usually expressed in  $m^2/inhabitant$ . This lack of more sensitive methods to different typologies and quality of green spaces negatively impacts on planning instruments and the development of effective policies to tackle unequal access to fundamental well-being benefits provided by urban green spaces.

The study provides a novel methodology to evaluate equitable access to urban green spaces, considering different typologies of green spaces, modes of access, vegetation cover, and social indicators. The method is applied in Santiago, Chile, a strongly socio-spatially segregated city that faces major challenges to sustain more resilient, healthier, and greener neighborhoods. Firstly, green spaces are mapped using existing public databases, as well as 1:15,000 photo-interpretation when necessary. Secondly, the degree of vegetation cover is obtained based on Sentinel-2 satellite images. Using ArcGIS 10.1 network analyst tool, service areas are calculated for each green space, where different distances are applied depending on their type. Finally, social indicators of each urban block are compared to identify the most deprived population on accessing urban green spaces at different scales.

The study reveals major accessibility gaps not only in the most vulnerable population, but also raises a systemic problem in urban green infrastructure planning. In that sense, it shows how planning instruments promote the design and construction of small (<0.5 ha) and fragmented urban green spaces. The accessibility assessment identifies major gaps and barriers to access green spaces with adequate vegetation coverage for Santiago's 36 municipalities. At the local scale, great disparity in access to smaller green spaces is found across different districts, being the ones located in the south the most deprived areas. A key finding highlights that less than 30% of the population in each municipality has access to a district-scale green space (0.5-2.0 ha), which constitutes a serious lack of adequate provision of district level green space within a walkable distance. With some exceptions, larger green spaces, such as major urban parks (2-10 ha), show a more equitable access and distribution.

The results obtained are useful to inform public policies, investment decisions and urban planning instruments, such as the consolidation of the Santiago+ Green Infrastructure Plan and the system of green spaces proposed in the Santiago Metropolitan Land Use Plan.

## EFFECT OF HABITAT FRAGMENTATION ON BIODIVERSITY: A LABORATORY EXPERIMENT FOCUSING ON SOIL MICROARTHROPODS

Karolina Argote<sup>1</sup> · Cécile Albert<sup>2</sup> · Mathieu Santonja<sup>1</sup> · Benoît Geslin<sup>1</sup>

<sup>1</sup>Aix-Marseille University · <sup>2</sup>French National Centre for Scientific Research

**H**abitat loss and fragmentation are major threats to biodiversity and until now separating their effects is challenging. Habitat configuration may play a primary role for biodiversity in landscapes with intermediate levels of habitat amount, such as urban or agricultural landscapes. These landscapes have a variable spatial arrangement, which means the opportunity for some arrangements to be more favorable for biodiversity than others. Earlier studies have provided empirical and theoretical support to this hypothesis but there are strong discrepancies among taxonomic groups and biological levels. Consequently, we still know little about the relative role of habitat configuration and matrix resistance shaping biodiversity in landscapes.

We use a laboratory-controlled microcosm experiment with a soil micro-arthropod population (*Folsomia candida*, Collembola) to understand the joint effect of habitat patches distance and matrix resistance on dynamic population. In our experiment, we manipulate the distance among habitat patches and the resistance of the substrate among patches. Our artificial landscapes consist of an inhospitable (dry) matrix with four moist cylinders of a carbon-plaster mixture of 35 mm diameter and 5 mm height with a 1 cm disk of decomposing oak leaf above each cylinder. We test ten isolation distances for each type of matrix, and for each distance four different substrates that form a gradient of resistance to the movement of collembolans: (1) fine black cotton fabric, (2) waterproof polyester taffeta cloth, (3) cold pressed watercolor paper, and (4) black polyester felt. These are chosen from a preliminary experiment in which we tested the movement success of collembolan from release point to habitat patch (with distance of 6.5 cm) for twenty different materials. In each landscape, forty animals of the same age are released on one of the four cylinders. During six weeks we monitor the movement of the collembolan, patch colonization and population dynamics on each cylinder. At the six weeks we measure the final population size on each patch.

We expect a co-joint effect of habitat isolation and matrix resistance on migration rate. As distance and resistance among patches increases the rate of colonization will decrease markedly. In turn, the absence of colonization in highly isolated landscapes could lead to density-dependence in the release patch, and potentially to smaller individuals in the initial population due to competition between individuals for limited resources. Mortality in the matrix could also hamper population size at the landscape scale. Our ongoing research is a major step towards understanding how ecological processes are simultaneously affected by isolation, distance and resistance. We expect to expand our experiments at the community level in a near future.

## HYDROLOGICAL RESOURCE AND HEALTH TOURISM OF VAL DI SOLE (ITALY): KEY ELEMENTS FOR SUSTAINABLE DEVELOPMENT OF INNER TERRITORIES

Chiara Chioni · Sara Favargiotti · Margherita Pasquali · Angelica Pianegonda

University of Trento

In the framework of the research project “B4R Branding4Resilience” (2020-2023), the authors are investigating the Italian inner areas and their thermal landscapes with the aim of developing a territorial strategy on the value of water resources. The current environmental and economic crisis has offered a new lens to look through at these territorially imbalanced areas as reservoirs of resilience – due to their richness in environmental resources, vernacular knowledge, cultural artifacts, and potential uses – which ought to be understood, planned, and managed. However, the contexts addressed by the Italian National Strategy on Inner Areas are often lacking successful regional policies and systemic territorial approaches to achieve effective transformations.

The ongoing research project is structured according to three operative phases: exploration, co-design, and co-visioning. The expected results are, on the one hand, to identify a territorial brand and, on the other hand, to define a shared and adaptive strategy for resilient communities. Resilience is here intended as a re-generative and adaptive behavior whose change’s processes and subsequent benefits have to be assessed in space and time with the local community, in order to preserve the identity of the area and to renew the well-being tourist offer.

This contribution aims to present and discuss the results of the exploration and co-design processes conducted by the authors in the Italian mountain inner area of Val di Sole, an Alpine valley located in Trentino-Alto Adige region with potentials and risks linked to its widespread water resources. According to a multi-disciplinary and multi-level methodology combining quality and quantitative approaches, a data collecting process was firstly conducted to map the ecological, social, and spatial elements of the area; then, a stakeholder analysis allowed to identify the local actors with whom to develop the co-design phase.

The result is a digital atlas of thematic maps, diagrams, and cross-cutting indicators: beside the interaction between various databases at different scales, the atlas is intended to support participative planning and design actions. The territorial brand of the “Val di Sole Blueprint” wants to offer an operative tool to drive scenarios and to implement the thermal landscapes as resources for the territory. The long-term goal is to create a territorial strategy on the value of the thermal water systems by promoting the enhancement of the territorial capital.

The forthcoming activities are expected to define a strategic roadmap for the sustainable enhancement and valorization of water resources: changing the perspective from thermal buildings to thermal landscapes, the natural environment which can offer physical and spiritual cures has to be protected and rediscovered with a sensible design approach for a better quality of life.

## ECOSYSTEM SERVICE INDICATORS AS A SPATIAL PLANNING TOOL IN THE URBAN LANDSCAPE ACROSS SCALES (NATIONAL, REGIONAL AND LOCAL)

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

Institute of Geography and Spatial Organization, Polish Academy of Sciences

The increasing pressure on the natural environment in cities, especially large cities and their suburban zones, caused, inter alia, by urban sprawl, an increase in car traffic and exposure to other sources of pollution results in a deterioration of the quality of life for people. Urban green space provides a wide range of benefits for people, including mitigating the effects of climate change (e.g. heat waves, flash floods), the urban heat island effect and soil sealing. Therefore, green spaces play a significant role in the game for urban space. The perception of green space through the prism of the benefits that ecosystems give to humans is particularly important for changing the approach to spatial planning in Poland. Although the concept of ecosystem services is not yet widely implemented in the national planning system, and is mainly the subject of scientific discourse, it was referred to in the National Urban Policy 2023. This policy recommends that local governments, when preparing their studies and spatial development plans, take into account indications regarding the use of the concept of ecosystem services in planning developed under the project “Urban MAES – ecosystem services in urbanized areas” conducted by the Ministry of the Environment.

Thus, to link science and spatial planning, our aim was to propose indicators of key urban ecosystem services adapted to three spatial scales: national, regional, and local. The proposed indicators include provisioning (only at the national level), regulating and cultural services. The selection of services and the indicators was based on the analysis of their significance in the urbanized space from the point of view of the well-being of residents. Indicators refer to ecosystem service potential, use or unmet demand. On a national scale, the indicators were calculated for all 20 functional urban areas (FUAs) in Poland with a population of over 250 thousand. We compared the values obtained for the urban centers, commuting zones and the entire FUAs. On the regional scale, the indicators were developed for the city area within the administrative boundaries (on the example of Warsaw), and for the local scale for a part of the city. Our results can support spatial planning and management decisions by providing quantified operational knowledge of the size of individual ecosystem services. They can be used in the preparation of strategic documents, studies of the conditions and directions of spatial development in various administrative units, spatial development plans for cities/functional areas or local spatial development plans.

## LANDSCAPE ECOLOGICAL CONTRIBUTION TO THE CONCEPT OF INTEGRATED DEVELOPMENT OF THE CITY OF MELITOPOL

Olexander Golubtsov

Institute of Geography, National Academy of Sciences of Ukraine

Since 2014, with the support of Germany and Switzerland, the principles of Integrated Urban Development following the Leipzig Charter and the 2030 Agenda have been implemented. Melitopol is one of the Ukrainian cities with a created The Concept of Integrated Urban Development (IUDC). The 'Ecology' sector covered the matter of research of natural urban conditions and ecological situation. The foundation of the research is the landscape ecological approach combined with the field methods of natural sciences, GIS, landscape planning.

The human community and flora and fauna species are defined as the main subjects of the urban landscape. The abiotic components are viewed as an arena to form conditions for vital activities of the landscape subjects. The detailing of the analysis is on the regional and local levels.

The interests of a human are achieving a comfortable and ecologically safe environment for life in the city and adapting to climate change. The evaluation criteria are clean air, water, and soil, good planting of greenery and the availability of the green rest areas, access to the water and possibility for self-purification, and absence of flooding and heat islands. The value criteria for places for species are their presence and preservation of the places of their existence.

First, the valuable places are defined according to the criteria for each subject. For example, for a human these include green spaces; for flora species – the fragments of the flood plains preserved in a natural condition. In the regional dimension, the places with a high level of biodiversity for the development of nature preserve territories, including the city, were defined.

The next step involves an analysis of the factors which influence the value of the places in the landscape. The identified structure of the initial nature landscape was viewed as a basis for urban development and is the key to understanding the processes in the modern landscape. Other components and peculiarities of its functioning of the modern landscape and suburbs.

All the layers with the characteristics of the city's landscape were organized in GIS for the following complex analysis, identifying and justification of the sustainable urban landscape configuration. The identified places include those which are subject to conservation as the most valuable ones (park as a place to have some rest for citizens as well as habitat); those which require development for increasing significance, connections formation (creation of new connected green areas in the areas of a high density of population); those which require measures to eliminate factors which significantly reduce or prevent the realization of the landscape subjects interests (sanitation of the river valley soil contamination by heavy metals).

Results of the landscape ecological analysis of the city have become the foundation for the development of the strategic goals and objectives, key projects which were integrated in IUD of Melitopol.

## FOREST FRAGMENTATION AT MULTIPLE SCALES IN SPAIN

Sergio González-Ávila · Belén Martín-Ramos · Emilio Ortega-Pérez

Technical University of Madrid

Land use and land cover changes leading to forest fragmentation threaten biodiversity and the habitat of species, such as those endangered. Spanish forestland has increased in recent decades, but forest fragmentation is still a concern for managers and planners. Moreover, recently a national strategy related to green infrastructure (GI), connectivity and restoration has been adopted by the Ministry for the Ecological Transition, which is responsible for biodiversity conservation. As a landscape characteristic highly related to connectivity and environmental ecosystem services provided by GI, a better knowledge on forest fragmentation is needed. In this context, landscape metrics quantifying forest fragmentation may aid in the assessment and planning of GI, but the lack of knowledge for a proper interpretation still constrains its applicability. Given the difficulties in linking landscape structures to landscape processes and functions, as a first step towards landscape metrics adoption, we propose a pure structural approach based on reference curves obtained at national scale to contextualize and qualify metric values.

Our goal was to provide a general perspective of forest fragmentation in Spain, extending the methodologies previously adopted at the EU level to a nationwide, more detailed, scale. Therefore, we used the Forest Area Density (FAD) metric as a measure of fragmentation and conducted multiscale calculations for all the forestland in Spain. We used data from the Spanish Forest Map (1:50,000) converted to a 30 meters resolution layer. Then we used GuidosToolbox software to calculate FAD for every pixel at five sizes of analysis window ( $7 \times 7$ ,  $13 \times 13$ ,  $27 \times 27$ ,  $81 \times 81$  and  $243 \times 243$  pixels). We repeated calculations dividing forests into three tree cover density classes (20-50%, 50-80% and >80%), and also by Forest Types (FT) as designated by main tree species (10 species and two types for each: pure and mixed). This division of forestland allowed us to uncover the role of cover density and main species in the fragmentation of Spanish forests. As an additional analysis we also generated a metric space with two axes, fragmentation (FAD values) and FTs variety, to identify representative 'profiles' relying upon the similarity of trajectories in the metric space over a range of spatial scales. These trajectories can be mapped in geographic space later on for a better interpretation. In this way, we analyzed at multiple scales the association between forest fragmentation, as a landscape characteristic modifiable through management, with a proxy for biodiversity (variety of FTs).

Our work produced a collection of maps displaying forest fragmentation at national scale and a set of multiscale reference curves for the FAD metric, which could be of importance not only for prioritizing forest areas to conserve or restore, but to assess metric values and derive and test ecological hypotheses with planning purposes.

## REVITALIZATION OF BOTANICAL GARDEN IN SPLIT, CROATIA – CHALLENGES OF IMPLEMENTATION AND LEGISLATION

Monika Kamenečki<sup>1</sup> · Petra Pereković<sup>1</sup> · Aneta Mudronja Pletenac<sup>1</sup> · Helena Miholić<sup>1</sup> · Daniel Krstonošić<sup>1</sup> · Mirko Ruščić<sup>2</sup> · Dora Tomić Reljić<sup>1</sup>

<sup>1</sup>University of Zagreb · <sup>2</sup>University of Split

The incentive for this research came from public insensitivity to natural values during the implementation of the landscape revitalization project (LRP) of the Botanical Garden on Marjan peninsula. Located within a protected area of the Marjan Forest Park it is characterized by natural values and unique landscape. The LRP was planned to preserve the existing valuable flora and different habitat types for the public and scientific research. The planning of this area sought to bring together natural and landscape values to connect users with the environment and to continue the pedagogical importance of the botanical garden. In the design phase, the link between conservation and scientific research on the approach to planning and design of a botanical garden were strictly defined. Given the complexity of space, during the project development arose many open issues related to (1) the protection of existing cultural heritage, (2) protection of natural values, and (3) safety of users defined by regulations in Construction Law (OG 153/13).

The revitalization of the Botanical Garden started in parallel with the protection of the Marjan Forest Park from bark beetle infestation and the removal of a large part of the infected Aleppo pine forest. Situation in which state, county and city institutions, associations, NGOs, experts, scientists and residents of the city of Split are involved has shown (1) that each of the stakeholder group formed different opinion based on their role in space, (2) absence of a common approach, and (3) unwillingness to dialogue.

The aim of the research is to determine methods and tools that will enable the optimization of future changes. Considering many involved stakeholders with different agenda the future management is still fuzzy. Partly it is because of inadequate legislation and spatial planning documents from the local to state level which disable the management of the Forest Park and Botanical Garden. In this extremely valuable protected landscape within the urban area it is important to implement conservation design and landscape management that support relevant opinions of all included stakeholders.

This research showed that scientists are most involved in protection processes, while the developers and local government are more inclined to expand built areas and implement sport and recreational facilities. The methods proved to be the most suitable are participatory surveys and workshops, field-work, mapping, vulnerability analysis, social cost-benefit analysis, research of public opinion values as part of a long tradition of studying landscape as personal and collective cultural constructions.



## CULTURAL ECOSYSTEM SERVICES OF URBAN GREEN SPACE IN WARSAW: ASSESSING AND MAPPING POTENTIAL, USE AND UNMET DEMAND

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

Institute of Geography and Spatial Organization, Polish Academy of Sciences

Urban green space provides a wide range of benefits for people. They reduce air, water and noise pollution, provide protection from flooding, droughts and heat waves, and maintain a connection between humans and nature. Recreation and recuperation in nature is of great importance for physical and mental well-being of urban residents (Geary et al., 2021; Weinbrenner et al., 2021). Interaction with nature, and in particular direct physical interaction, has a significant impact on human health: it reduces stress, promotes recovery after illness, reduces mental fatigue and improves concentration (Ward Thompson et al., 2012). Many studies have shown that the awareness of ecological processes and benefits derived from nature increases with the frequency of direct interactions with the natural environment, therefore, environmental education in the natural environment is of particular importance for promoting the principles of sustainable development in the society (Affek, Kowalska, 2017).

Urban green space is more and more valued and protected, but often lose out in the competition for land as the share of the population living in urban areas continues to rise. Not only the area of green space is important, but also their spatial distribution in the city, which makes them more or less accessible to residents. Maintaining the appropriate proportions between built-up areas and green public areas and their optimal distribution should be ensured in urban spatial plans.

Our aim was to assess and map key cultural services provided by urban green space in Warsaw. We proposed five indicators to quantify the potential, use or unmet demand for recreation and education in nature. Three of them were based on expert assessment, two – on social valuation (Google Maps review scores). They were calculated for Warsaw within its administrative boundaries, where urban green space account for nearly 50% of the area. The results of our analysis, referring to the city sub-districts or individual green spaces, can support management decisions and spatial scenario optimization for the capital of Poland.

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## SPATIAL PLANNING AND SHARED ACTION FOR CLIMATE AND LAND USE CHANGE IN THE SOUTHEASTERN UNITED STATES

Rua Mordecai · Amy Keister · Hilary Morris · Louise Vaughn · D. Todd Jones-Farrand · Daniel Adams · Blair Tirpak

U.S. Fish and Wildlife Service

**M**any countries continue to struggle with how to connect large spatial plans with conservation decisions at multiple scales. The Southeast Conservation Adaptation Strategy was formed in 2011 as a partnership between state and federal agencies across 15 states and two U.S. territories. Its vision is to create a connected network of lands and waters that supports thriving fish and wildlife populations and improved quality of life for people. To support this partnership, we developed an integrated spatial planning approach that: (1) responds to climate and land use change and (2) facilitates use of the plan at multiple scales. To develop the spatial plan, known as the Southeast Conservation Blueprint (Blueprint), we use the core area algorithm in zonation at 30 m resolution based on a series of natural and cultural resource indicators. To facilitate the use of the plan, we use a series of approaches based on user experience research and product development methods commonly used by technology companies like Google and Instagram. The Blueprint is currently helping over 250 people from more than 100 different organizations inform their conservation decisions. We will provide an example of connected Blueprint uses that include parcel, state, multi-state, and national scales. The overall framework used to develop and support the Blueprint, created over the last 12 years, could help other collaborative landscape planning efforts across the globe support shared actions across multiple scales.

## LANDSCAPE ECOLOGICAL APPROACH TO QUANTIFY THE CHANGE OF LAND-USE REGIMES: EXAMPLE OF RUSSIAN STEPPES

Alexander Prishchepov

University of Copenhagen

Landscapes are the product of physiography, biophysical and human interactions. Landscape transformations, including the change of land-use regimes, may shape the functioning of the landscapes and shift them into a new mode. While satellite remote sensing provides fundamental technology to monitor land-use / land-cover changes, quantification of landscape ecological indices across the changing landscapes may serve as a robust approach to quantify the change of land-use regimes and identify novel typologies. Here we bring an example of the steppe Orenburg province of Russia in the Eurasian steppe belt, which was once a part of the Virgin Lands Campaign (1954-1963), when croplands expanded at the expense of agro-environmental frontiers and underwent massive cropland abandonment after 1990. We monitored agricultural land-cover change with Landsat and Sentinel-2 imagery for 1990-2000-2010-2018. Further, we used a set of landscape ecological indices (Landscape Shape Index, Shannon Diversity Index, Mean Patch Area, Contiguity Index and Euclidean Nearest Neighbor Distance) and statistics on population and crop yields to quantify the changes in land-use regimes at the district level.

Our analysis showed massive steppe recovery at the expense of abandoned croplands from 1990 to 2000, but also their recultivation from 2000 to 2018. Mean area, contiguity and Euclidean distance between steppe patches increased due to cropland abandonment and later decreased due to recultivation, while Landscape Shape Index remained stable. Shannon Diversity Index, which showed a diversity of transitions from cropland to grassland and vice versa for 1990-2000-2010-2018, revealed unique transitions of studied landscapes. Once we performed hierarchical clustering by combining calculated landscape indices and statistics on changes in agricultural productivity (grain yields) and population density changes, the analysis revealed unique clusters of new agricultural landscape typologies by 2018. Among those, we identified stable landscapes with little cropland abandonment and recultivation, high wheat yields and high population density, but also landscape typology with complete cropland contraction without recultivation, low yields, and population decline. Similarly, we identified typology with strong fluctuation of cultivated and abandoned croplands across studied yields, low population density and low yields. Former Virgin Lands Campaign areas were more exposed to defragmentation of steppes and population decline, but also to fluctuation of cropland abandonment and recultivation. In sum, landscape indices were useful to evaluate the changing land-use regimes by bringing the example of the Eurasian steppe. Identified typologies of landscape transformation may provide opportunities for detailed development of land-use planning, including biodiversity conservation on lands with decreased cropland cultivation activities, large steppe patches and low population density.

## IMPACT OF CLIMATE AND LAND USE CHANGE ON SELECTED FISH SPECIES IN MOUNTAINOUS STREAMS OF CZECHIA

Stanislav Ruman

University of Ostrava

The impact of climate and land-use change for various fish species was widely studied across different European rivers. Results of these studies showed shifts of the suitable living conditions to the upper part of the rivers caused by the increase in water temperature or the extension of species that prefer warmer water. This research was aimed to assess the impact of climate and land-use change for three salmonid species in detail (i) and to find suitable locations for the river incubation (ii). Geodetic survey and monitoring of water levels and the water temperature was conducted within six mountainous river reaches in Czechia. Scenarios of land use and climate change were created and served as input for rainfall-runoff and hydraulic models. Results of these models were combined with the aim to assess the potential risk of climate and land-use change. These risks were connected with critical values of water depth during the low flows, water velocities during the flood, and critical water temperature as the main factors affecting the living conditions for selected fish species. The output was the map of potential risk for selected fish species in six river reaches in the Czechia for the present and future scenario.

The result of this study showed a decrease in areas with suitable living conditions for selected fish species. The decrease was caused by an increase in velocities during the floods and a decrease in water levels during the low flows. An increase, in the air temperature caused by climate change, did not cause so high an increase in the water temperature as it can influence a long time surviving of selected fish species. This can be attributed to the selection of the mountainous reaches, where water temperature will not achieve so high values as in the middle or lower part of the river. Although some of the crucial factors (water depth, velocity, and temperature) affecting the environment of selected fish species were assessed, there remain others that need to be investigated and add to the assessment, such as sediment regime, water quality, and stream fragmentation. The maps will serve the local authorities, fishermen, and organizations involved in the protection of these species. Furthermore, it will be used as a basis for the selection of suitable locations within studied reaches where the incubation of fish species has the highest potential to be successful.

## A REVIEW OF ECOSYSTEM CONDITION INDICATORS TO SUPPORT URBAN ECOSYSTEM ACCOUNTING

Francesco Sica<sup>1</sup> · Chiara Cortinovis<sup>2</sup> · Davide Geneletti<sup>1</sup>

<sup>1</sup>University of Trento · <sup>2</sup>Humboldt University of Berlin

Understanding and assessing ecosystem conditions is a key step in ecosystem accounting as described in the System of Environmental-Economic Accounting, namely an integrated framework for organizing biophysical data, assessing ecosystem services, and measuring the associated economic values. Including condition indicators in the assessment of ecosystem services and their values allows integrating ecological knowledge and landscape science into decision-making processes. Despite a growing literature on the identification of condition indicators for different ecosystem types (fueled by the EU MAES initiative, among others), relatively few studies focus on urban ecosystems. To address this gap, this research focused on the following questions:

- What are the most suitable indicators to assess and quantify urban ecosystem conditions?
- To what extent indicators proposed to assess the conditions of other ecosystem types can be applied also to urban ecosystems?
- How can condition indicators be connected to the capacity of urban ecosystems to provide ecosystem services?
- How information on urban ecosystem conditions can be used in the framework of ecosystem accounting exercises?

To address these questions, we undertook a systematic review of the scientific literature. A first set of 358 papers was analyzed, extracting information about the indicators that measure specific ecosystem characteristics that are connected to the conditions of ecosystems. Based on the review, we obtained a set of condition indicators for different types of urban ecosystems. The indicators were categorized according to the DPSIR framework and linked to relevant ecosystem services. For each condition indicator, we discussed suitable scales of analysis and possible uses in the framework of urban ecosystem accounting exercises. We conclude by discussing the role that different indicators of urban ecosystem conditions can play in supporting different types of policy questions within processes for sustainable urban planning, including the integration of nature-based solutions aimed, e.g., at water resources management, climate regulation, air filtration, flood mitigation.

## DEVELOPING GLOBAL HIGH-RESOLUTION LAND-USE DATASETS FOR BIODIVERSITY MODELLING

Tamsin Woodman<sup>1</sup> · Peter Alexander<sup>2</sup> · David Burslem<sup>1</sup> · Justin Travis<sup>1</sup>

<sup>1</sup>University of Aberdeen · <sup>2</sup>University of Edinburgh

Land-use change (LUC) is a major driver of biodiversity loss but has received less attention than climate change in biodiversity scenarios. Models of land-use change make projections under different socioeconomic scenarios, which can be integrated with biodiversity models to understand the impacts of LUC on species distributions and abundance. A variety of land-use models are available which cover a range of scales, resolutions, and LUC drivers. Global-scale land-use models incorporate drivers such as trade, food demand, and climate change, but produce output at low resolutions which do not match the scale at which organisms are affected.

We aim to generate high resolution land-use projections from the global-scale land-use model PLUMv2, which can be integrated with biodiversity models to investigate the possible future impacts of global LUC on species.

We adapted an existing downscaling method to convert PLUMv2 output from 0.5 degrees to 1 km spatial resolution and implemented the method as an R package. The algorithm takes a high-resolution baseline map of land-use and derives the suitability of each grid cell for each land-use class from the area of that land-use in neighbouring cells and user-specified predictors, such as soil nutrients. Areas of LUC from the first PLUMv2 time step are allocated to high-resolution grid cells based on their suitability values. The resulting downscaled land-use map becomes the baseline for downscaling the next time step of PLUMv2 output.

We calibrated the downscaling method with historic land-use data from the 1 km resolution HILDA+ dataset to find the optimal parameters for downscaling PLUMv2 land-use. After calibration, the method was applied to PLUMv2 land-use projections for multiple socioeconomic scenarios using land-use in 2010 from the HILDA+ dataset as a baseline.

We will present results on the spatial and temporal accuracy of the downscaling algorithm when applied to the HILDA+ dataset. The optimal parameters for downscaling HILDA+ land-use will be identified from the calibration results, and the downscaled PLUMv2 land-use maps for multiple socioeconomic scenarios compared.

The downscaled land-use projections are harmonised with the HILDA+ historic land-use dataset, providing global land-use maps at 1 km resolution from 1899 to 2100. There may not be a single set of optimal parameters for downscaling, as the accuracy of the downscaling algorithm when applied to HILDA+ data may vary through space and time. The uncertainty in the downscaled future land-use maps arises both from uncertainty in the PLUMv2 model and the downscaling algorithm.

Our future land-use datasets can be used as input to biodiversity models, such as the agent-based model RangeShifter, to investigate how future LUC will impact biodiversity. The land-use maps may be combined with climate change predictions to understand the joint effects of LUC and climate change on species.

## EVALUATING EFFECTS OF DIFFERENT MANAGEMENT STRATEGIES ON BENEFICIAL ARTHROPODS IN AGROECOSYSTEMS: LANDSCAPE-SCALE POPULATION MODELLING APPROACH

Elżbieta Ziółkowska<sup>1</sup> · Christopher Topping<sup>2</sup> · Agnieszka Bednarska<sup>3</sup> · Ryszard Laskowski<sup>1</sup>

<sup>1</sup>Jagiellonian University · <sup>2</sup>Aarhus University · <sup>3</sup>Institute of Nature Conservation, Polish Academy of Sciences

Over the last few decades a dramatic decrease in abundance of non-pest arthropods has been observed worldwide in agriculturally-dominated landscapes. Intensification of agricultural practices is considered as the main driver of this loss. We do not know, however, the relative contribution to decline of different anthropogenic stressors that are part of this process: whether the extensive use of pesticides, decreasing landscape heterogeneity, large-scale monocultures, or/and the lack of suitable habitats serving as refuges for arthropods plays the most important role. These stressors may in fact interact in non-linear ways and are inherently spatio-temporal in nature.

The objective of our research was to estimate the relative importance of insecticide use and landscape structure for population dynamics of a model species *Bembidion lampros*, the representative of a large, diverse and important group of ecosystem service providers – the carabid beetles. We used high-resolution dynamic landscape models and advanced spatially-explicit population modelling within the ALMaSS (Animal, Landscape and Man Simulation System; <https://projects.au.dk/almass>) modelling framework to estimate the effects of (1) in-crop mitigation measures through the application of insecticides with reduced lethality, and (2) off-crop mitigation measures by increasing abundance of grassy field margins for beetle populations along the gradient of landscape heterogeneity.

We observed substantial increases in mean overall beetle density and (even larger) in mean beetle occupancy with even small reduction in insecticide-driven lethality. The impacts of increasing grassy field margins depended on their width and overall abundance in the landscape. Only field margins of at least 4 m wide and applied to at least 40% of fields, resulted in an increase in beetle population density comparable to the scenario with the smallest reduction of insecticide-driven lethality we considered. We, therefore, suggest the importance of field margins rather as a supporting not stand-alone mitigation measure. Adding sufficiently broad off-field habitats should help to maintain viable beetle populations in agricultural landscapes even with moderate use of insecticides. We showed that the effectiveness of mitigation measures applied strongly depends on landscape heterogeneity, as we found the highest impacts of the measures tested in study areas with the lowest landscape diversity and proportion of semi-natural habitats. For effectiveness of off-crop measures the farmland structure was also important. Thus, to achieve the same management or mitigation target in different landscapes might require different strategies.

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# 6. Policy making for European landscapes

## *Policy making for European landscapes*

### **Symposium organisers**

*Agata Cieszewska* (Warsaw University of Life Sciences), *Werner Rolf* (Technical University of Munich), *Isabel Loupa-Ramos* (Technical University of Lisbon), *Sónia M. Carvalho Ribeiro* (Federal University of Minas Gerais), *Veerle Van Eetvelde* (Ghent University), *Jarosław Balon* (Jagiellonian University), *Jerzy Solon* (Institute of Geography and Spatial Organisation, Polish Academy of Sciences)

### **Summary**

Growing and diversifying threats to the environment pose an increasingly demanding challenge to modern, sustainable and socially equitable development. This session will address a wide array of formal and informal instruments for policymaking and their abilities to address future challenges and steer changes of European landscape on the transition path to sustainability.

### **Description**

On the one hand, we will look at formal EU level policies, focusing on the European Green Deal. EU put forward the European Green Deal as a new development strategy which also challenges new approaches for landscape thinking, planning and design. This strategy will also shape the discipline of Landscape Ecology and its development by providing funding for activities and research for sustainable landscape development.

As an informal strategy another focus will be the Florence Convention (also known as European Landscape Convention – ELC). In the 20 years since the adoption of the Convention, European countries and regions have made significant progress in landscape resources recognition, inventory and protection as well as in landscape management and planning. It has not just given new impulse to basic studies in landscape ecology and landscape-based spatial management but strongly influenced the integration of landscape issues into the formulation of national, regional and local spatial policies.

The general objective of the symposium is to share knowledge and experiences on the links between European policies and landscape ecology. It will discuss how landscape ecology is an inter- and transdisciplinary science, bridging natural and social sciences for a holistic understanding of landscape as a socio-ecological system. Among main policy areas that are to contribute to environmental transformation, several directly concern landscape ecology, such as biodiversity, sustainable agriculture and forest, others indirectly, sustainable mobility and renewable energy. The symposium will focus on how policies, stimulate the development of landscape ecology research on the one hand, while landscape ecological understanding contributes to the development of resilient landscapes and societies. Furthermore, we want to look beyond European policies and would like to reflect these issues with experiences from Europe and all around the world to learn from each other.



## IMPLEMENTATION OF THE COUNCIL OF EUROPE LANDSCAPE CONVENTION IN FINLAND: A HOLISTIC APPROACH TO IDENTIFY NATIONALLY VALUABLE LANDSCAPE AREAS

Nina Ahola

Finnish Environment Institute

Nationally Valuable Landscape Areas are the most typical cultural landscapes in Finnish countryside. These landscapes are valued for their diverse, culturally shaped nature, agriculture, natural livelihoods, and traditional architecture. Valuable landscape areas were inventoried in 2010-2015. The inventory was supplemented in 2016-2021 based on the feedback from two public hearings and several consultation rounds, in conjunction with authorities, local experts and inhabitants. The Ministry of the Environment guided the work. The outcome of the inventory was accepted by Government Decision in 2021.

According to the national-level inventory, there are 186 valuable landscapes. Most of the areas are representative agricultural landscapes around the country. A few of them are Sámi cultural landscapes that represent landscapes typical to reindeer husbandry and other natural livelihoods, and a few are marked by archipelago livelihoods or forestry. Evaluation considered e.g., landscape structure (vegetation zones, soil, water, topography, bedrock), land cover, monuments, history, age of building stock, livelihoods, and recreational use of areas. Identified landscapes are also rich in biodiversity. Hence, election criteria include natural and human shaped features and interaction of the two. To identify the most outstanding landscapes, areas were assessed by combining these characteristics.

Identification of valuable landscapes contribute to the goals of the Council of Europe Landscape Convention (CoELC) regarding sustainable development, management of landscapes, and harmonising changes. The inventory meets the requirements of CoELC's measures on identification and assessment of landscapes. The process is also connected to awareness raising as well as participation and inclusion measures derived from CoELC. In Finland, landscapes are recognized in Land Use and Building Act in which it is required that the values of cultural environment and natural heritage are safeguarded in land use planning – landscape areas should be observed in regional and detailed plans.

In addition to their significance to land use, landscape areas benefit from their status when, for example, applying for environmental subsidies. Landscape changes are monitored and assessed in these areas as well. Identification of landscape areas contribute to promoting appreciation of landscapes in terms of natural and cultural diversity. National landscape policy aimed at the protection, management and planning of landscapes is currently under preparation in accordance with CoELC. When defining policy goals and measures, balancing competing interests in the society is a challenge to be considered. Valuable landscapes form one part of the knowledge base needed to set quality objectives for all different types of landscapes reflecting also views of the public about their surroundings and livelihoods in the future.

## LANDSCAPE DIVERSITY IN THE WIELKOPOLSKIE VOIVODESHIP AND THE CURRENT AS WELL AS FUTURE DIRECTIONS OF ITS PROTECTION

Sylwia Bródka · Marta Kubacka · Andrzej Macias

Adam Mickiewicz University

**A**s part of the implementation of the provisions of the European Landscape Convention, a landscape audit of the provinces has been underway in Poland for a few years. The main objectives of the audit are the delimitation of landscape units, assessment of their values, and identification of the priority of landscapes to be protected. This study presents the results of research on the landscape division of the Wielkopolskie voivodeship and a geostatistical analysis of the differentiation of ecological units. With reference to legal regulations in force in Poland, the landscape diversity of the province was characterized using two divisions: geophysical regionalization and landscape typology. In the case of regional division, the meso- and microregions of physical and geographical rank are referenced. The proposed microregional division is the first example in Poland of such a detailed landscape analysis completed for the area of the voivodeship. In the case of typological division, the study conducted in cooperation with the Wielkopolska Bureau of Spatial Planning in Poznań was used. The statistical analysis included metrics to quantitatively characterize landscape composition.

The results of the study were then compared with the distribution of areas associated with different forms of landscape protection such as national parks, landscape parks, and protected landscape areas. The applied methodology and the results obtained indicate the important role of physical and geographical microregions in the complex analyses of landscape diversity and their broad application in procedures connected with landscape planning and environmental protection.

## DOES SPATIAL PLANNING IN THE POLISH CARPATHIANS MAKE SENSE?

Agata Ćwik

University of Rzeszów

**R**atification of the European Landscape Convention (ELC) by Poland at the beginning of the 21st century coincided in time with the adoption of The Framework Convention on the Protection and Sustainable Development of the Carpathians (Carpathian Convention – CC). Although the other document is not focused directly on the notion of landscape, this comprehensive approach to the preservation of the Carpathians' natural and cultural values is a common platform that connects both these documents. In recent years, the CC has become an inspiration to undertake several significant programs designed to preserve or restore the Carpathian landscape values (among others, Carpathians Unite – mechanism of consultation and cooperation for implementation of the CC). Numerous guidelines, recommendations, and even strategic documents, such as the Strategy for Sustainable Tourism Development of the Carpathians (2014), which should be implemented through spatial planning, have been created as an outcome of the activities implementing the CC. Although these documents take into account landscape ecology knowledge it turns out that chaotic land management goes against scientific knowledge and international legislation. An example of this situation can be the development of built-up areas occurring at inappropriate sites such as, for instance, landslide prone areas, floodplains, and steep slopes, but also even the phenomenon of development dispersion which generates numerous man-environment conflicts.

A pilot study conducted in more than 200 municipalities in the Polish Western Carpathians showed that out of almost 1,315,000 buildings existing there as much as 4% are located in landslide areas, with this percentage ranging from 0 to 21% for the individual municipalities. What is more, this indicator is not correlated in any way with the respective municipality's planning situation since there are building developments in landslide prone areas both in the municipalities where there are no local spatial plans at all and in areas that are covered in whole by such plans (Statistics Poland data, as of 2020). Spearman's correlation coefficient ( $r_s$ ) for this relationship is -0.0731. A question therefore arises – what factors cause land management in this very valuable part of Poland to go against the knowledge about the functioning of the natural environment if local spatial plans should incorporate such knowledge and prevent wrong location decisions? This question still remains open.

## OPPORTUNITIES AND BARRIERS TO IMPLEMENTATION OF THE EUROPEAN BIODIVERSITY STRATEGY 2030 – URBAN FOREST PERSPECTIVE

Renata Giedych · Agata Cieszewska

Warsaw University of Life Sciences

**W**ithin the administrative boundaries of cities there is currently a significant share of undeveloped land, including agricultural and former farmland. In the urban policies pursued so far they have usually constituted a reserve for development. Currently, however, spatial planning in Poland needs to prepare land balances in relation to demographic trends, which means that cities will have to change their policies on such land. In Polish cities, arable land and former arable land cover 42.6% of the area on average. In this context, an important proposal contained in the European Green Deal strategy, together with the New Forestry Strategy, is to increase the proportion of woodland not only in rural areas, but also in cities. This policy aims to improve climatic conditions relevant to climate change adaptation, as well as biodiversity and ecological connectivity. Therefore, agricultural and post-agricultural areas in cities – especially on weaker soils – could be a place of implementation of new EU strategies. Paradoxically, the lack of implementation instruments at the national level is an obstacle. Currently, afforestation mechanisms apply only to rural areas. In this context the initiatives taken by municipalities, which take matters into their own hands, are important. A good example is the Programme for Increasing the Forest Cover of the City of Kraków for 2018-2040.

## COMMONNESS AND DIVERSITY OF LANDSCAPE IN POLAND

Jarosław Balon · Paweł Krąż · Wojciech Maciejowski

Jagiellonian University

The landscape in Poland is diverse in terms of: the number of landscape types, the number of landscape units, area, shape, thickness, origin, human activity and other features. Many types of landscapes in Poland are common across the country, and some landscapes are present only in selected regions of Poland. For the purposes of the landscape audit, the identification and assessment of the landscape is performed within the administrative boundaries of voivodships. In that case, will it be possible to rationally protect and manage landscapes that are particularly important to Poland or societies in general? In the paper, we will present various approaches to the commonness and diversity of Polish landscapes at various scales of detail: national, regional and local, with the use of various landscape typologies, databases and landscape indicators.

## GREEN DEAL AND HERITAGE PROTECTION: OPPORTUNITIES AND THREATS OF SUSTAINABLE MONUMENT REVITALIZATION

Ewa Mackiewicz

University of Silesia in Katowice

The cultural landscape contains elements influencing its perception. The architectural monuments and historical spatial layouts determine the landscape's value and specificity. Civilisation causes the constant evolution of the landscape, and the changes that occur may enhance the aesthetic of the surroundings or cause its degradation.

The monuments protection relates to several restrictions to preserve their historic and aesthetic values. Each interference with the monument requires conservation services permit that guard its authenticity. Implementing pro-environmental solutions and green infrastructure is challenging due to the restrictions above. At the same time, the contemporary climate condition requires radical measures to reduce the negative impact on the environment. The Green Deal assumes, among other things, increasing buildings energy efficiency. At the interference between heritage and environmental protection issues, questions arise about priorities. Restrictions imposed on monuments make it difficult, sometimes impossible, to undertake retrofit available for modern construction. Improving energy efficiency and utility values of old buildings is possible thanks to an interdisciplinary analysis covering both the authentic substance and the available pro-ecological solutions that will not affect monuments' historic and aesthetic values .

Sustainable renovation requires an audit that considers ecological, economic and cultural factors. The surveys conducted among the administrators of residences allow for analysing the conditions for applying pro-environmental solutions in historic buildings. They lead to identifying factors supporting or limiting sustainable renovation, which is essential for the effective management of cultural heritage. The research results are the basis for developing tools for managing monuments revitalisation.

Can the use of modern solutions save a monument? Do the applied pro-ecological technologies bring the expected benefits, or maybe violate the historical value of the heritage? Will a historic building not adapted to modern standards be abandoned due to high maintenance costs? How to conduct revitalisation to increase economic and energy efficiency without affecting the historical values? These questions require interdisciplinary actions preceded by a holistic analysis of heritage revitalisation conditions.

Innovative solutions in the revitalisation of monuments are an opportunity to adapt them and increase the comfort of use. Improving energy efficiency and the use of blue-green infrastructure also optimises operating costs. Unfortunately, focusing only on ecological, functional and economic effects may significantly affect the historical, aesthetic and landscape values. When looking for optimal solutions, it is necessary to initiate dialogue between stakeholders, particularly the owners of monuments, conservation services and environmental protection institutions.

## THE SOIL DEAL IN HORIZON EUROPE: LIVING LABS AT THE LANDSCAPE SCALE

Teresa Pinto-Correia

University of Évora

The Soil Deal for Europe is one of the five missions approved by the European Commission in 2021, to be set in place step by step until 2026. Its goal is set to get in place 100 living labs and lighthouses to lead the transition towards healthy soils by 2030. These 100 living labs are to be created in 100 regions (41% of the EU 242 NUTS2 regions), each one dealing with specific land use systems, characteristic of a given regional landscape. Living labs are 'real-life' places for experiments and innovation aiming for soil regeneration, and will be composed of 10-20 individual experimental sites and at least one lighthouse (demonstration farms), delivering, for all land-use types (farm, forest, urban and industrial):

- knowledge on socio-economic and behavioural drivers of the adoption of innovations or beneficial practices (mission objectives 1-6);
- tested and validated land or soil management practices with significant soil health improvement and uptake potential (mission objectives 1-6);
- practice-proof monitoring technologies and indicators (mission objectives 1-6);
- demonstration activities and events on lighthouse and other experimental sites in rural and urban areas (mission objectives 1-6 and 8);
- elements for research and innovation needs from practitioners.

In this presentation we will present the strategy of this mission, and how living labs are anchored in the landscape perspective. The strategic option to get these living labs installed links to the acknowledgement that if we want to go ahead in soil regeneration, it is people and their management that needs to change. The mission puts people at the center of change. And therefore also the option has been to adopt a strong territorial approach, so that networks of those people who relate to soil management are mobilized and activated to progress towards more sustainable soil management. The process of research is built in co-construction between science and practice. And in science, between multiple disciplines. Citizens who are users of the landscape (supported in a given soil) as well as consumers, are to get more involved in options on soil management in their region. The systemic perspective that is anchored on the landscape will therefore be central to implement successful living labs for the future.

## IMPLICATIONS OF THE EUROPEAN GREEN DEAL ON LANDSCAPES: A CROSS COUNTRY ANALYSIS ON LAND USE POLICIES

Werner Rolf<sup>1</sup> · Isabel Loupa-Ramos<sup>2</sup> · Agata Cieszewska<sup>3</sup>

<sup>1</sup>Technical University of Munich · <sup>2</sup>Technical University of Lisbon · <sup>3</sup>Warsaw University of Life Sciences

This communication aims to provide an outlook how in the latest developments Member States across Europe are implementing main policy objectives and strategies into their policy framework. This talk will present an outcome of scanning of recent policy documents in three different countries, namely Portugal, Germany, and Poland.

In Portugal, taking advantage of the revision of policy guidance for the 2020-2030 period in different sectors lead to a prolific integration Green Deal objectives in national legislation. Thus, the scanning focuses on strategic policies and programs updated during 2020 and 2021 with expected impact on the landscape.

In Germany, the scan focuses on coalition agreement of the new government in place, elected September 2021, entitled “To dare more progress – an Alliance for freedom, justice and sustainability”.

In Poland, the work on individual strategies is quite slow, which results from political conditions, but the existing legislation allows to assess the direction of activities related to EMF Cross country analysis aims to identify ambitions of the targets, prioritizations, expected magnitude of impacts on land use and landscape. The results will be discussed in the context of the green-on-green debate and its contribution sustainable landscape development.

Based on the first outcomes being presented we want to discuss with participants about similarities or differences to further EU member countries as well as other parts of the world, with similar Green Deal Approaches. Based on main objectives of the European Green Deal this talk will present a cross case analysis in three different countries, namely Portugal, Germany, and Poland.



## FROM GEOGRAPHICAL REGIONS TO LOCAL LANDSCAPES – ABIOTIC-BIOTIC HIERARCHY AND HUMAN IMPACT

Jerzy Solon<sup>1</sup> · Andrzej Richling<sup>2</sup> · Paweł Babul<sup>3</sup> · Katarzyna Jabłońska<sup>4</sup>

<sup>1</sup>Institute of Geography and Spatial Organization, Polish Academy of Sciences · <sup>2</sup>Warsaw University · <sup>3</sup>Podlaskie Office of Spatial Planning in Białystok · <sup>4</sup>Podlaskie Office of Spatial Planning in Białystok Branch in Suwałki

The European Landscape Convention, enacted in 2000 and ratified by Poland in 2004, recommends that State Parties, i.a. identify all landscapes across the territory and analyze their characteristics and the forces and pressures transforming them. This recommendation was taken into account in the 2015 Act, which introduced, in particular, the obligation to conduct a so-called landscape audit, i.e. a periodic comprehensive review and assessment of the condition of Poland's landscapes. This, in turn, resulted in the need to develop a widely accepted methodology for delimitation, typology and valorization of current landscapes and to place it within the framework of well-established theoretical concepts developed on the ground of landscape geography and ecology.

The initially developed conception assumes distinguishing spatial units (landscapes) 'from the top', whereby the basis is the division into physical-geographic regions. It required additional elaboration of a new, more detailed division into mesoregions and taking into account – if possible – division into microregions. Next, meso- or microregions, distinguished only on the basis of abiotic criteria, are divided into basic landscape units (landscapes), characterized by uniform landscape matrix. As a result of these subdivisions, the scale of size of individual landscapes should be selected so that they still have a geographical dimension and ecological sense, and at the same time enable the analysis of internal structure with the help of landscape ecological and landscape architecture tools. In doing so, the distinguished units must meet the following conditions: (1) homogeneity of the landscape matrix while maintaining spatial heterogeneity, (2) preservation of functional links between spatial elements of the landscape, and (3) repeatability of spatial structure and physiognomy in different parts of the landscape. To make the results of these measures comparable across the country, a completely new typology of landscapes was also developed.

Based on an example from the northern part of Podlaskie voivodeship, we would like to present preliminary results of this procedure, as well as the spatial differentiation of the area at different scales, corresponding to particular types of natural and landscape units, and against this background discuss the most important variables regulating natural and economic processes, and indicate the links between scientific knowledge and different levels of spatial planning taking into account the preservation of natural value and historical-cultural heritage.

## SOCIAL AWARENESS OF FOOD WASTE AND EVALUATION OF ACTIVITIES CARRIED OUT BY RETAIL OUTLETS ON THIS MATTER, BASED ON THE EXAMPLE OF THE CITY OF POZNAŃ

Milena Zięba · Sylwia Bródka

Adam Mickiewicz University

The problem of wasting food in the world is a very serious threat to the environment, society and economy of many countries with different levels of civilization development. The production and distribution of food causes disasters such as greenhouse gas emissions, excessive water consumption and other direct or indirect impacts on other environmental resources. In Poland, about 4.8 million tons of food is wasted every year (Project PROM: <https://projektprom.pl/>). The main element of the food chain responsible for this problem are consumers, who annually generate 60% of food waste in the country (approximately 3 million tonnes). A certain amount of food that would normally expire and become unusable goes to Food Banks and is obtained by other food related organisations. However, the above-mentioned activities are not sufficient, which is related to the need for a broader approach to this issue, taking into account different phases of the product life cycle.

Among the measures taken to combat the problem of food waste is a set of legal regulations called the “European Green Deal”, the task of which is to support European Union countries in changes for a resource-efficient and competitive economy. One of the proposed solutions is the “From farm to table” strategy, which means creating a sustainable food system in Europe. A bill passed by the Polish government on 19th July 2019 concentrates on counteracting food waste (Dz.U. 2019 poz. 1680), which imposes an obligation on food-related businesses to conduct educational and information campaigns as well as their cooperation with other related companies when it comes to free provision of food products.

As part of the research, a survey was carried out to identify the causes of food waste by the citizens of Poznań, as well as to determine the role of social awareness and participation in limiting the negative effects of this phenomenon. The survey will allow to obtain reliable information on the state of social knowledge in relation to the identified problems. In addition, the questionnaire included questions related to the assessment of the effectiveness of initiatives taken by retail outlets in terms of reducing food wastage. The obtained results will surely make it possible to identify the strengths and weaknesses of the activities currently undertaken and to indicate the directions of their optimization in the future.

# 7. Agricultural and productive landscapes

## *Finding future pathways for sustainable agricultural landscapes in Europe: concepts and empirical evidence in different European contexts*

### **Symposium organisers**

Vasco Diogo (Swiss Federal Institute for Forest, Snow and Landscape Research), Felix Herzog (Agroscope), Teresa Pinto-Correia (University of Évora), Peter Verburg (Vrije Universiteit Amsterdam)

### **Summary**

The symposium aims to provide a platform for exchanging with researchers that are currently working on projects aiming to identify future pathways for sustainable agricultural landscapes in the European context. This may include different perspectives and concepts such as sustainable intensification, precision agriculture, agroforestry, High Nature Value (HNV) farming, organic farming, sustainable water use in agriculture, and climate-smart agriculture. Participants are invited to present study designs, methods and results from their projects.

### **Description**

In the coming decades, agricultural development in Europe is expected to face a multitude of complex sustainability challenges. Firstly, climate change is likely to affect crop yields and water availability, and consequently, the economic viability of agricultural systems. In addition, there is a strong pressure to keep improving production efficiency in order to remain competitive in the increasingly globalised commodity markets and to ensure a sufficient supply of food for a growing world population. At the same time, there is also an increasing awareness that current intensive agricultural practices significantly contribute to severe socio-ecological impacts, including biodiversity loss and the degradation of important ecosystem services. As a result of these challenges, divergent trajectories are currently observed across Europe: scale enlargement and further intensification of production in some areas, replacement of conventional agriculture by less intensive production systems in others, or farmland abandonment in remote low-fertility areas.

Several alternative concepts and approaches has been proposed to reconcile the need to achieve food security with the requirements for minimising the environmental impacts of agriculture. Such pathways include, for example, sustainable intensification, agroforestry, High Nature Value farming, organic farming, sustainable water use in agriculture, and climate-smart agriculture. These approaches have been recently receiving the attention from the policy arena as solutions for sustainable food production, as evidenced in the EU's Farm-to-Fork Strategy. Finding the solutions that can best address these challenges is, however, highly site-specific, depending on the local characteristics of the production systems and their political, economic and socio-cultural contexts. Trade-offs beyond the farm-level may also emerge, such as broader impacts on landscapes' functions and cultural value, and displacement of production. Landscape ecology can contribute to better understand and assess the multi-scale benefits and impacts of alternative pathways, while taking into account the heterogeneity of different contexts. Recent research has been focussing on identifying alternative pathways for sustainable agricultural landscapes in Europe, as well as assessing their potential sustainability trade-offs, and finding what triggers and incentives may be required to achieve these pathways.

The objective of this symposium is to synthesise current landscape ecology perspectives of sustainability pathways in the context of European agriculture. The following questions will be addressed:

- What are potential alternative development pathways of sustainable agriculture in different European landscapes?
- What broader trends affecting agriculture (e.g. societal preferences, climate change, technology development) need to be accounted for while envisioning such pathways?
- What trade-offs may emerge from these pathways?
- What incentives may be required to enable their operationalisation?

## SCALE-DEPENDENT EFFECTIVENESS OF ON-FIELD VS OFF-FIELD AGRICULTURAL ENVIRONMENTAL MEASURES FOR WILD BEES

Péter Batáry<sup>1</sup> · Teja Tscharntke<sup>2</sup>

<sup>1</sup>Centre for Ecological Research · <sup>2</sup>University of Göttingen

The effectiveness of agri-environment schemes depends on scheme type, taxon and landscape. Here, we show how spatial scale, i.e. studied transect, field or farm level, and controlling for yield loss, can drastically change the evaluation of biodiversity benefits of on-field (organic farming) vs off-field (flower strips) schemes. We selected ten agricultural landscapes in Central Germany, each with a triplet of winter wheat fields: one organic, one conventional with flower strip, and one conventional without flower strip as a control. We surveyed the abundance of wild bees at field edges in two years.

We found that data at the transect level may lead to misleading evaluations because flower strips, covering only 5% of conventional fields, support fewer bees than large organic fields (Batáry, Tscharntke, 2022). However, if a 50% cereal yield loss of organic farming is considered to compare equivalent yield levels, 50 ha conventional plus 50 ha flower strip farming promotes 3.5-times more bees than 100 ha organic farming. In conclusion, considering various scales in the evaluation of agri-environment scheme measures is necessary to get a balanced understanding of their ecological and economic effects and their effectiveness.

Batáry P., Tscharntke T. (2022). *Scale-dependent effectiveness of on-fields vs. off-field agri-environmental measures for wild bees*. *Basic Appl. Ecol.*, 62: 55-60.

## WEED COMMUNITIES ARE MORE DIVERSE, BUT NOT MORE ABUNDANT, IN BOCAGE LANDSCAPES

Sebastien Boinot<sup>1</sup> · Cendrine Mony<sup>2</sup> · Aude Ernoult<sup>2</sup> · Stéphanie Aviron<sup>1</sup> · Claire Ricono<sup>2</sup> ·  
Eloïse Couthouis<sup>1</sup> · Guillaume Fried<sup>3</sup> · Audrey Alignier<sup>1</sup>

<sup>1</sup>INRAE, UMR 0980 BAGAP · <sup>2</sup>UMR CNRS ECOBIO · <sup>3</sup>Anses, Entomology and Invasive Plants unit of the Plant Health Laboratory

**A**groforestry systems provide many ecosystem services, including biodiversity conservation in agricultural landscapes, but their effects on weed communities remain poorly investigated. In this regard, bocage landscapes could affect weed communities through two main processes: increased environmental heterogeneity in arable fields, and plant spillover from hedgerows. Due to differences in management intensity, these bocage effects are also likely to vary between farming systems (conventional vs organic).

We sampled arable weeds in 74 fields, half under conventional farming and half under organic farming, located along two independent landscape gradients: total length of hedgerows and organic farming cover, in Brittany (France). We analysed the effect of bocage and farming practices on species diversity, functional diversity and functional structure of weed communities. Further, we used Ellenberg indicator values and fidelity to non-crop habitats to assess the 'environmental heterogeneity' and 'spillover' hypotheses, respectively.

Our study revealed that weed communities were more diverse, but not more abundant, in bocage landscapes. Bocage increased species diversity of weeds, but also community-weighted variance of specific leaf area, plant height at maturity and seed mass. The dominance of competitive weeds was reduced in bocage landscapes, as indicated by lower community-weighted mean but higher variance of plant height. Positive effects of bocage on weed diversity were driven by increased environmental heterogeneity rather than spillover of transient species from hedgerows. Bocage effects were generally independent of farming systems at field and landscape scales. Our results suggest that the simplification of bocage landscapes (i.e. the destruction of hedgerows) is a major selection pressure on weed assemblages, at least as important as conventional farming. Through increased environmental heterogeneity, agroforestry systems could not only enhance ecosystem services provided by weed communities, but also reduce weed-crop competition.

## LANDSCAPE LABS APPROACH FOR CO-DESIGNING INSECT-FRIENDLY AGRICULTURAL LANDSCAPES

Maria Busse<sup>1</sup> · Rosemarie Siebert<sup>1</sup> · Michael Glemnitz<sup>1</sup> · Claudia Bethwell<sup>1</sup> · Fabian Nürnberger<sup>2</sup> · Annette Bartels<sup>3</sup> · Silke Dachbrodt-Saaydeh<sup>4</sup> · Veronika Fick-Haas<sup>4</sup> · Tanja Rottstock<sup>4</sup> · Phillipp Scharschmidt<sup>1</sup>

<sup>1</sup>Leibniz Centre for Agricultural Landscape Research · <sup>2</sup>Thünen Institute of Biodiversity · <sup>3</sup>Chamber of Agriculture Lower Saxony · <sup>4</sup>Julius Kühn Institute

**F**acilitating of insects in agricultural systems is an urgent matter because insects are dramatically decreasing in numbers and variety whereas they play a crucial role for ecosystem functioning and by providing ecosystem services. Recent agri-environmental schemes fail to counteract the declining trends. One reason is the misfit between the claim for ecologically efficient ‘dark green’ measures by ecologists and the selection and degree of their uptake by farmers. Actually, there is (1) a quantitative and qualitative lack of implemented insect-friendly farming practices, (2) little knowledge about farmers’ perspectives concerning their problem awareness and attitudes, and (3) need for accepted solutions at landscape level. To address these gaps at the science-practice-policy interface, we established the project FinAL that combines a living landscape lab approach with a co-design process in three German landscapes. The landscape lab approach represents a promising pathway to provide more food resources as well as living and reproduction habitats for insects in agricultural landscapes by transdisciplinary collaborations. In our landscape labs, we involve different disciplines (e.g., agri-ecologists, entomologists, economists, and social scientists) and landscape key actors (farmers, other land users, advisory services, nature conservation organisations, etc.) to co-design mainly production-integrated solutions and collectively experimenting such innovative solutions in real life settings. We developed an integrative process with iterative feedback-loops, which encompasses stakeholder perception and role analysis and a sequence of co-design workshops per landscape laboratory. The workshop aimed at (1) jointly discussing synergies/trade-offs, political-institutional framing conditions, and the practicability of insect-friendly measures, (2) co-designing of preferred insect-friendly measures, and (3) participatory mapping to locate measures at the landscape scale for further implementation.

In addition to a detailed description of co-design process, we want to present the main results and reflect our co-design process in the landscape labs. As supporting factors for the collaborative process we identified (1) building upon established science-practice networks, (2) working with regional intermediaries who function as landscape coordinators, (3) active and continuous collaborations at the landscape level which lead to co-learning and enhanced social capital, and (4) financial compensation of measures as incentive for farmers. To achieve the goal of facilitating of insects in agricultural systems we consider the following aspects as favourable: (1) taking the whole landscape into account, including agricultural production areas and semi-natural habitats, (2) using guiding principles for landscape transformation, and (3) scientifically monitoring and evaluating of insects, ecosystem services, and vegetation.

## MAPPING RESOURCES AND GOOD PRACTICES: CORNERSTONES FOR A SUSTAINABLE VALORIZATION OF INNER RURAL AREAS

Rebekka Dossche

University of Genoa

**R**ural areas in Europe have undertaken different types of trajectories. Mediterranean mountain areas, for example, are characterized by landscapes that were once notorious for its man-maintained agro-silvo-pastoral systems, with a high balance between human management, restrictive environmental conditions and biological diversity. Many of these landscapes underwent a process of degradation due to large-scale land abandonment since the second half of the 20th century, particularly in remote low-fertility areas.

Today, those rural areas still have a lot of resources and good practices, which are not valorized within the mainstream paradigm of rural development, but are rather important within a (neo-) endogenous rural development approach. This contribution wants to grasp the potential and the issues of rural mountain areas, with the aim to propose a series of recommendations and innovative ideas and strategies to be implemented by local policy organs.

The research project TeRA SoRA “Resources and good practices in inner areas: a model of mapping the potential and issues for a sustainable valorization of the territorial heritage” was financed by the private foundation Compagnia di San Paolo. The case study is composed by 30 municipalities classified as integrated or internal mountain areas in Piedmonts Apennines (Istituto di Ricerca Economico Sociali, 2019). 17 municipalities are considered ‘inner areas’ by the National Strategy for Inner Areas (Strategia Nazionale delle Aree Interne), a direct action to support sustainable territorial competitiveness, in order to counter the demographic decline that characterizes the Italian internal areas. The aim of the Strategy is to create new income opportunities and to ensure that the inhabitants have access to essential services (local public transport, education and social and health services) and to improve the maintenance of the territory itself.

An online mapping survey was conducted (Maptionnaire) to collect a first dataset of landscape potential and problems. The survey was disseminated through eight stakeholders (a cooperative farm, environmental organizations, school institute, socio-cultural organizations, etc.) and four partners (three mountain unions and one socio-cultural organization). The data was analyzed within a GIS environment and through grounded theory. The results were discussed during a round table discussion with the local stakeholders. The outcome was a series of basemaps that were used for interactive mapping meetings. In this presentation, we will show how mapping the potential and issues within rural communities supports the implementation of the National Strategy at the local level.



## FARMER CLUSTERS FOR REALISING AGROBIODIVERSITY MANAGEMENT ACROSS ECOSYSTEMS (FRAMEWORK) – EXPERIENCES FROM THE FIRST YEAR OF THE CZECH FARMER CLUSTER

Iris C. Bohnet<sup>1</sup> · Kristýna Drhlíková<sup>1</sup> · Markéta Hendrychová<sup>1</sup> · Kristina Janečková<sup>1</sup> · Emilie Trakalová<sup>1</sup> · Jan Travníček<sup>2</sup> · Lukáš Zagata<sup>1</sup>

<sup>1</sup>Czech University of Life Sciences Prague · <sup>2</sup>Czech Organics

**F**RAMework is a H2020 funded transdisciplinary research project (2020-2025) that builds on the Farmer Cluster approach to increase agrobiodiversity across Europe. Farmer Clusters have been successfully established in the UK where farmers and land managers are working together in their local area, supported by a facilitator, to collectively deliver greater landscape-scale biodiversity outcomes than they could on their own. Over the past 18 months, 11 Farmer Clusters have been established in Europe and the UK as part of FRAMework. First projects to increase biodiversity across the farmed landscape have been identified and are being implemented in the Farmer Clusters. Common monitoring protocols have been developed for birds, pollinators, and vegetation and applied by experts in the field in all Farmer Clusters. Farmers and citizens will be trained in monitoring to increase awareness and understanding of agrobiodiversity in the landscape. A citizen observatory and information hub, created for the project, will enable farmers and citizens to share information on biodiversity and agriculture.

In the Czech Republic, the first Farmer Cluster has been established in southern Moravia. Capitalizing on the networks and ideas of a well-established organic farmer, nine farmers, who manage about 3000 ha, collaborate in the Czech Farmer Cluster. Facilitated by a part-time professional advisor, the Farmer Cluster has collectively progressed ideas on how to improve agrobiodiversity in their landscape. A first project is being implemented, birds, pollinators, and vegetation has been monitored and farmers have been interviewed to establish a baseline for FRAMework. Experiences and some early lessons from the first year of the Czech Farmer Cluster will be shared in our presentation.

## THE ART OF BLUE-GREEN ALLIANCES. CO-CREATING SUSTAINABLE AGRICULTURAL LANDSCAPES

Sylvie Fosselle · Jeroen De Waegemaeker

Flanders Research Institute for Agriculture, Fisheries and Food

Over the past years, North Western European agriculture was hit hard by re-occurring summer droughts, thus questioning the sustainability of our agricultural landscapes. During drought events, policy making concentrates on reactive measures, such as the ban of water extraction by farmers. Yet there is also a need for developing pro-active measures including the development of climate-proof agricultural landscapes. The latter comprises the creation of blue-green infrastructure in agricultural areas such as, for example, the construction of infiltration ponds and the restoration of depressional wetlands. Operating at the landscape level entails that individuals and organisations living and working in the area should form local alliances to plan, co-create, implement and manage blue-green infrastructure. In rural areas, these alliances comprise farmers, land owners, water managers, nature conservationists, residents and policy makers.

In Flanders, many local alliances were formed over the past five years, each of them aiming to develop climate-proof agricultural landscapes by creating a blue-green infrastructure. These alliances are supported by multiple governmental programs and initiatives set-up in order to incentivize the development of blue-green infrastructures in Flanders' agricultural landscape. In this presentation, we show the obstacles and the opportunities in the operationalization of blue-green infrastructure, focusing on the role of local alliances. In particular, we investigate farmers' inclusion in the local alliances since they are the principal land users of the agricultural area, they own a lot of land and have tacit knowledge of the local area. To that end, we review local reports and studies, conduct interviews with key stakeholders from the local alliances and facilitate the set-up of a community of practice (CoP) of the local alliances to better understand what kind of knowledge and skills they have and exchange. In addition, we study how the design and the co-creation of the blue-green infrastructure is organized within a local alliance.

We conclude that setting up social learning between local alliances that are responsible for the implementation is extremely important in order to incentivize the development of blue-green infrastructure. Therefore, our results suggest that policy making must support social learning just as much as technical knowledge building in order to promote pathways to sustainable agriculture such as the development of blue-green infrastructure. Because social learning is a lengthy and fickle process, we advise policy makers to support the social learning in a structural way rather than through temporary, sporadic governmental programs. Furthermore, we highlight that alliance building must start from the social dynamics already present in the area, and thus the co-creation of a blue-green infrastructure is inherently tailor-made and likewise requires tailor-made incentives.

## DISENTANGLING THE INTERRELATED ABIOTIC AND BIOTIC PATHWAYS LINKING LANDSCAPE COMPLEXITY AND CROP PRODUCTION

Frederik Gerits<sup>1,2</sup> · Lies Messely<sup>2</sup> · Bert Reubens<sup>2</sup> · Kris Verheyen<sup>1</sup>

<sup>1</sup>Ghent University · <sup>2</sup>Flanders Research Institute for Agriculture, Fisheries and Food

Landscape complexity and its related functional agrobiodiversity (FAB) has severely declined during the last decades, resulting in detrimental effects on multiple agro-ecosystem services such as natural pest control and pollination. Complexity stands for both compositional and configurational heterogeneity and influences the effectiveness of local measures to increase FAB-based ecosystem services. The impact of landscape complexity on multiple ecosystem functions is, however, largely underexplored.

To study landscape scale effects, we used standardized mini-gardens of 1 m<sup>2</sup> planted with ten different vegetable crops as phytometers to monitor multi-crop yield and herbivory in combination with the functional arthropod community and microclimate. We installed the gardens at locations with variable surrounding landscape complexity, providing the explanatory variables. The vegetables were selected to have contrasting requirements in terms of, for example, nutrients, growth conditions or pollination services, as well as a different susceptibility to pests. Monitoring of the mini-gardens, installed in the towns of Melle, Merelbeke and Oosterzele in Flanders (Belgium), was done in 2018 and 2019 together with 90 citizen scientists.

Our results show that an increasing share of high green vegetation (> 3 m high) in a 500 meter radius is important to buffer the temperature variation in the gardens, while the share of agricultural land use has an opposite effect. Agricultural land use furthermore positively influences the activity-density of predatory arthropods and pollinators, most probably due to a concentration effect. These abiotic and biotic variables affected leaf herbivory and crop productivity of crops in the mini-gardens in different ways, resulting in a net positive effect of semi-natural habitat on the overall yield across the crops. These outcomes indicate that there are different interrelated pathways to consider when managing for landscape scale variables such as high green vegetation and arable land use to shape the right biotic circumstances for multiple agro-ecosystem services. In 2021 the experiment was repeated with 25 mini-gardens in the Campine region in Flanders, in the towns of Geel and Laakdal. The comparison of the results from both spatial independent landscapes will be presented in this session and will help to generalize the outcomes towards identifying context-sensitive pathways for sustainable agriculture in Flanders.

## TRANSFORMATIVE LEARNING ABOUT AGROBIODIVERSITY IN A TWO-YEAR PARTICIPATORY TRAJECTORY

Frederik Gerits<sup>1,2</sup> · Kris Verheyen<sup>1</sup> · Bert Reubens<sup>2</sup> · Lies Messely<sup>2</sup>

<sup>1</sup>Ghent University · <sup>2</sup>Flanders Research Institute for Agriculture, Fisheries and Food

**A**grobiodiversity has to be reinforced in order to enhance conservation efforts and support the provision of multiple ecosystem services in rural areas. Achieving this in an effective and efficient way requires the upscaling of measures promoting agrobiodiversity from the parcel to the landscape level. Interventions at the landscape level require multiple actors to become involved, including farmers, private land owners, communities, nature organizations. This implies that questions arise about how we can engage different stakeholder profiles to take action for agrobiodiversity and support multiple agroecosystem services. One way to stimulate engagement is through learning in citizen science projects, where actors interact with the positive and negative effects of agrobiodiversity. Therefore, we need a better understanding of what aspects of citizen science projects facilitate and counteract learning outcomes towards sustainable transitions.

Here we present the learning outcomes of a citizen science project where 90 volunteers weekly interacted with agrobiodiversity in a landscape observatory in the municipalities of Melle, Merelbeke and Oosterzele in Flanders (Belgium). The observatory consisted of 40 standardized mini-gardens of 1 m<sup>2</sup>, planted with ten vegetable crops. Every mini-garden was assigned to one or more volunteers, who were all local landscape actors. The volunteers were asked to do a weekly visit of their assigned mini-garden between May and September in 2018 and 2019 (20 visits/year). Tasks included, for instance, watering, weeding and harvesting, all according to a detailed research protocol. During both seasons, there were weekly contacts between volunteers and the research team during informal field visits, via email, in a private Facebook group and on several gathering events.

The learning outcomes were assessed by a post-project qualitative questionnaire, distributed among 84 participants. 97% of the 36 respondents reported to have learned, mostly instrumental learning about vegetable gardening and arthropods. 61% indicate that their opinion about biodiversity or attention for the environment has changed and 53% changed their behaviour. Furthermore, it was clear that learning outcomes were highly associated with the prior knowledge of the participants. Frequent communication, mutual visibility among researchers and volunteers and a tactile learning tool were identified as strong learning catalysts.

For future citizen science projects, we recommend to differentiate between participants with and without prior knowledge and connect people with different knowledge levels. Learning can be promoted when written information is experienced in a tactile tool. Successful data gathering in citizen science projects is facilitated by volunteers that feel part of an enthusiast group and engaged research team. It is therefore advised to ensure high mutual visibility of actions by volunteers and researchers. In conclusion, participatory and citizen science projects have potential to change perspectives and behaviour towards (functional) agrobiodiversity in rural areas.

## FROM GLOBAL THREAT TO LOCAL ACTION – CONSIDERING MULTIPLE DIMENSIONS OF REGIONALITY FOR SUCCESSFUL CLIMATE CHANGE ADAPTATION

Michael Glemnitz<sup>1</sup> · Jan Helbig<sup>2</sup> · Tobias Conradt<sup>3</sup> · Joachim Auerbacher<sup>4</sup> · Christine von Buttlar<sup>5</sup> · Kristina Kirfel<sup>1</sup> · Claudia Bethwell<sup>1</sup>

<sup>1</sup>Leibniz Centre for Agricultural Landscape Research · <sup>2</sup>Julius Kühn Institute · <sup>3</sup>Potsdam Institute for Climate Impact Research · <sup>4</sup>Justus Liebig University Giessen · <sup>5</sup>IGLU Goettingen

Climate change poses multiple challenges on future arable farming in Central Europe. Increased temperatures, modified precipitation patterns to the adverse of the requirements of plant growth in connection with aggravated pest pressure will most likely force farmers to modify their agronomic systems. Furthermore, agriculture is challenged by society to contribute itself to greenhouse gas reduction. Our research aims at identifying feasible adaptation measures for arable farming. We use a participatory, regionally adapted development approach and assess potential measures by interdisciplinary modelling. We aim at identifying and mitigating trade-offs between ecological advantages and economic viability.

For three research regions in Northern (Schleswig Holstein), Eastern (Fläming) and Southwest Germany (Kraichgau) we identified through a participatory approach five different adaptation and mitigation strategies with respect to arable farming. We set up standard cropping patterns by using statistical means which are regionally adjusted to observed crop prevalence. Different cropping patterns were allocated on a sub-regional scale through a clustering approach. Each crop was characterized by specific cultivation methods (e.g. ploughing or no-till), fertilization schemes (mineral or organic) and distinct plant protection schemes (in three intensity levels).

We analysed past climate data and future climate modelling results using 17 CORDEX model chains according to the RCP 8.5 pathway on a 12.5 km grid resolution. We used a statistical approach to relate climate parameters to yield levels in observational years to estimate possible yield developments in 2040 and 2060 for 10 major crops. We use the optimization model MODAM to estimate shifts in land use according to profitability. With regard to climate change, we modelled four adaptation scenarios for each region (increased intercropping, reduced tillage, a regionally adapted measure, and a scenario dedicated to GHG reduction), while considering technical and regulatory constraints.

The different adaptation strategies were evaluated against a multitude of indicators with a multi-criterial assessment. Economic indicators calculated by the database-backed calculation model ADEBAR(BE) evaluated the change in profitability due to climate change and adaptation. Ecological indicators assessing GHG emissions and energy consumption were computed using the MiLA model. In addition, soil conservation and water pollution risks were also evaluated. Estimated land use shares allowed to extrapolate the crop related results on a landscape level. This allowed for an analysis of trade-offs among the land use and adaptation options and the identification of particularly promising region-specific adaptation pathways. Finally, efficient agricultural measures to contribute to GHG reduction were identified.

## CONVENTIONAL INTENSIFICATION, AGROECOLOGICAL TRANSITION OR MARGINALIZATION? WHAT ARE THE DOMINANT AGRICULTURAL DEVELOPMENT TRAJECTORIES IN DIFFERENT LANDSCAPES ACROSS EUROPE

Julian Helfenstein<sup>1</sup> · Samuel Hepner<sup>2</sup> · Amelie Kreuzer<sup>1</sup> · Matthias Bürgi<sup>3</sup> · Peter Verburg<sup>4</sup> · Felix Herzog<sup>1</sup>

<sup>1</sup>Agroscope · <sup>2</sup>University of Bern · <sup>3</sup>Swiss Federal Institute for Forest, Snow and Landscape Research · <sup>4</sup>Vrije Universiteit Amsterdam

Since the industrial revolution of agriculture, farms across Europe have increasingly relied on external inputs such as fertilizer, pesticides, and imported feed, and have become more specialized. These developments, here called conventional intensification, have helped to increase agricultural yields manifold but have also severely altered agricultural landscapes. Intensification of agriculture and landscape simplification have led to several environmental problems, including biodiversity loss, greenhouse gas emissions, and pollution of water bodies. In response, political and social initiatives have pushed for lowering environmental costs of agriculture (agroecological transition). At the same time, marginalization is leading to widespread land abandonment in less-favored regions.

In this study, we investigated to what degree farm and landscape level development over the past twenty years align with conventional intensification, agroecological transition, marginalization or persistence pathways across Europe. We studied 15 study sites spreading a wide range of production systems and geographic contexts in Europe. In each study site, we mapped landscape change and performed interviews with farmers to determine indicators of land use and land management change. We will share results from landscape and farm level changes from the different study sites and give insights in the prevalence of development pathways in different regions of Europe.

## MODERN AGROFORESTRY SYSTEMS FOR BIODIVERSITY, ECOSYSTEM SERVICES AND FOR SUSTAINABLE INTENSIFICATION: WHAT CAN WE EXPECT?

Felix Herzog · Sonja Kay

Agroscope

**M**odern agroforestry systems, e.g. alley cropping, are expected to contribute to sustainable intensification of European agriculture. What can we learn from landscape ecological studies on woody farmland elements in this respect?

**Biodiversity:** Woody elements increase the diversity of birds and arthropods, in particular if they are well connected (Bailey et al., 2010). Bertrand et al. (2019) found that in early spring, bees, ladybeetles and lacewings mainly collected pollen of trees and shrubs. Connectedness improved pollination services, interactions with herbivorous insects, fruit set and tree growth (Schüepp et al., 2013, 2014). Yet, well connected fruit orchards were more affected by the invasive pest *Drosophila suzukii* (Henning, Mazzi, 2018) and some bird species (e.g. skylark) require open farmland without vertical structures.

**Ecosystem services:** Combining crops with trees can increase overall biomass production due to more efficient resource use. This increase comes partly at the expense of food production, once the trees are well developed (e.g. Sereke et al., 2015). Landscapes with trees are rated higher for their visual quality (Schüpbach et al., 2020) and for recreation, social interaction, and spiritual values than open farmland (Rolo et al., 2021).

**Resilience of agricultural landscapes:** Trees in farming landscapes reduce negative externalities such as erosion or water pollution, mitigate climate extremes and sequester carbon (Kay et al., 2019).

Modern agroforestry systems are likely to yield similar biodiversity effects as the ones observed for woody farmland elements in general. Agroforestry can contribute to stabilizing agro-ecosystems under climate change, but it will not necessarily increase food production. Spatial targeting will minimize potential negative effects on certain species, and improve the resilience of agricultural landscapes.

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Henning E.I., Mazzi D. (2018). *Spotted wing drosophila in sweet cherry orchards in relation to forest characteristics*. Insects, 9(3): 118.

Kay S. et al. (2019). *Agroforestry creates carbon sinks whilst enhancing the environment in agricultural landscapes in Europe*. Land Use Policy, 83: 581-593.

Rolo V. et al. (2021). *Mixtures of forest and agroforestry alleviate trade-offs between ecosystem services in European rural landscapes*. Ecosyst. Services, 50: 101318.

Schüepp C. (2014). *Habitat isolation affects plant-herbivore-enemy interactions on cherry trees*. Biol. Control, 71: 56-64.

Schüepp C. et al. (2013). *Disentangling multiple drivers of pollination in a landscape-scale experiment*. Proc. Royal Soc. B, 281: 20132667.

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## ORGANIC FARMING CAN CONSERVE BIODIVERSITY MORE COST-EFFECTIVELY IN LANDSCAPE WITH LOW COMPLEXITY

William Sidemo Holm

Lund University

Landscape complexity often influences the biodiversity benefits of organic farming relative to conventional farming. However, it is unknown how landscape complexity relates to the opportunity cost of organic farming, and its cost-effectiveness in promoting biodiversity. We developed and used an ecological-economic model to explore how increasing the proportion of organic farming affects flowering plant species richness and opportunity costs in agricultural landscapes with varying landscape complexity.

We found that landscape complexity (measured as the proportion of the landscape constituting semi-natural grasslands) affected the marginal conservation cost of increasing species richness by converting conventionally farmed arable land into organic. Generally, the marginal conservation cost increased with increasing landscape complexity. Furthermore, the marginal conservation cost increased for each preserved species, as well as with the proportion of the landscape that was already under organic management. We conclude that accounting for landscape complexity when targeting areas for organic farming can contribute to increasing the cost-effectiveness (by lowering the marginal conservation cost) of organic farming in promoting biodiversity, and thereby a more efficient use of conservation policy budgets. Thus, accounting for the impact of landscape complexity can have considerable impact on the welfare effects of policy payments to promote organic agriculture.



## ASSESSING EUROPEAN FARMERS' WILLINGNESS TO IMPLEMENT BIODIVERSITY-FRIENDLY FARMING MEASURES – COMBINING EVIDENCE FROM A SYSTEMATIC LITERATURE REVIEW AND FARMER INTERVIEWS ACROSS EUROPE

Fabian Klebl<sup>1,2</sup> · Kati Häfner<sup>1</sup> · Annette Piorr<sup>1</sup>

<sup>1</sup>Leibniz Centre for Agricultural Landscape Research · <sup>2</sup>Humboldt University of Berlin

**F**armers have a key role in halting the loss of biodiversity in agricultural landscapes. However, maintaining or improving production efficiency while minimising adverse impacts on biodiversity is challenging. In response to this, policy instruments, such as (innovative) incentive schemes, are designed to support sustainable production practices. So far, the participation in biodiversity management schemes remains insufficient to overturn biodiversity loss. Therefore, the aim of our study is to review and assess factors influencing farmers' willingness to implement biodiversity-friendly farming measures along diverse trajectories including extensification, intensification, structural diversification, and adjusted management practices.

We applied a three step approach. First, we conducted a comprehensive literature review of 457 scientific studies to identify factors influencing European farmers' willingness to implement biodiversity-friendly management. Second, derived from the findings of the review, we developed a conceptual framework addressing various scales ranging from farmers' intrinsic determinants, to farm-scale factors, to a scale of landscape, policy and society. Based on this conceptual framework, we conducted 50 semi-structured qualitative in-depth interviews with farmers in ten European countries (i.e. CH, SE, FR, NL, RO, EE, PT, ES, UK, and HU) as a third step. The interviews were audio-recorded, transcribed and translated for Thematic Analysis via MaxQDA.

We found the implementation of biodiversity-friendly management along the diverse trajectories to be highly dependent on the regional context, which is defined by the (history of) agricultural practices, traditions, culture, trust towards institutions. In addition, the degree of professionalization and commodification of agricultural practices also appeared to be important. As there is a clear lack of studies conducted in Eastern Europe, we particularly focus on these countries in our analysis.

We further identified a variety of key factors enabling or hindering the implementation of biodiversity-friendly management. We found, for instance, that programmes that are flexible, participative, and well-adjusted to the local conditions are particularly more likely to be accepted. Furthermore, the farmers' farming philosophy and self-identity (which is, in turn, is culturally shaped by the conception of what characterizes a 'good farmer') also play a significant role.

Future pathways have to incorporate effective policies that are adapted to farmers' needs and tailored to the regional context they are part of. Therefore, policies, such as the European Common Agricultural Policy, have to provide the flexibility to achieve biodiversity targets by allowing more context-sensitive adjustments while simultaneously offering financial security and stability. Thus, we recommend a hybrid result-oriented approach as an add-on for low-threshold management programmes, which allow for tailored decisions and adapted pathways in sustainable farmland management.

## “UNDERSTANDING” OF THE AGRICULTURALLY SHAPED ENVIRONMENT AS AN IMPORTANT FACTOR FOR SUSTAINABLE DEVELOPMENT IN RURAL AREAS

Judith-Maria Maruschke · Franz Wortha · Daniel Schiller

University Greifswald

The necessity for social-ecological transformations towards sustainability is becoming increasingly urgent in order to sustain environments for the benefit of future generations. Currently, the resource ‘land’ is put forward as an important domain of transformation, for example in the flagship report of the German Advisory Council on Global Change (WBGU, 2020). The report repeatedly refers to the need for changing into more sustainable land use practices, with a focus on rural areas. Land use is characterized by different kinds of societal claims, resulting in land-use conflicts and trade-offs, e.g. between agriculture and nature conservation, tourism and energy production, the spread of settlement areas, and preservation of space for recreation (Kirschke et al., 2021).

Conflict research suggests that finding common solutions is essentially promoted through understanding the point of view of others and the creation of mutual understanding (Karolczak, 2013). Based on this motivation, it is the aim of this study to create the construct of “understanding” conceptually, to validate it empirically with structural equation modeling, and to demonstrate that understanding has a positive impact on the potential for sustainable development. In this case, the focus is not on a general kind of understanding, but rather on specific aspects of understanding agriculturally shaped environments in rural areas.

The empirical data for the paper has been collected by a large-scale population survey in an urban and rural area of Western Pomerania, Germany. The region is characterized by a peripheral location in Northeastern Germany, low population density and predominantly agricultural landscapes. The particular focus will be on regional and socioeconomic differences in the “understanding” of the agriculturally shaped environment in Western Pomerania. The underlying research for this study has been carried out within the ‘Vorpommern Connect’ project funded by the Federal Ministry of Education and Research (BMBF) within the funding initiative ‘Stadt-Land-Plus’.

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## BUILDING A SHARED VISION FOR THE FUTURE OF MULTIFUNCTIONAL AGRICULTURAL LANDSCAPES. LESSONS FROM A LONG TERM SOCIO-ECOLOGICAL RESEARCH SITE IN SOUTH WESTERN FRANCE

Annie Ouin<sup>1</sup> · Nicola Gallai<sup>2</sup> · Francis Macary<sup>3</sup> · Anne Probst<sup>4</sup> · Julie Ryschawy<sup>5</sup> · Anne Sourdril<sup>6</sup>  
· Jean-François Dejoux<sup>7</sup> · Mark Hewison<sup>8</sup>

<sup>1</sup>INRAE, UMR 1201 DYNAFOR · <sup>2</sup>ENSFEA, UMR LEREPS · <sup>3</sup>INRAE, UR ETTIS · <sup>4</sup>CNRS, UMR 5245 · <sup>5</sup>INRAE, UMR 1248 AGIR · <sup>6</sup>CNRS, UMR 7533 Ladyss · <sup>7</sup>CNES-CNRS-INRAE-IRD-UT3, CESBIO · <sup>8</sup>INRAE, CEFS

Societal demand for multifunctional agricultural landscapes keeps increasing. To promote such landscapes, it is necessary to identify which components of landscape heterogeneity support multiple ecosystem services, as well as levers of action to promote these landscape properties. The social-ecological theoretical framework for multifunctional landscapes has inspired 40 years of research in the Long Term Socio-Ecological Research (LTSER) site of Vallées et Coteaux de Gascogne (VCG), which is part of the LTSER platform ZA PYGAR located in south-west France. Researchers from different domains of social and biophysical sciences have worked together to produce a multidisciplinary understanding of both drivers of VCG landscape dynamics and the role of landscape heterogeneity for multiple ecosystem services. Local features of the VCG and social systems have interacted with broader contextual drivers (e.g. CAP) and lead to the maintenance of a high level of landscape heterogeneity.

We show how the different components of landscape heterogeneity (composition, configuration but also heterogeneity of practices) influence cultural, provisioning, supporting, and regulating services. In collaboration with stakeholders, we developed scenarios to explore possible futures for the VCG landscapes. The modelling of some ecosystem services (water quality, pollination), based on the long-term monitoring are used to assess the consequences of these scenarios on landscape multifunctionality. This synthesis demonstrates how LTSER sites can be particularly relevant to explore future pathways for promoting multifunctional agricultural landscapes that are able to fulfil multiple societal demands.

## GERMAN BIOSPHERE RESERVES AS PIONEERS FOR A SUSTAINABLE AGRICULTURAL LAND USE – SUCCESSFUL SUPPORT FOR INSECT PROMOTING MEASURES

Gyde Petersen

Leibniz Centre for Agricultural Landscape Research

The alarming loss of biodiversity in agricultural landscapes has prompted a range of responses, such as agri-environmental measures (AEM) for fostering biodiversity within the Common Agricultural Policy (CAP). Current schemes lack in various ways, such as the premium height being based solely on income foregone and additional costs. Another political dysfunctionality is the current focus on modifying agricultural practices on isolated plots, even though evidence suggests that modifying practices at the landscape level may be required for an effective conservation of biodiversity. At last, AEM design focuses on fostering biodiversity as a whole and the distinction between various biodiversity functions is not clear. Yet, insect-biodiversity and its functions for ecosystems are not yet considered in AEM design.

In order to allocate agricultural subsidies more efficiently and to foster insect biodiversity, there is a need to draw conclusions about possible improvements of AEM design, implementation and allocation with respect to pollinator conservation. Too little is known about farmers' perceptions on pollinator conservation, their knowledge about pollinator's benefits and their needs with regard to the implementation of pollinator beneficial management practices.

Biosphere reserves can serve as model landscapes for insect promotion in agriculture. In response to a poor conservation status of insect species in agricultural landscapes, five German biosphere reserves dedicated themselves to set up an insect promoting transformation of their agricultural landscapes. The project addresses insect biodiversity at a regional landscape level, involving various land users' perspectives and aiming at improving land users acceptance for the implementation of insect promoting measures, incorporated at the whole farm management and landscape level.

A Qualitative Comparative Analysis (QCA) of 25 farmer cases was conducted in the frame of the BROMMI project in order to identify factors which influence farmers' intention to perform insect beneficial measures. We analyse causal relationships of factors leading to a successful integration of insect promoting measures. The study focuses on farmers' perspectives that manage their land within a certain biosphere reserve involved in the project and their differences across regions. Interviewed practitioners were considered to be open-minded towards the protection of insects.

With regard to the described challenges, the study aims to identify causalities between farmers' perceptions and knowledge of insects and their managerial needs when implementing insect beneficial measures into their production. Preliminary findings show regional differences in the choice of a given set of four insect beneficial farming practices with regard to regional and farm structure factors. Answers of farmers perceiving the term insect conservation as a means of fighting a pollinator crisis show to be in a causal relationship with farmers that define insects as beneficials and expecting positive effects towards monetary factors (implementation costs, income gains/losses, production risks) of insect-friendly farming practices.

## COLLABORATIVE LANDSCAPE PLANNING IN A CHANGING WORLD. MANAGING CONFLICTS AND MAKING PLACES IN A DANISH RIVER VALLEY

Lotte Ruegaard Petersen · Jørgen Primdahl · Jens Emborg

University of Copenhagen

Climate change mitigation and adaptation, biodiversity conservation, outdoor recreation, and rural development in an urbanized world represent major policy agendas affecting contemporary agricultural landscapes. At international and national levels the agendas are handled by different policy domains. Despite attempts to integrate, fundamentally, they are segregated when it comes to aims, measures and budgets. Eventually they will, however, inevitably meet and integrate – no matter how poorly or mal-functional it may be. If not before, this will happen as the policies hit the ground at farm or landscape level. The farmer is a target for many policy measures, but in many situations, coordination at the landscape scale is required. However, coordination does often not happen, the different schemes are implemented individually. Also land use conflicts and more place based aims such as wetland restoration, facilitation of grazing, and provision of recreational facilities need to be handled in integrated ways.

The aim of our investigation is to better understand these challenges and contribute to a framework for more collaborative and comprehensive planning, which has the capacity to deal with both conflict management and place making processes. Two overall questions have been guiding our investigation: (1) How can collaboration on the future of a river valley be organized in ways which both enable the handling of environmental conflicts and contribute to making the landscape a better place? (2) How can we analyze and understand collaborative processes aiming at planning for complex landscape futures including social learning?

Using a recently finished collaborative landscape planning process for a Danish river valley as a case, and drawing on insights from the literature in the fields of spatial planning, environmental conflict management and social learning, we analyze and discuss the questions above and investigate the conditions for collaborative landscape governance. The collaborative planning process involved landowners, citizens, various NGO's and local as well as national authorities. Data includes qualitative interviews, observations and outcomes from various meetings, events and workshops, as well as a focus group interview.

While focusing on conflicts over water course and water level management in the valley we report results and insights gained during the two year long planning process in which we have participated as action researchers. Finally, we close our presentation by a specific discussion of the likely outcomes of the river valley project followed by general reflections on how conflict management and collaborative planning together represent an approach to promote social learning and to involve and integrate separate aims and perspectives in a globalized world.

## A TYPOLOGY OF AGRICULTURAL LAND SYSTEMS TO FACILITATE TARGETED ACTION FOR FARMLAND BIODIVERSITY ENHANCEMENT IN GERMANY

Martin Pingel<sup>1</sup> · Diana Sietz<sup>2</sup> · Norbert Röder<sup>2</sup> · Maren Birkenstock<sup>2</sup> · Lisa Raab<sup>2</sup> · Sebastian Klimek<sup>2</sup> · Burkhard Golla<sup>1</sup>

<sup>1</sup>Julius Kühn Institute · <sup>2</sup>Thünen Institute

Increasing agricultural land-use intensity and simplification of landscapes drive farmland biodiversity loss and ecosystem service degradation. To accelerate the transition towards sustainable agriculture, alternative concepts to current intensive agricultural practices (e.g. sustainable intensification, High Nature Value farming) need to be tailored at regional scales depending on the landscape composition and structure, management intensity and environmental conditions. This need could be addressed by classifying and mapping agricultural land systems, which we define as components of the Earth that encompass all processes and activities related to agricultural land-use. However, comprehensive classifications or typologies that characterize agricultural land systems by including the dimensions of land cover, landscape structure, land-use intensity and abiotic environment are largely lacking.

Here, we present a typology of agricultural land systems for Germany based on cluster analysis. We integrated spatially explicit data on land cover, landscape structure, land-use intensity, and biophysical data. Six land cover classes and three metrics of landscape structure (Shannon diversity, patch size, edge density) were deployed at a spatial resolution of 100 ha. Input costs for different types of agricultural production systems (e.g. marketable annual crop farming, intensive cattle farming) were used as a measure for land-use intensity. Long-term climate data and terrain ruggedness were included as biophysical parameters.

The cluster analysis resulted in eight agricultural land system types. Two types were dominated by arable land and marketable crop farming but depicted different levels of landscape structure, highlighting a marked east-west divide in terms of diversity of land cover types and patch size. Other types exhibited pronounced spatial patterns and were dominated by animal husbandry distinguishing intensive cattle and pig/poultry farming. The typology also differentiated four mosaic landscapes, which reflected varying composition of land cover but also environmental conditions in terms of climate and relief. Workshops with experts from different disciplines (e.g. landscape ecology, agriculture and conservation) were conducted to discuss and evaluate the typology.

Our typology contributes to a better understanding of the complexity of agricultural land systems and may serve as a framework to report the status and trends of farmland biodiversity and their drivers more effectively than on a national basis. Particularly, the agricultural land system types can support the implementation of more targeted, context-specific conservation actions, such as eco-schemes and agri-environment-climate schemes as part of the post-2020 Common Agricultural Policy, to enhance biodiversity and associated ecosystem services in agricultural landscapes.

## COOPERATIVE VERSUS NON-COOPERATIVE BEHAVIOUR: USING AGENT-BASED MODELLING TO IDENTIFY SPATIAL SUPPLY-DEMAND MISMATCHES OF ECOSYSTEM SERVICES AND TO COORDINATE CONFLICTING ACTORS' DEMANDS

Mostafa Shaaban<sup>1</sup> · Ioanna Mouratiadou<sup>1,2</sup> · Annette Piorr<sup>1</sup>

<sup>1</sup>Leibniz Centre for Agricultural Landscape Research · <sup>2</sup>ISARA Lyon

**A**gricultural ecosystems are the source of important common pool resources providing multiple goods and services, thus playing a crucial role in sustaining human well-being. Yet, the competitive overuse as well as the misuse of this type of ecosystem largely persists. The presence of multiple beneficiaries of agriculture landscapes represents a dilemma for each of them and society as a whole: how to compromise between the individual satisfaction of demands for ecosystem services (ESs) and the consideration of conflicting demands between actors? Sophisticated modelling tools that can represent the complexity of such a dilemma at the sub-regional spatial scale are still lacking. To that end, in this study we assess the potential of the newly-developed spatial agent-based model (ABM) “Viability of Social-Ecological Agroecosystem” (ViSA) to identify approaches for alleviating conflicting demands between different actors and reduce the supply-demand gaps for selected ESs. The model is developed and used as part of the project “Digital Agricultural Knowledge and Information System (DAKIS)” (<https://adz-dakis.com/en/>) which aims to support farmers in agricultural management choices with real-time digital data and spatially-explicit modelling to enable the resource-efficient sustainable production of ESS. We use ViSA to simulate cooperative as well as non-cooperative social-ecological interactions between beneficiaries of ESs under different management options to understand lock-ins and obstacles that hinder the sustainability of the system in a ten-year timeframe. We address five different ESs (biomass yield, erosion control, carbon sequestration, water availability and biodiversity) and consider diverse groups of actors in an agricultural landscape in northeast Germany (farmers, foresters, retailers, inhabitants, policy makers, etc.). The actors are differentiated by their decision preferences for specific agricultural management options and by different portfolios of capitals behind their behavioral efforts, including financial, human, social, natural, physical and cultural capital.

The results of the simulation reveal the extent to which cropping diversification, as one tested management option, under cooperative behavior is more advantageous compared to non-cooperative behavior. It shows a positive impact on the supply-demand gap, on actors' capitals, as well as on conflict risk reduction. We conclude that ViSA represents a novel promising tool for tackling complex systems and for identifying conditions that secure the viability of the social-ecological agroecosystem, while addressing the demand-oriented provision of ESs and capturing interactions at the landscape level. It allows examining the evolution of the system under diverse scenarios of management options and decision rules to support stakeholders in making decisions to satisfy their demands for ESs while considering the demands of other actors.

## COULD EUROPE ACHIEVE PROTEIN SELF-SUFFICIENCY BY DIVERSIFYING REGIONAL CROPPING SYSTEMS WITH LEGUMES?

Anne Elise Stratton<sup>1</sup> · Catharina Schulp<sup>1</sup> · Katharina Waha<sup>2</sup> · Peter Verburg<sup>1</sup>

<sup>1</sup>Vrije Universiteit Amsterdam · <sup>2</sup>Commonwealth Scientific and Industrial Research Organisation

**A**s a dietary source of protein and minerals, grain legume crops such as beans and peas are increasingly recognized as sustainable and healthy alternatives to animal-source foods. In Europe, legume production has suffered a decades-long decline due to policies supporting intensive cereal production that favored simplified wheat-maize crop rotations. In addition to their well-known environmental benefits, recent research has suggested that legumes could contribute to greater protein self-sufficiency in Europe by increasing availability of locally produced plant protein. Yet, no prior work has evaluated the potential of growing grain legumes to fulfill the protein needs of European diets.

Our study addresses this gap in knowledge by quantifying the extent to which regional European cropping systems could meet current and future protein demand by diversifying existing crop rotations with legumes for human consumption. Building from 2018 European crop maps at high spatial resolution, we simulate the addition and substitution of legumes for fallows and cereals in typified rotations at the field scale, and assess the potential effects of legume-based diversification of crop rotations on protein yield at a regional (NUTS 1, 2, 3), national (NUTS 0), and EU level in 2030. We select the most suitable legumes for rotations using biophysical suitability factors, including current and future projected climate and soil conditions (FAO GAEZ), altitude, growing season requirements, rotational compatibility, and contributions to protein production and crop diversity. We then estimate the proportions of human protein consumption that could be satisfied at the baseline and in 2030 under several diet scenarios: current consumption (high meat), projected consumption (high meat), fully plant-based diet (no meat), EAT-Lancet/flexitarian diet (low meat).

We hypothesize that by adding food legumes to current crop rotations, Europe could achieve protein self-sufficiency for human consumers under low-meat and no-meat diet scenarios. Under meat-rich diet scenarios, protein self-sufficiency would likely decrease proportionally with the fraction of legume protein allocated to animal feed. We expect the impact of legume diversification scenarios for protein self-sufficiency to be greatest in regions with high protein demand and low baseline legume production. Increasing the proportion of legumes in regional crop rotations would not only improve crop diversity, but would also reduce European dependence on imported legume crops (i.e., Brazilian soybean) to fulfill demand for dietary protein. Diversifying European crop rotations and diets with grain legumes could advance multiple aims of the EU Farm to Fork Strategy while strengthening sustainable food systems globally.



## TRADITIONAL AGRICULTURAL LANDSCAPES – AN OPPORTUNITY FOR BIODIVERSITY CONSERVATION

Anca Georgiana Vasilescu<sup>1,2</sup> · Alin Pleșoianu<sup>1</sup> · Ileana Pătru-Stupariu<sup>1</sup> · Andreea Niță<sup>1</sup>

<sup>1</sup>University of Bucharest · <sup>2</sup>National Agency for Protected Natural Areas

In the context of climate change, decline of biodiversity and current socio-economic trends, numerous concepts and approaches have been devised to encourage sustainable agriculture and a better connection between agricultural activities and nature. Concepts such as high nature value farming, organic farming, traditional agricultural landscape, agricultural heritage systems, farmland biodiversity are promoted for the maintenance or development of sustainable agricultural systems, with an emphasis on providing ecosystem services, biodiversity conservation and heritage protection. Traditional agricultural landscapes offer promising opportunities for biodiversity conservation and lessons for more sustainable agriculture in the future.

This review was based on 300 scientific articles extracted from the Web of Science database published between 1990 and 2021, that had as subject the evolution of traditional agricultural landscapes, their role in biodiversity conservation and the associated directions in this field. We present the evolution of research and current trends in traditional agricultural landscapes, considering the following research question: can the conservation of traditional agricultural landscapes be an alternative to sustainable agriculture in the European context?

According to our findings, there has been an increase in concern regarding the conservation of traditional agricultural landscapes and implicitly about the roles they play in conserving biodiversity, as evidenced by the number of articles from 1990-2021 that acknowledge that biodiversity is associated with low-intensity agriculture, in which agricultural practices have remained largely unchanged over time. By the year 2000, research highlights the decline of traditional agricultural systems, with methodologies based mainly on mapping landscape changes and identifying the effects of these changes on the environment. After 2000, research emphasizes the importance of maintaining traditional agricultural landscapes due to their association with a high diversity of species, often of conservative interest.

We present the evolution of the concepts associated with traditional agricultural landscapes, in order to gain a better understanding of the current situation of the sustainability of the agricultural landscape. We illustrate the opportunities of considering traditional agricultural landscapes in biodiversity conservation.

## FARMING SYSTEM ARCHETYPES FOR MODELLING IMPACTS OF AGRICULTURAL POLICIES

Tomáš Václavík<sup>1</sup> · Michael Beckmann<sup>2</sup> · Marek Bednář<sup>1</sup> · Sanja Brdar<sup>3</sup> · Anna Cord<sup>4</sup> · Cristina Domingo-Marimon<sup>5</sup> · Arjan Gosal<sup>6</sup> · Fanny Langerwisch<sup>1</sup> · Anne Paulus<sup>2</sup> · Guy Ziv<sup>6</sup>

<sup>1</sup>Palacký University Olomouc · <sup>2</sup>Helmholtz Centre for Environmental Research · <sup>3</sup>BioSense Institute · <sup>4</sup>Dresden University of Technology · <sup>5</sup>Centre for Research on Ecology and Forestry Applications · <sup>6</sup>University of Leeds

**N**early half of the land in Europe is used for agriculture, providing a range of ecosystem services and livelihoods for 10 million farmers. However, current models used to assess the impact of agricultural policies struggle to capture the complexity of farmers' decision-making, which can lead to incorrect predictions of policy outcomes. In this paper, we apply archetype analysis, a key methodological approach in landscape research for organizing the complexity of social-ecological systems, to develop and test a generalized typology of farming systems. The Farming System Archetypes (FSAs) classify farms according to characteristics important for decision-making into units that are assumed to react similarly to policy change. Exemplified in five case studies across Europe, we map FSAs by geospatial relations of unique farm-level data on (1) farm specialization (a relative share of the standard crop and animal production – e.g. general cropping, horticulture, permanent crops, grazing livestock) and (2) economic size (the total value of standard production calculated from the area of individual crops and the number of animals at an agricultural holding). We test the usefulness of our typology by investigating the spatial correlation between FSAs and the adoption of agri-environmental schemes (AES), a typical example of agricultural policy. Specifically, we examine the degree to which AES adoption can be explained by archetypes of farming systems and whether additional farm characteristics and biophysical variables are needed to understand the local context that influences farmers' decisions on AES implementation.

## FARMER DECISION-MAKING ON AGRI-ENVIRONMENTAL SCHEMES: AN AGENT-BASED MODELLING APPROACH TO EVALUATE DIFFERENT POLICY DESIGNS

Meike Will<sup>1</sup> · Chunhui Li<sup>2</sup> · Nastasija Grujić<sup>3</sup> · Jiaqi Ge<sup>2</sup> · Guy Ziv<sup>2</sup> · Birgit Müller<sup>1</sup>

<sup>1</sup>Helmholtz Centre for Environmental Research · <sup>2</sup>University of Leeds · <sup>3</sup>BioSense Institute

**M**odel-based analyses can effectively contribute to investigating leverage points for sustainability transformations in agriculture. They allow for a systematic assessment of policies under changing environmental, economic, or institutional conditions and can be used to evaluate the efficiency of different policy designs. For analyzing agricultural systems, agent-based modeling is particularly useful as it allows to represent behavior of individual farmers – the crucial actors at the landscape level.

We use this approach in the context of farmers' decision making on the adoption of agri-environmental schemes (AES). AES are voluntary programs offered as part of the European Union's Common Agricultural Policy to provide incentives for environmentally friendly farming practices. However, farmers' interest in participation has remained lower than expected. Various studies across Europe highlight a broad range of economic, ecological and social factors that play a role in the decision to adopt AES. To systematically test the impact of different policy designs on the adoption rate among farmers and the resulting spatial allocation of AES, we designed an agent-based model where decisions of individual farmers on four selected schemes are explicitly included.

In the model, farmer behavior is empirically based on data from interviews conducted in five geographically and culturally diverse case studies across Europe. In particular, we consider the observed heterogeneity of farmers, for example in terms of which schemes are chosen based on fit with existing farming practices. In addition, we rely on the results of a discrete choice experiment to quantify farmers' preferences for specific features of AES contracts. Taking the Mulde River basin in Germany as an example, we use the agent-based model to critically evaluate agricultural policies and analyze how they should be designed to achieve the desired impact. These results will feed into biophysical analyses to quantify the environmental impacts of AES adoption. In addition, the insights should be transferred from specific case studies to other EU regions to provide stakeholders with an effective tool for assessing the impact of future policies.

## ***Novel perspectives on traditional agricultural features, structures and practices promoting landscape sustainability***

### **Symposium organisers**

*Cristina Quintas Soriano* (University of Almeria), *María García-Martín* (Swiss Federal Institute for Forest, Snow and Landscape Research), *Mario Torralba* (University of Kassel / University of Göttingen), *Tobias Plieninger* (University of Göttingen)

### **Summary**

This session will centre on local agricultural practices and structures that, despite their limited extension, have disproportionate importance in the promotion of landscape sustainability. Typically, these features and structures are associated with multifunctional agricultural landscapes and are supported by rich local-ecological knowledge. The context-specific nature of these agricultural features and practices makes them difficult for integration in planning policies, while the scholar literature is rather fragmented. As such, this session will welcome innovative approaches for mapping, valuing or assessing the importance of these practices and structures by applying biophysical, socio-cultural or inter- and transdisciplinary approaches.

### **Description**

Over long periods of time, the tight interactions between society and their surrounding agricultural landscapes have often resulted in a series of locally adapted structures and practices, which contributed to support local livelihoods in a sustainable way. Some examples of these landscape structures would be agricultural terraces, dry-stone walls, hedgerows, and irrigation channels. Some examples of practices would be tree haymaking and transhumance.

Typically, these landscape features are associated with multifunctional agricultural landscapes and are supported by rich local ecological knowledge. Despite their limited extension, they often have an important role in the conservation of biodiversity and for the promotion of environmental and socio-cultural values.

These practices and structures are particularly vulnerable to current drivers of change. Their disappearance, often associated with processes of land use abandonment or intensification, is accompanied with hard-to-reverse erosion of the values associated with these agricultural landscapes. The context-specific nature of these landscape features makes them difficult for integration in landscape planning policies, while their presence in scholar literature is rather fragmented. This poses serious challenges for their management and preservation. In this session, we will welcome contributions focused on mapping, evaluating and valuing these landscape structures and practices. Our interest ranges from place-based studies focused on a specific landscape to large-scale mapping assessments applying biophysical or socio-cultural approaches.

We will welcome studies that:

- Evaluate practices and/or structures that contribute to landscape sustainability focused on agroecosystems.
- Develop biophysical or socio-cultural approaches to value practices or structures.
- Use place-based case studies or large-scale assessments.

The aim of the session is to connect researchers working on similar topics but different landscapes; to promote the exchange of methods and approaches, and to identify ideas and strategies to promote these landscape structures and practices.

## LAND SHARING INITIATIVE – INTEGRATED APPROACH AND FRAMEWORK

Iztok Erjavec · Klemen Risto Bizjak

NGO

**W**e will present integral approach which was developed by Trans4m movement and is addressing all themes of symposia and relevant issues in landscape ecology. There will be framework presentation of trans disciplinary tools and perspectives of this holistic approach based on our work on eco-social innovations through intergenerational cooperation for preservation and restoration of landscapes. This will provide landscape ecologists insight how to link past, present and future to face global challenges and how to develop their own integral approach appropriate to their field of interest and research. This model further serves to address imbalances within specific fields, such as research development, nature protection, enterprises and economics.

A key aspect will be a presentation of work on eco-social innovations, discussing an insight on how to develop research approaches for sustainable landscapes and societies of the future. The purpose is through preserving nature enabling new sustainable development opportunities for the inhabitants. Two overarching questions of our work are: is nature an obstacle or motor for new sustainable development opportunities in landscapes? and can we preserve nature and help inhabitants improve their economic and social status? A conclusion is that if we want to restore traditional cultural landscapes we need to reintroduce traditional agricultural practices! This implies also that preservation of knowledge of traditional multipurpose is needed, and as researchers we must be able to give this knowledge academic value and incorporate it in our research.

These eco-social innovations approach evolved from a basic idea to connect elderly farmers from rural areas with people from urban areas, that were facing economic and social challenges for cooperative food growing, sharing of harvest and resources. The concept has been named WISE – Work Integration Social Cooperative. A final key aspect of this approach is that consumers are converted into investors – through buying of products and services from WISE they invest into nature preservation and development of social enterprise sector for alleviation of social and environmental problems.

Idea is that eco-social innovations can contribute to the achievement of a range of mutual benefits: preservation and restoration of traditional cultural landscapes; restoration of traditional multipurpose organic farming; cultivation of abandoned and derelict land; intergenerational transfer of knowledge; higher self-sufficiency with organic food; new business opportunities for development in rural areas; improvement of economic and social status of participants; reintegration of people facing social and economic challenges into society; learning new skills through work, food growing and marketing; reducing costs of society for nature protection and social contributions; empower participants for employment and management of cooperative.

## PROMOTING MULTI-STAKEHOLDER PARTICIPATORY CONSERVATION ON AGRICULTURAL HERITAGE LANDSCAPES: A CRITICAL REVIEW OF ACTION RESEARCH FROM SHEXIAN DRYLAND STONE TERRACED SYSTEM

Tianyu Guo

University of Göttingen

Participatory approach is frequently used in landscape conservation practices. As for agricultural heritage landscapes, due to its farming characteristics, it is always a complicated and comprehensive topic to make a balance between livelihood needs and conservation practices. The concept Globally Important Agricultural Heritage Systems initiative have been carried out 20 years and it became a regular programme of FAO since 2015, a large amount of conservation actions has been implemented in the designation and proposed sites. However, there is a huge gap to review the actions taken place in one site to provide a systematic conservation strategy and promote the participatory method. The purpose of our study is to do a critical review about the participatory actions in Shexian Dryland Stone Terraced System and reveal the participatory mechanism under the context of multi-stakeholder conservation.

We employed a qualitative method by combining text analysis and narrative analysis. We collected action records, project reports, annual reports from local government and other written documents since 2015 from the participants. Then we ran first-turn text analysis to build action chronology and interview framework. Later we did online interviews with the key actors mainly about their motivation to participate, contribution, self-assessment and perspectives to the actions, and suggestions to the future action planning. Afterwards, we ran the narrative analysis with the second-turn text analysis to identify the role of different stakeholders into research team, local government, local association, local farmers and NGOs. We found (1) the participatory actions could be categorized into outside research investigation, community renaissance and capacity building of local people and local culture output three type, (2) how the stakeholders play their role in each type, and (3) the gap to implement effective actions for each type. We also found (1) the conservation and development of agricultural heritage systems as one optional top-down policy at county level, the final subject of implementation, has obvious limitation to motivate local government to put effort into, (2) the bottom-up actions as the main body to carry out the conservation practices still have a long way to motivate most local farmers to participate in, and (3) local knowledge conservation became a key discourse to initiate co-actions and it brought natural rationality to mobilize community members to keep farming. We discussed making a balance between top-down policy and bottom-up initiatives is the last mile to realize the maximum efficiency of current participatory action on the conservation of agricultural heritage landscape.

## ABANDONMENT AND INTENSIFICATION – CURRENT THREATS TO THE RELIC AGRICULTURAL LANDSCAPE FEATURES AND STRUCTURES IN THE SUDETES MTS., SW POLAND

Agnieszka Latocha-Wites

University of Wrocław

The land use and land cover in the Sudetes Mountains has been substantially changed in the last 100 years due to diverse political and socio-economic factors. First, there was a trend of a long-term depopulation and abandonment of settlements and agricultural areas, followed by the secondary succession of vegetation. Recently, there is a new trend to develop new, mostly recreational, housing and tourist infrastructure. Additionally, the EU agri-environmental schemes – which Poland joined in 2004 – contribute to new transformations of land use as well. All these processes affect the historical structures and features of the traditional agricultural landscapes. There are numerous agricultural terraces, old field roads and hollow ways (road gullies), as well as many dry-stone walls and stone heaps which can still be identified in the landscape. Although they are relic features related to former agricultural land use, they represent a high value of the traditional, historic cultural landscape. However, these features and structures are usually not appreciated in the current planning and development policies and their protection or promotion is very weak, if any.

The study aims to present the spatial distribution of these relic landscape features and structures related to former agriculture in the depopulated areas, to present their morphometric characteristics and to discuss their state of preservation in the modern landscape. Furthermore, the current threats to these structures will be discussed, such as overgrowing, lack of accessibility due to dense forest cover, removal by people for various purposes, destruction due to new investments, etc. In the final part the reflections of the potential possibilities to protect and promote these features will be presented with potential recommendations for further landscape planning. The methods used in the research included: analysis of cartographic sources and orthophotomaps from different time periods, field surveys and morphometric analysis, and LiDAR data analysis.

## ASSESSMENT OF HEROIC TERRACED LANDSCAPES IN AOSTA VALLEY (ITALY) USING A HOLISTIC APPROACH

Enrico Pomatto · Paola Gullino · Marco Devecchi · Federica Larcher

University of Turin

The “Art of dry-stone walling, knowledge and techniques” was recognized in 2018 in eight European Countries as UNESCO’s intangible cultural heritage to be preserved. Terraced landscapes are often characterized by vineyards that are managed in different ways, strictly connected with sites’ characteristics and history. For these contexts it is recognized the attribute ‘heroic viticulture’ because their management requires a very big efforts, principally due to their poor attitude for the mechanization. This is the first reason of the abandonment processes that threaten their integrity. The loss of historical landscapes and the increasing of hydrogeological risks are the primary consequences of these dynamics. International scientific community is at the forefront of the terraced landscape’ study with the aim of their safeguard, also trough research projects that regard different contexts. It is the case of the project called InTerraced\_net (EU Interreg funding, 2018), that involves nine cross-border territories between Switzerland and Italy, including the Aosta Valley (North-West Italy). It is about the littlest Italian Region, extending over 3260 km<sup>2</sup> where about 124,500 people are living in. Terraces are mainly used for vine growing.

The aim of the research was to assess Valle d’Aosta terraced landscapes using a holistic approach, involving researchers and professionals coming from different disciplines: agronomic, botanical, pedological and anthropological sciences. Three terraced sample areas, representative of different agriculture conditions in the region, were identified. Terraces’ construction types and landscape’s landmarks were studied. A field form was used for analysing land uses, agronomic aspects, construction types and state of conservation. Direct interviews with local farmers were performed. A bottom-up approach was also used administering to winegrowers an online questionnaire. Perceptive analyses were performed during different seasons with field inspections and with cartographic elaborations using QGIS 3.16.2 Hannover.

Results showed that in Aosta Valley there are two main terraces’ typologies: the first one, more common, is made by dry stone walls, very tall in the southern part of the region and short in the northern. While the medium part of the valley is characterized by ridge terraces. Also, the vine’s breeding techniques are influenced by the context: the low pergola, espalier and high pergola are present respectively in the northern, central and southern part of the Aosta Valley. Probably due to a favorable climate, in central and southern part of the valley there are some landscape dynamics related with the introduction of olive trees. It brings a landscape change but also obstructs the abandonment processes. The research proposed an innovative and multidisciplinary approach internationally replicable for terraced landscapes’ research, useful for future planning addresses.



## THE ROLE OF BIOCULTURAL VALUES AND PRACTICES IN LANDSCAPE CONSERVATION AND LOCAL WELL-BEING

Cristina Quintas-Soriano<sup>1</sup> · Mario Torralba<sup>2,3</sup> · María García-Martín<sup>4</sup> · Tobias Plieninger<sup>2,3</sup>

<sup>1</sup>University of Almería · <sup>2</sup>University of Kassel · <sup>3</sup>University of Göttingen · <sup>4</sup>Swiss Federal Institute for Forest, Snow and Landscape Research

Every landscape on Earth is influenced to some degree by people, and in turn, societies and cultures are shaped by landscapes. Biocultural diversity is the notion that biological and cultural diversity are dependent on each other, and that biological diversity is managed, conserved, and created by different cultural groups. Agricultural landscapes are visibly shaped by human practices, and in these areas, the relationship between nature and culture runs deep, where everyday practices and traditions have coevolved with the environment over millennia. This is especially true in Mediterranean agricultural landscapes where the traditional management of the land has endured over millennia. However, these landscapes depend on human interventions and currently are threatened by their abandonment, driving by migration to more urban areas, intensification processes, or aging of the population, having a direct impact on the human well-being of local communities.

In this study, we explore biocultural practices that support human well-being in Las Hurdes, Spain. To this end, we carry out a face-to-face survey across the local population to evaluate biocultural practices and their linkages to human well-being and the nature contributions that supply to local communities. We discuss that traditional agricultural practices act as biocultural refugia in a world of decreasing local knowledge and that different biocultural values confer diversity and enhance social-ecological resilience in those mountain agroecosystems.

## CREATIVE PRACTICE METHODOLOGIES FOR UNDERSTANDING APICULTURAL PRACTICES IN DELTA LANDSCAPES

Maggie Roe<sup>1</sup> · Niki Black<sup>1</sup> · Cat Button<sup>1</sup> · Emilie Cremin<sup>2</sup>

<sup>1</sup>Newcastle University · <sup>2</sup>University of Glasgow

Relationships between bees, humans and landscapes can be traced back at least 10,000 years (Nayik et al., 2014). Socio-cultural practices linked to apiculture have evolved and are reflected in the forms and relationships embedded and evident in many landscapes including the customs and traditions related to honey-gathering. The most valuable service provided by bees is pollination which is vital for the sustenance of biodiversity and agricultural production (Oldroyd, Nanork, 2009). Changing economic demands, climate change and agricultural practices (e.g. use of pesticides and fertilisers) are increasingly impacting bee behaviour and survival, and therefore on the livelihoods of both bee-keepers and honey-gatherers.

Living Deltas is an interdisciplinary research hub led by Newcastle University which includes 55 co-investigators and 60 early career researchers focusing on the sustainability of contemporary delta livelihoods and landscapes. This paper reports on the development of a research approach based on an innovative collaboration with artists in the Ganges/Meghna delta region of the Sundarbans forest that spans the Bangladesh-India boundary. Through examining changes to traditional cultural practices associated with apiculture (bee keeping and honey gathering), and possible drivers of these changes, we are seeking to understand how this might impact on the sustainability of delta landscapes and their inhabitants. We are also interested in how artists can interpret and communicate the rituals, spiritual and belief practices and superstitions which characterise and indicate the intricate or immersive relationships between people, non-human species (including bees) and natural processes in these landscapes.

Artist-led collection and production of visual representations and co-creative workshops are key components of this work. The small, remote communities rely for their livelihoods on multiple agricultural and hunter-gather activities, taking advantage of the resources of multifunctional landscapes and apicultural practices play a significant role. Livelihoods are economically precarious and vulnerable to considerable dangers including extreme climate events and attack by species such as tigers and crocodiles.

The aim of the paper is to provide initial findings from the collaboration, explain the challenges encountered during this ongoing collaborative and creative process, and to reflect on the opportunities that such interdisciplinary working raises particularly addressing issues of 'data', academic cultures and the characteristics of creative practice for participatory working. We also reflect on how a focus on bees has provided considerable opportunities for interdisciplinary working across the Living Deltas Hub.

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## TRADITIONAL SYLVOPASTORAL SYSTEMS BETWEEN SUSTAINABILITY AND MULTIFUNCTIONALITY: THE SABANA DE MORRO IN EL SALVADOR AND THE PASTURES WITH CAROB TREES IN ITALY

Antonio Santoro<sup>1</sup> · Francesco Piras<sup>1</sup> · Ever Alexis Martinez Aguilar<sup>2</sup>

<sup>1</sup>University of Florence · <sup>2</sup>University of El Salvador

**T**raditional agro-silvo-pastoral systems represent multifunctional systems that can contribute to the preservation of both environmental and cultural values. Thanks to their multifunctional role, they can support small farmers, contribute to hydrogeological risk reduction, preservation of soil, agrobiodiversity, cultural landscapes and traditional knowledge, as well as being examples of mitigation and adaptation towards climate change and of sustainable rural development. The growing interest on their multifunctional role and the opportunities for the sustainable development of rural areas, have contributed to the establishment of a FAO programme called GIAHS (Globally Important Agricultural Heritage Systems), whose aim is not only the identification and preservation of agricultural systems of global importance, but also to apply dynamic conservation principles to promote sustainable development with direct and indirect benefits for local communities.

The research focused on two traditional silvopastoral systems in different continents, but with common features: sabana de morro in El Salvador and pastures with carob trees in Sicily, Italy. Both sites are characterized by traditional cattle breeding on wooded pastures and by a network of linear features (hedges or drystone walls) acting as property divisions and as ecological corridors. The study deeply analysed the landscape structure, with particular attention to land uses, scattered trees and linear features, through the creation of specific maps and the calculation of spatial indexes, in order to provide data for the preservation and valorisation of these systems as a whole, and to monitor changes over time. Results showed that linear features made of different materials but both resulting from local farmers' knowledge, can play a similar ecological and social function, acting as divisions between one pasture and another, as delimitations of property boundaries and creating important microhabitats and a network of ecological corridors. Moreover, both systems proved to be based on strong interactions between trees, cattle and farmers. Scattered trees on pastures provide fruits used to integrate the diet of grazing cattle and shade for the animals in hot climates, while cattle contribute by spreading the seeds that also take advantage of the manure. The result is the preservation of traditional practices and of ecological corridors, therefore of cultural landscapes that support local farmers' livelihood.

The preservation of cultural landscapes cannot be detached from a deep understanding of the multifunctional role of the various features, such as scattered trees, terraces, dry-stone walls, channels. The applied methodology, based on a detailed assessment of land uses and of punctual and linear features, allowed to identify peculiarities and vulnerabilities, in order to properly monitor, manage and plan the future of traditional agro-silvo-pastoral systems.

## INFLUENCE OF LANDSCAPE AGRICULTURAL FEATURES, FIELD STRUCTURE, AND FARM TOPOGRAPHY ON THE IMPORTANCE OF ECOLOGICAL FOCUS AREAS FOR FARMLAND SUSTAINABILITY

Viviana Alarcón Segura<sup>1</sup> · Stephanie Roilo<sup>1</sup> · Anne Paulus<sup>2</sup> · Michael Beckmann<sup>2</sup> · Anna Cord<sup>1</sup>

<sup>1</sup>Dresden University of Technology · <sup>2</sup>Helmholtz Centre for Environmental Research

**E**cological Focus Areas (EFA) were introduced into the European Common Agricultural Policy in 2013 as greening measures to help improve the ecological conditions of agricultural land. Since their introduction, EFAs have been criticized for lacking regulations to ensure their allocation to ecologically relevant areas. Structured surveys suggest that farmers tend to decide where to designate EFA elements on their farms based on economic or administrative constraints rather than ecological considerations. While interview data can help to understand socio-economic drivers of EFA allocation, high-resolution spatially explicit data can reveal an additional set of factors influencing EFA decisions. For example, climate, topography, and farm structure may play a crucial role in limiting the options available for farmers to manage their land and must be considered when analyzing farmers' decision-making.

We combined spatially explicit field-level data on land use, environmental, and farm structural variables of the Mulde region (Saxony, Germany) from two consecutive years (2018 and 2019) to identify critical factors driving EFA allocation. We tested the hypothesis that (1) non-productive EFA, such as fallow land, field edges, or buffer strips, are allocated in less favorable fields (e.g., higher slopes, lower soil fertility), (2) productive EFA (i.e., legumes) are assigned to fields with average or favorable conditions for crop production, and (3) landscape features already present on the farm boundaries (e.g., field trees, wetlands, field borders, and stone walls) determine which type of EFA elements are chosen and their allocation.

We found that the percentage of landscape features on a farm played a crucial role in EFA allocation. Farms with a higher percentage of these elements tended to fulfill EFA requirements by allocating additional non-productive rather than productive EFA options. Field shape and size also influenced the allocation of productive and non-productive EFA in opposite ways. Productive EFAs were allocated more often on large and compact fields, while non-productive options and landscape features remained in smaller, linear-shaped fields that were less suitable for crop production. Fields with low soil fertility, low soil moisture, higher risk of erosion, and higher elevations were more frequently chosen for non-productive EFA options. Productive options were mostly allocated in fields with higher-quality soil conditions.

Our study shows that traditional agricultural features, farm topology, and structure (factors that humans do not easily modify) are crucial in determining the ecological success of green policies. We contribute to understanding how future agricultural policies can use spatial perspectives to improve ecological outcomes and demonstrate how the analysis of the current EFA allocation from a spatial perspective could help design outcome-oriented eco schemes for the forthcoming green policies.

## *Defining a safe operating space for the future development of European agricultural landscapes*

### **Symposium organisers**

*Felix Herzog (Agroscope), Sonja Kay (Agroscope), Florian Danzinger (University of Vienna), Peter Zander (Leibniz Centre for Agricultural Landscape Research), Johannes Schuler (Leibniz Centre for Agricultural Landscape Research), Thomas Wrabka (University of Vienna), Kalev Sepp (University of Tartu)*

### **Summary**

European agricultural landscapes are changing, often with significant environmental costs for ecosystem services (ESs) and for biodiversity. To protect these and improve the adaptive capacity of the agro-ecological system to changing land use, region-specific ecological infrastructures need to be identified and (policy) instruments must be put in place to maintain them. The symposium seeks contributions on how a safe operating space for the future development of agricultural landscapes can be identified. This will include production perspectives, their ecological impacts, and barriers to implementing biodiversity and ESs protection policies.

### **Description**

The management of biodiversity and ecosystem services (ESs) in agricultural landscapes must take into account agricultural land use, landscape structures and relevant stakeholders. Agricultural activities affect the environment and continuously adapt to e.g. economic incentives, scientific and technological developments, socio-political frameworks, climate change, etc. The relative importance of those drivers varies regionally. Because maintaining biodiversity in agricultural landscapes is essential to sustaining their functionality and adaptive capacity, a landscape-scale view of the agricultural system is needed to safeguard ecological infrastructure, associated farmland biodiversity, and its functions (ESs) under current and future drivers.

To address those questions, the European research project SALBES (Scenarios for Agricultural Landscapes' Biodiversity and Ecosystem Services) applies the planetary boundary framework to define a safe operating space. It is tested as a guideline for policy making to steer the development of agricultural landscapes, and as a theory and concept, based on integrated, stakeholder guided, evidence-based analyses. The approach is tested in four European case study areas. We hypothesize that the integration of three components is essential to safeguard the functionality of biodiversity and ESs in agricultural landscapes: The green landscape infrastructure, adaptive management, and multi-actor approaches.

Against this background, this session provides a platform for presenting similar approaches and other scenario building and modelling tools that tackle these issues at the landscape level. We invite presentations focussing on environmental policy making and management principles for agricultural landscapes.

## CO-DESIGNING ECOLOGICALLY AND ECONOMICALLY EFFICIENT MEASURES FOR CONSERVING FARMLAND BIODIVERSITY AT LANDSCAPE LEVEL

Anna Cord<sup>1</sup> · Lisanne Hölting<sup>1</sup> · Jan Engler<sup>1</sup> · Nina Hagemann<sup>1</sup> · Björn Andres<sup>1</sup> · Frank Wätzold<sup>2</sup> · Astrid Sturm<sup>2</sup> · Maria Lee Kernecker<sup>3</sup> · Stefanie Bülow<sup>4</sup> · Kerstin Emonds<sup>5</sup>

<sup>1</sup>Dresden University of Technology · <sup>2</sup>Brandenburg University of Technology Cottbus-Senftenberg · <sup>3</sup>Leibniz Centre for Agricultural Landscape Research · <sup>4</sup>Landscape Conservation Association Northwest Saxony e.V. · <sup>5</sup>National Natural Landscapes e.V.

**E**uropean agricultural landscapes are changing and farmland biodiversity is rapidly declining. In order to maintain biodiversity and the ecosystem services that depend on it, we need measures that efficiently promote biodiversity and increase landscape diversity and that are economically viable and accepted by the relevant stakeholders. The presentation will outline the conceptual design as well as first results of the transdisciplinary project ECO<sup>2</sup>SCAPE (Co-design of ecologically and economically efficient policy instruments and measures for conserving biodiversity and ecosystem services in cultural landscapes). The ECO<sup>2</sup>SCAPE research approach combines sociological, ecological and economic valuation concepts as well as political science analyses: factors influencing the societal valuation of biodiversity and ecosystem services are investigated using interviews, ethnographic methods and empirical sociological research; new techniques of eco-acoustic monitoring of farmland birds in combination with machine learning methods are tested and developed; models for estimating the ecological effects of conservation measures in farmland are further developed and linked with cost estimates to develop ecological-economic models at the landscape level; innovative payment approaches (especially results-based and cooperative payment models) are developed; policy instruments are analysed for their potential to integrate the developed measures.

The results are incorporated into recommendations for an innovative policy mix as well as spatially-explicit ecological-economic optimisations, which are used, among other things, for the development of a software-based planning tool for the local landscape management association. The study region is part of the catchment area of the Vereinigte Mulde in northern Saxony (Germany). The region is characterised by intensive but also diverse land use, contains designated biologically unique protected areas and is representative of many cultural landscapes in Germany. The transferability and relevance of the project results is investigated in three selected German biosphere reserves and ensured by an external advisory board consisting of representatives from different scientific disciplines and interest groups. Overall, the project aims to advance the latest knowledge on effective biodiversity conservation in agricultural landscapes. This includes a landscape-level approach, co-design, community involvement and acceptance, and financial and social incentives for the implementation of conservation measures.

## AGRICULTURAL LIFE CYCLE ASSESSMENT FOR SPATIALLY EXPLICIT BIODIVERSITY MODELLING

Noëlle Klein<sup>1,2</sup> · Felix Herzog<sup>1</sup> · Adrienne Grêt-Regamey<sup>2</sup> · Philippe Jeanneret<sup>1</sup> · Maarten van Strien<sup>2</sup> · Sonja Kay<sup>1</sup>

<sup>1</sup>Agroscope · <sup>2</sup>ETH Zürich

**A**n increasing human population and food demand called for a more efficient agricultural production and intensified agricultural practices. Mechanised farming depends on larger fields and uniformity, leading to increased landscape homogeneity resulting in biodiversity loss. The halt of this loss has been postulated in international (Sustainable development goal 15) and national policy targets (biodiversity strategies) and is of major importance for the functioning of farmland ecosystems and provisioning of services. Thus, biodiversity-friendly management is promoted through European agricultural policies. A major restriction to these policies is the limited knowledge on their actual efficiency to foster biodiversity. Models can be useful tools to evaluate the impact of (agricultural) management and to predict long-term effects on biodiversity. While there is increasing knowledge on the effects of small-scale agricultural practices especially on particular species, it remains challenging to assess biodiversity as an entity. Functioning comprehensive indicators could be extremely useful for agricultural policies, but it remains difficult to apply them in a spatially explicit manner, especially for mobile species.

In this study, two mobile species groups (birds and butterflies) have been monitored in two contrasting agricultural landscapes in Switzerland. Detailed agricultural management (patch level) and structural variables (landscape level) have been associated with species richness and abundance, highlighting the role of extensive structures, and the importance to consider spatial variables in biodiversity models. In addition, we generated biodiversity predictions by applying the Swiss Agricultural Life Cycle Assessment for biodiversity (SALCA-BD), a non-spatially explicit model evaluating the impact of land use and cover on biodiversity. By comparing these predictions to the observed species richness, we investigated the model performance, focussing on the spatial parameters that improve model predictions.

Our results highlight the importance of including spatial variables into modelling approaches to improve biodiversity predictions, illustrated through the example of an LCA biodiversity model. Improving biodiversity models is of high importance for local prioritization of land-use management options such as an efficient placement of semi-natural habitats. The models should support developing sophisticated future land-use policies that favour productive agriculture through ecologically sustainable management of agricultural landscapes.

## PARTICIPATORY SCENARIO DESIGN FOR ECOSYSTEM SERVICES AND BIODIVERSITY MODELLING AT LANDSCAPE LEVEL

Martin Schönhart<sup>1</sup> · Monika Suškevičs<sup>2</sup> · Katrin Karner<sup>1</sup> · Claudia Bethwell<sup>3</sup> · Florian Danzinger<sup>4</sup> · Michael Glemnitz<sup>3</sup> · Felix Herzog<sup>5</sup> · Sonja Kay<sup>5</sup> · Takamasa Nishizawa<sup>3</sup> · Johannes Schuler<sup>3</sup> · Ulrich Stachow<sup>3</sup> · Christine Umstätter<sup>5</sup> · Thomas Wrba<sup>4</sup> · Peter Zander<sup>3</sup>

<sup>1</sup>University of Natural Resources and Life Sciences, Vienna · <sup>2</sup>Estonian University of Life Sciences · <sup>3</sup>Leibniz Centre for Agricultural Landscape Research · <sup>4</sup>University of Vienna · <sup>5</sup>Agroscope

**E**cosystem service and biodiversity modelling at landscape level pose a number of scientific and planning challenges. Analyses of the effects of alternative states of bio-physical or socio-economic framework conditions require assumptions on exogenous model input parameters. In a modelling context, scenarios are bundles of consistently defined qualitative and quantitative parameters possibly complemented with storylines. Consequently, scenarios determine model outcomes. They are a powerful tool for stakeholder interaction, model results communication, and landscape planning. Hence, stakeholder participation in scenario design processes may improve the robustness of results, increase their acceptability among stakeholders and supports dissemination of results.

Scenarios are a core component of the international ERA-NET BiodivERsA project SALBES (Scenarios for Agricultural Landscapes' Biodiversity and Ecosystem Services; <https://salbes.eu>). They include four main components, i.e. the climate, the socio-economic framework conditions of land use, potentially available land use management practices, and local biodiversity actions that may impact land users' choice of practices. A unique feature of SALBES is its use of the Shared Socio-economic Pathways for European agriculture and food systems (Eur-Agri-SSPs; <https://eur-agri-spps.boku.ac.at>). Since the Eur-Agri-SSPs are based on the global SSPs, SALBES can consistently embed its landscape level scenario analysis into global climate change research efforts. The SALBES scenarios encompass a near (2030), mid-range (2050) and distant (2080) future perspective to support today's landscape planning actions (e.g. CAP reform) and the development of long-term visions for sustainable landscape development. Near future scenarios are developed to support policy adaptations and land use management to improve biodiversity in the short run. Distant future scenarios are developed to capture future trends in climate and socio-economic characteristics in order to gain insights that allow counteractions or adaptations in long term management of agricultural land use and related policies. Future framework conditions define a safe operating space and what it shall protect. Ex-ante analysis reveals actions and timelines to establish such safe operating spaces e.g. by safeguarding green infrastructure and adapting agricultural management.

SALBES scenario design is based on a shared protocol. It encompasses several feedback loops between scientists and stakeholders including three regional workshops in each of the four case studies. We present preliminary results from this process with a specific focus on the nested scenario structure, methodological procedures for participation, the potential value and limitations of the scenarios in ecosystem service and biodiversity modelling, and the theoretical foundations to identify a safe operating space at landscape level in participatory scenario contexts.



## THRESHOLDS FOR SUSTAINABLE SOIL MANAGEMENT BASED ON ECOSYSTEM SERVICES

Bastian Steinhoff-Knopp<sup>1,2</sup> · Benjamin Burkhard<sup>1,3</sup>

<sup>1</sup>Leibniz University Hannover · <sup>2</sup>Thünen Institute · <sup>3</sup>Leibniz Centre for Agricultural Landscape Research

**S**ustainable soil management is key to maintaining the functionality and biodiversity of agricultural landscapes and their ecosystem services (ES). Soils – and with them whole landscapes – across Europe are under pressure. Soil erosion remains the major threat to agricultural soils, whose long-term functionality and ability to provide multiple ES can only be ensured through sustainable soil management guided by appropriate soil protection policies.

A remaining problem in soil protection is the definition and justification of effective thresholds for soil threats at which farmers are required to initiate soil protection measures (like adapted management, change from crop to grassland farming). For soil erosion, site-specific maximum acceptable soil erosion rates ('tolerable soil loss') would be helpful with which agricultural management schemes can be compared. The definition of thresholds must be site-specific, based on scientific evidence and concepts accepted by stakeholders and farmers. The overall goal is the long-term preservation of the functionality of soils and their ability to contribute to the long-term supply of multiple ecosystem services within multifunctional agricultural landscapes.

This contribution presents a concept, in which soil-related ES are combined with the potential degradation of soils by soil erosion to define threshold values at which ES supply can be sustainably ensured. It is based on the site-specific assessment of soil-related ES backed up by detailed soil information, monitoring data and the inverse derivation of soil loss rates at which the full supply of these ES can no longer be safeguarded. Farm management and soil cultivation measures can be adapted to comply the thresholds and preserve the functionality of agricultural landscapes. With the presented site-specific definition of thresholds, the concept can contribute to the definition of a safe operating space for agricultural landscapes and appropriate management schemes.

## NAVIGATING TRADE-OFFS IN FUTURE EUROPEAN AGRICULTURAL LANDSCAPES

Peter Verburg<sup>1,2</sup> · Leen Felix<sup>1</sup>

<sup>1</sup>Vrije Universiteit Amsterdam · <sup>2</sup>Swiss Federal Institute for Forest, Snow and Landscape Research

**E**uropean landscapes show different, opposing developments at the same time: agricultural intensity is increasing in large parts of Europe while at the same time we find areas of agricultural abandonment in other places, and, smaller areas where more extensive, sustainable farming systems are adopted. The impacts of these differential developments depend on location. While at some locations the loss of productivity upon abandonment and re-wilding is small, while the benefits are large, this is different for other locations.

For all three potential directions of development we simulated a wide range of ecosystem service impacts. For each agricultural location in Europe we, based on these impacts, mapped the trade-off patterns between the different ecosystem services. Based on these we indicated where and to what extent which trajectory of agricultural development was most beneficial or detrimental.

These European-wide results help to target policy and incentives to the regions where benefits can be highest and trade-offs lowest, enabling agricultural development towards fitting within the planetary boundaries and contributing to the EU green deal targets.

# *Productive urban landscapes – benefits, co-benefits and new modes for planning*

## **Symposium organisers**

*Werner Rolf* (Technical University of Munich), *Simona R. Grădinaru* (University of Bucharest)

## **Summary**

In this symposium, we want to explore how landscape ecology can provide knowledge for better addressing the relationship between agriculture and the urban environment. We encourage contributions which focus on functions and processes related to productive landscapes, as well as the role of spatial planning on how to address them.

## **Description**

Across Europe, agricultural land use dominates the open spaces. However, impacted by population growth and rapid urbanization, the peri-urbanity undergoes a dynamic of chaotic development. In the context of increasing concerns over the depletion of food providing areas and raising awareness on human well-being, it is imperative to generate more and better knowledge on the dynamics of services, disservices, trade-offs and conflicts at the interface between cities and agricultural land.

Linked in subnational regional settings, the urban and agriculture can affect each other in negative as well as positive ways. On the one hand, urban growth leads to land consumption at the cost of productive agricultural land. Between 2000 and 2018, 70% of all land converted to artificial surfaces was farmland, a trend that is expected to continue. On the other hand, agricultural land is increasingly integrated within cities. That is because food provision is not the only service that agricultural lands provide. Co-benefits such as habitat for wildlife and recreation spaces for urban dwellers are equally important. Thus, urban and peri-urban agriculture offer promising pathways to promote transformation towards sustainable development. However, agricultural land may not always be welcomed by urban dwellers and conflicts may arise.

In this symposium, we want to explore these different perspectives on changes, effects and mechanisms to manage them. We want to address how landscape ecology can provide knowledge on the relationship between agricultural and cities, with the aim of supporting sustainable land use developments. Contributions are encouraged to address the following questions:

- What are services, disservices, trade-offs and conflicts of agricultural land and farming in peri-urban contexts?
- What are the benefits of agroecological transition, ecological intensification and diversification approaches for cities?
- What are the benefits and shortcoming of integrating farmland into the urban agenda?
- Which formal and informal instruments do cities adopt for integrating agriculture in their agendas?
- What are new modes of food production with co-benefits in peri-urban landscapes and for alliances between urban and rural partners?
- What are new modes to organize collaboration between public agencies, farmers and the public?

The discussions will be structured in two slots based on the following topics:

- New relations between farming for food production with co-benefits,
- New modes for planning to support such settings in peri-urban area.

## PROVISIONING SERVICES OF HISTORIC GARDENS IN THE IRANIAN URBAN AND PERI-URBAN CONTEXTS

Majid Amani-Beni<sup>1</sup> · Mohammad Reza Khalilnezhad<sup>2</sup>

<sup>1</sup>Southwest Jiaotong University · <sup>2</sup>University of Birjand

One of the historic capabilities of Birjand city (East of Iran) is the existence of a large number of historic gardens that, despite the great importance from the perspective of landscape architecture, sufficient attention has not yet been given to the gardens from the viewpoint of landscape planning (Khalilnezhad, Tobias, 2016; Amani-Beni et al., 2021). One of the newest global approaches to historic gardens is the revival of agricultural and productive capabilities of gardens through methods and approaches called urban agriculture. While urban agriculture encompasses the tangible edible heritage of urban gardens, it also prioritizes engaging civil society in agricultural activities (Khalilnezhad, 2016). In urban agriculture, in addition to the owners of the gardens, urban dwellers benefit greatly from the collective gardening in the urban gardens (Farzin et al., 2020; Khalilnezhad, Golchin, 2021; Amani-Beni et al., 2022).

This study attempts to identify the strengths and weaknesses of Birjand's historic gardens for the development of urban agriculture, and therefore seeks to answer the following question: are Birjand's historic gardens appropriate for urban agricultural development?

The research method in this study is analytical-descriptive and main data were collected from bibliographic databases and through interviews with garden managers, experts, consultants, and some gardeners about 11 historic gardens. In addition, field studies in historic gardens have been conducted by the authors. Questionnaires were also used to collect the data including physical facilities of gardens, agricultural production activities in gardens, agricultural and horticultural objectives, marketing of horticultural products, and agricultural economics.

The results show that a large part of the area of Birjand's historic gardens is dedicated to agricultural activities. According to the findings of this study, historic gardens have the potential to create opportunities for public participation in the production, training, and consumption of agricultural and horticultural products. A combination of different goals, whether commercial, educational, social, therapeutic, or environmental, can be the key to the success of place-making of the historic gardens through urban agriculture. According to this strategy, the historic garden can be a place for interaction between different groups and users. Therefore, the formation of Continuous Productive Urban Landscapes (CPULs) depends on the strategy of public participation and involving citizens in the re-planning of historic gardens for the development of the edible public green space so that all gardens, whether private, public, or endowed, would be places for the presence and participation of citizens in the development of urban agriculture.

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Amani-Beni M. et al. (2022). *Socio-Cultural Appropriateness of the Use of Historic Persian Gardens for Modern Urban Edible Gardens*. *Land*, 11(1): 38.

Farzin S. et al. (2020). *Investigation on Recognition of the Type of Multifunctional Landscape in Persian Garden (Case Study: Akbariyeh World Heritage Garden)*. *MANZAR*, 12(52): 6-17.

Khalilnezhad M.R., Golchin, P. (2021). *Evaluating the preferences and level of participation of the academic community in urban agriculture: the case of University of Sistan and Baluchestan*. *Environ. Scien.*, 19(3): 193-216.

Khalilnezhad S.M.R. (2016). *Urban Agriculture as a Tool for City and Landscape Planning in Iran with Emphasize On the Role of Persian Garden*. Technische Universität Kaiserslautern. (PhD thesis)

Khalilnezhad S.M.R., Tobias K. (2016). *The productive landscape in Persian gardens, foundations and features*. *BAGH-E NAZAR*, 133(38): 3-16.

## DELIVERING A HEALTHY AND SUSTAINABLE FOOD ECONOMY IN LETCHWORTH GARDEN CITY

Amelie Andre

University of Hertfordshire

In the late 19th century, Sir Ebenezer Howard shared a vision for new Garden City communities where the local food supply and consumption chain was shaped as a holistic rural-urban economic resource (Howard, 1898). While the Garden City movement had a major influence on urban planning history and practice, Howard's emphasis on integrating town and country in food terms has often been overlooked as a core feature. Today, the urban agenda increasingly includes food systems to tackle public health, social inequity, and sustainability issues. Hence, practitioners and researchers explore the various facets of urban food and its interplay with the close environment to address the gap that the conventional food trade leaves on a local scale. Linking the Garden City spatial, economic, and political legacy with today's urban food agenda, this doctoral research explores the inherited unique governance and socio-spatial context of the world's first Garden City, Letchworth, in England. The research project aims at unfolding how these theoretical and applied features could influence a healthy and sustainable local food economy.

The research uses mixed methods to link the local food economy with practices on site. Quantitative methods entail mapping food-related locations with Geographic Information System software. Examined through Urban Morphological Analysis close-ups, maps enable the characterization of the spatial food features of the Garden City. These first inputs are cross-examined through ethnographic tools that include photographic surveys, observation, participation, and semi-structured interviews. The qualitative methods provide additional lived-experience perspectives against the initial bird's-eye view dataset to obtain a fine-tune knowledge of the local land use and food practices.

Three themes emerge from the data collected. First, originally designed to offer a local and fair food economy, today Letchworth's urban layout shows opportunities for local food production and procurement. The second segment regards the unique governance framework in Letchworth that implements public land ownership and land-value capture. These two principles are significant assets for policy decisions on land stewardship, use, and protection, but yet don't fully operate for local food consumption. Lastly, investigations suggest that the town's genesis carries shared values for local institutions, businesses, or community-led initiatives to contribute to alternative and sustainable food systems on a local level.

The research outcomes contribute to the explorations on urban food planning, highlighting how a place-based approach is critical to underpin sustainable food systems in the context of climate change exacerbating food inequity. In that regard, the Garden City legacy demonstrates how edible landscape, community empowerment, and land stewardship are three critical levers to underpin placemaking and support food governance to create resilient food cities.

Howard E. (1898). *To-Morrow: A Peaceful Path to the Real Reform*. London: Swan Sonnenschein & Co Ltd.

## ECOSYSTEM SERVICES IN THE MILAN SOUTH-EASTERN EDGES. AN INTERDISCIPLINARY MONITORING APPROACH

Valentina Capocéfalo · Gemma Chiaffarelli · Alice Giulia Dal Borgo · Ilda Vagge

University of Milan

**P**eri-urban agricultural land functional recovery implies multi-facets processes, where human and ecological dynamics mostly need to be coupled in order to ensure effective results. Ecological and human sciences can help, from different perspectives, interlinking this plurality of impacts, while building composite management strategies for overcoming the existing barriers and enhancing the capacity of these systems of delivering multi-spectrum services within urbanized and agricultural areas. Based on these premises a study is being led on the Milan south-eastern rural edges, in an area interested by different agroecological projects and multistakeholder strategic visions. In particular, the study focuses on the effect of the policy strategies and effective actions on one side on the landscape agroecological functionality and, on the other side, on the role of this area as cultural medium, in relation to the participative approach implemented by the existing projects, directly involving citizens. Both aspects of the study address the issue of reconnecting and re-establishing a positive permeability between the urban and rural matrices.

On the ecological side, the study was preliminary focused on a detailed analysis of the current landscape ecological features. Based on field surveys and GIS analyses, the physiognomic, structural and dynamic traits of the landscape mosaic elements were studied, as well as their spatial patterns (Ingegnoli, 2002). A qualitative analysis of fluxes dynamics across the landscape mosaic helped mapping the existing barriers currently compromising the overall environmental stability of the area (Chiaffarelli, Vagge, 2021). This analysis was conceived as a useful tool for prioritising future interventions, allowing to map the possible effects attainable on landscape ecological dynamics through the agroecosystem diversification (in its composition, structure, dynamism and spatial configuration) and the mitigation of landscape texture gaps.

Moreover, the analysis results were the starting point for the setting of a methodology on the monitoring and assessment of the current and potential capacity of the area of implementing and generating ecosystem services, valuable both for the urban system balance and, on a cultural perspective, for its citizens (Dal Borgo et al., 2021). The concepts of connection, permeability and accessibility were indeed investigated not only from an ecological point of view, but also on their social and cultural sides. Indeed, a specific study is being led on the identification and evaluation of cultural ecosystem functions and services generated within regenerative agriculture and agroecology projects in the area, well known to the authors, who have already established partnerships with local associations and institutions.

The here presented evaluations represent useful methodological premises for the ongoing building of a comprehensive framework for the qualitative and quantitative assessment of the role of the studied peri-urban area in the provision of valuable and recognized ecosystem services, both on their ecological and cultural features.

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Dal Borgo A.G. et al. (2021). *Luoghi e comunità. Storie di rigenerazione*. Milano-Udine: Mimesis.

Ingegnoli V. (2002). *Landscape Ecology: A Widening Foundation*. Berlin-New York: Springer-Verlag.

## HOW MUCH PEOPLE ABANDONED AGRICULTURAL LANDS IN PERI-URBAN AREAS CAN FEED?

Simona Grădinaru<sup>1</sup> · Cristian Ioja<sup>1</sup> · Gabriel Ovidiu Vanau<sup>1</sup> · Mihai Razvan Nita<sup>1</sup> · Werner Rolf<sup>2</sup>

<sup>1</sup>University of Bucharest · <sup>2</sup>Technical University of Munich

In Europe, there are increasing interests to ensure regional food security in a sustainable way. One possible way is to recultivate abandoned agricultural lands. In many Eastern European countries land abandonment has affected agricultural lands, ranging from those in rural to the ones in urbanized areas. In this work, we will focus on the latter ones. This presentation will propose a method to assess the potential for food production of the abandoned agricultural lands located in urban and peri-urban areas. The Bucharest – Ilfov urban region is used as an example to illustrate the approach, being a rapidly urbanizing region, which has been largely affected by land abandonment over the past decade.

Three recultivation scenarios were developed in consideration of changes depending on the factors of land market, agricultural technology and climate change. For each scenario, we calculated the yields and the number of calories potentially produced by the main crops cultivated in the region. Findings show that recultivation potentials vary between 19% and 70% of the abandoned land surface, with higher yields projected to result from technological investments to the agricultural system. The number of people potentially fed by recultivating abandoned lands with mixed crops (e.g., grains, vegetables) ranges between 5.1 and 6.7 per ha. This production could support the region food supply and strengthen linkages between farmers and the urban population. The presentation concludes with the need to develop policies supporting urban food security while promoting the livelihood of local communities.

## FROM AGROPARK TO AGROPARK NETWORK: EXPLORING STAKEHOLDER PERSPECTIVES IN THE METROPOLITAN AREA OF LISBON

Lina María Hoyos · Isabel Loupa-Ramos

University of Lisbon

**F**ood production has been pivotal for shaping cities presenting social, economic and environmental challenges. Since the 80's agroparks have emerged in European context for improving urban and peri-urban agriculture. The areas emerged as land-based proposals for safeguarding small agriculture that was under pressure from urban expansion (Fandani, 2019). This land-based proposal also represented opportunities for complementing food production with other urban and peri-urban demands related to ecosystem services provision (Yacamán, Zazo, 2015). Even though there is a variety of areas called agropark, the concept is yet to be clarified for all context.

In this communication we aim at unravelling the multiple dimensions of the concept of agropark and how to progress towards the concept of agropark network by using as case study the Metropolitan area of Lisbon in Portugal. Data were collected in a living lab setting through interviews to 12 local and regional stakeholders exploring their vision about the definition, land characteristics, possible ecological values, governance requirements and other elements for the construction of the concept of network of agroparks. Taking into account that neither agroparks nor network of agroparks exist in Portugal, the interviews explored the concept in the light of the advantages and challenges for the urban and peri-urban agriculture and its incorporation in the Portuguese planning instruments and policies.

Result show that the concept of agropark builds on areas of peri-urban and urban food production complemented with cultural ecosystem services that rural and urban area and its population. Regarding the agropark network it is a multiscale and multilevel, physical and non-physical platform built on social multi-actor agreements in the landscape. Ultimately, this research showed that better understanding and clarification of the concepts is crucial in mobilizing stakeholders to integrate food planning in territorial planning and management instruments at different scales.

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## EVALUATING THE SUSTAINABILITY OF DIFFERENT TYPES OF URBAN AGRICULTURE – AN INTEGRATED PARTICIPATORY APPROACH

Henriette John · Martina Artmann

Leibniz Institute of Ecological Urban and Regional Development

In cities a mosaic of different types of urban agriculture (UA) can be found (e.g., community gardens, vertical farming, community-supported agriculture). However, knowledge about advantages and disadvantages of different UA-types is still fragmented. In particular, it lacks an understanding in which regard technology-based and nature-based UA supports a sustainable food production in cities. Within our Edible Cities project funded by the German Research Foundation (DFG), we are aiming at systematically assessing different types of UA in a multidimensional way. We include ecological, social and economic criteria and their corresponding ecosystem services. The objective of the project is to comparatively evaluate the sustainability of nature-based and technology-based types of urban food production.

In our presentation we will introduce an integrated sustainability assessment of urban agriculture based on an Analytical Hierarchy Process (AHP) linked with a participatory approach. Our assessment framework will be exemplified by focussing on vertical farming, as a technology-based type of UA, and community-supported agriculture exemplarily representing nature-based UA. In a first European expert survey the most important sub-criteria per sustainability dimension have been identified and selected. The most important sub-criteria for the ecological dimension include microclimate and hydrology regulation, biodiversity and circular economy. As most important social sub-criteria education, community building and civic participation have been identified by the experts. Securing food quality and safety and its affordability as well as strengthening local economy are considered to be crucial for the economic sustainability dimension of urban agriculture.

Based on these results, the importance of the selected sub-criteria have been weighted in a second survey including selected German cities with different settlement densities and urbanization degrees as our case studies. The survey addressed urban administrations, nongovernmental organisations and practitioners as key actors for the implementation of UA. Finally, we will provide insights into our development of indicators for assessing the sustainability of vertical farming and community-supported agriculture.

Conceptually, our approach and results provide scientific fundamentals contributing to the further development of an integrative assessment framework (Artmann, Sartison, 2018) for a systematic comparative analysis and evaluation of different types of UA. From an urban planning point of view, they support the strategic promotion of sustainable types of urban food production depending on local framework conditions.

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## CLASSIFYING HYBRID COLLABORATIVE MODELS FOR REGIONAL SHORT FOOD SUPPLY CHAINS – PROVIDING A BASIS FOR ASSESSING SUSTAINABILITY TRANSFORMATION IN THE RURAL-URBAN NEXUS

Katrin Martens<sup>1</sup> · Annette Piorr<sup>1</sup> · Sebastian Rogga<sup>1</sup> · Bernd Pölling<sup>2</sup> · Jana Zscheischler<sup>1</sup> ·  
Andreas Obersteg<sup>3</sup>

<sup>1</sup>Leibniz Centre for Agricultural Landscape Research · <sup>2</sup>South Westphalia University of Applied Sciences ·

<sup>3</sup>HafenCity University Hamburg

In response to the negative effects caused by structures of the dominant agricultural system and by new market opportunities, more and more regionalized food supply structures have re-emerged in the urban-rural context of industrialized countries in recent years. We observe that regionalized food supply structures often go along with new forms of hybrid collaboration models, which include actors and institutions that have not collaborated in the past. They form new “alliances for sustainable development” in the agricultural and food sector, especially at the interfaces between urban and rural areas. However, a discourse has flared up in science and practice about the benefits of such hybrid collaborations, e.g. their sustainability, referring to a lack of critical systematization and calling for the need to create an assessment baseline for regional examples. Such a baseline would allow drawing conclusions about the transformative potential of such collaboration models and their potential to serve as blueprints for other regions.

In this work, a classification approach derived from the social enterprise literature is tested and extended with the aim of designing a systematization of new hybrid collaborations that allows for comparisons between regions and is sensitive to their dynamics. In an application we show how the classification approach considering the dimensions ‘actors’, ‘resources’ and ‘actions’, serves to discovering patterns in the development of regional short food supply chain practices, identifying individual transition paths and thus making statements about their sustainability and challenges.

## LINKING FOOD AND LAND SYSTEM RESEARCH ALONG URBAN-RURAL LINKAGES IN EUROPE

Markus Meyer<sup>1</sup> · Andrea Früh-Müller<sup>2</sup> · Isabella Lehmann<sup>2</sup> · Nina Schwarz<sup>3</sup>

<sup>1</sup>Anhalt University of Applied Sciences · <sup>2</sup>Research Group on Agricultural and Regional Development ·

<sup>3</sup>University of Twente

**F**ood-system studies often assess dynamics, in production, consumption or processing and logistics in a spatially abstract manner. Land-system studies traditionally analyze land-use/land cover change with its environmental and societal drivers as well as impacts and are typically spatially explicit. Primary production is a main node where food and land systems overlap. Urban-rural linkages are an interesting perspective as both research strands analyze major processes at this interface: the rural-urban exchange of food and urban sprawl. In our contribution, we will propose a framework to reveal the interplay between food- and land-system research along urban-rural linkages in Europe.

We used a systematic literature review to determine how existing studies address the interface of food and land systems. We identified three clusters of studies: economic, footprint and crop modeling studies (cluster 1), and scenario-based land-use/land-cover change and remote sensing studies (cluster 2), and (qualitative) policy studies (cluster 3). The reviewed studies only partially integrate land- and food-system research. Most studies are stronger on the land- than on the food-system side and miss processing as well as distribution and sales. In addition, major linkages between land and food systems are implemented deterministically in current studies (e.g., through static land requirements for diets). Here, the role of actors and dynamic models considering systemic feedbacks could improve the realism of studies. Future research should especially address and quantify governance largely, which is hardly quantified to date. Urban-rural linkages are weakly considered and if considered only from an urban perspective. Thereby, it would be interesting to study to which extent rural population and governance shape urban-rural-linkages, and how a change of focus from rural to urban areas could provide additional insights.

## GETTING THERE: LEARNING FROM ENGAGEMENT PRACTICE ON CONVIVIAL URBANISM TO DEVELOP PRODUCTIVE URBAN LANDSCAPES

Susan Parham<sup>1</sup> · Maximilian Manderscheid<sup>2</sup> · Ferne Edwards<sup>3</sup>

<sup>1</sup>University of Hertfordshire · <sup>2</sup>University of Natural Resources and Life Sciences, Vienna · <sup>3</sup>Norwegian University of Science and Technology

In this paper we reflect on peri-urban food focused initiatives broadly framed around sustainable, convivial urbanism, which have sought to employ highly socially engaged methods for working together on productive urban landscapes. Notions of what constitutes such landscapes have been informed by constructs including convivial green space, edible cities, transect-based agrarian urbanism, ecological and edible urbanism, and a growing body of work broadly within the framing of nature-based solutions. These approaches share an applied focus on developing and reconfiguring sustainable productive landscapes and townscapes from dense city quarters to peri-urban edges to respond to urgent climate change, biodiversity and environmental justice challenges. We assert that while we may know where we need to go to make and remake productive urban landscapes to successfully bring together rural and urban, and while we are all too aware of the importance of the ecology of these landscapes to our shared future, how to get there remains an extremely vexed issue despite the rich theoretical framing now available. We explore these applied challenges through four primary data-based examples: (1) the use of a transition pathway methodology to inform masterplanning in the 'EdiCitNet' project across seven cities including Berlin, Sant Feliu de Llobregat and Šempeter pri Gorici, (2) the Espigoladors gleaning program from Barcelona that redistributes wasted produce from farmers' fields to people in need in the city, (3) an urban design-based food retrofitting project in the new town setting of Hatfield in the United Kingdom, and (4) food cooperative initiatives connecting citizen consumers with producers in Vienna, Austria.

In this research presentation and paper we aim to explore how diverse partners can construct and shape inclusive programmes to reach a wide audience using design-focused food interventions to peri-urban landscapes to meet everyday food needs and combat food inequality. We aim to identify what shared characteristics, drivers and barriers within such applied projects can inform sustainable, convivial urbanism. The lessons drawn from these practice-based examples focus on new modes of planning, collaboration and placemaking that integrate agriculture and the urban environment in peri-urban settings; offer practical proposals for implementation: and are directed towards sustainable land use planning in future. Shedding light on the interactions of country and city through these perspectives on food and productive urban landscapes offers new learnings on understanding, planning and engaging in urban landscapes.

## CHANGES IN THE DIVERSITY OF URBAN SOIL LANDSCAPES: AN EXAMPLE FROM A MEDIUM-SIZED CITY

Sylwia Pindral · Rafał Kot · Piotr Hulisz

Nicolaus Copernicus University

**D**ue to a number of functions, soils are an important element of the environment, constituting a place for life development. They can be divided into various units, according to their genesis, properties, and functions. Soilscape is a part of the environment that, as a result of the mutual interaction of soil-forming factors forms an interdependent unit, that differs from neighboring areas. The research was carried out in the Inowrocław – the city developed from an industrial center to a place fulfilling multiple functions (industrial, spa, agricultural, transport). Our research aimed to create a qualitative and quantitative method of diversity analysis using selected landscape metrics and to develop maps of changes in the diversity of urban soil landscapes for the years 1934, 1978, and 2016.

The research was carried out in the following stages: (1) selection of input data, (2) data digitization, (3) development of urban soil map and soil transformation map, (4) creation of hexagonal grid within the city's administrative boundaries, and (5) calculation of landscape metrics (Number of Patches, Patch Richness, Total Edge, Maximum Diversity, Simpson's Diversity Index, Simpson's Evenness Index, Shannon's Diversity Index, and Shannon's Evenness Index) for each hexagon (10,000 m<sup>2</sup>) and calculating original pedodiversity index (PI) using bonitation method.

We proved that the PI is a good indicator of general soil landscapes changes that were linked to the degree of human soil transformation. The share of the highest values of the PI increased from 15.9% in 1934, 17.3% in 1978, to 20.9% in 2016. In the 1960s and 1970s – the formation and spread of the strongest transformed areas occurred. This process covered mainly arable land with soils of very high utility value. It was the result of the rapid development of industry and housing. On the other hand, in the period (1978-2016) industry restructuring and the specific development of the residential areas took place. This caused the decrease of pedodiversity in several zones as a result of combining relatively small patches into homogeneous large-area units.

The obtained results, due to their potential applicability, may be useful in updating the spatial development plans, as well as the environmental protection programs. In addition, the functioning of soils in the urban ecosystem and their ecosystem services are often omitted in the development of spatial management documents. Taking into account climate change and the increasing consumption, all soil resources may be of inestimable value in the future, thus restoring them for agricultural purposes can be a significant goal for stakeholders.

## AGRICULTURE UNDER PRESSURE: SPATIAL AND TEMPORAL TRADE-OFF DYNAMICS OF NATURE'S CONTRIBUTIONS TO PEOPLE IN PERI-URBAN AGRARIAN LANDSCAPES

Matteo Riva<sup>1</sup> · Felix Kienast<sup>2</sup> · Adrienne Grêt-Regamey<sup>1</sup>

<sup>1</sup>ETH Zürich · <sup>2</sup>Swiss Federal Institute for Forest, Snow and Landscape Research

**T**echnological innovations and land transformation processes are increasing food production worldwide. However, a growing global population, changing lifestyles, urbanization, land scarcity and climate change are putting agricultural areas under pressure. Apart from providing food, agricultural areas provide a variety of other services such as habitat for various species, water regulation, aesthetic values or recreational opportunities, encapsulated within the concept of nature's contributions to people (NCPs). In this context of increasing pressure on agriculture, the resulting demands for NCPs call for collaborative management strategies that ensure a harmonious and beneficial coexistence of the different claims. Knowledge of the spatial and temporal fluctuations in supply of and demand for NCPs is essential to appropriately inform these management approaches. Strategic planning documents of Switzerland and the canton of Zurich were used to guide the choice of relevant NCPs. These NCPs were quantified using data from the mid-twentieth century until today, including land use and land cover, socioeconomic and biophysical variables as well as agricultural production data. This provided the basis to represent trade-offs between areas of supply and demand over time, with particular focus on the spatial scale at which these processes unfold. We conclude by discussing how such a historical assessment of NCPs supply, demand and flows in peri-urban agrarian landscapes can help manage landscapes for multifunctionality, i.e. support the ability of ecosystems to simultaneously perform multiple functions, leading to a balanced provision of multiple NCPs.

## PERI-URBAN FARMLAND AS PART OF URBAN GREEN INFRASTRUCTURE – FOUR MODES FOR PLANNING

Werner Rolf

Technical University of Munich

Urbanization and agricultural land use are two of the main drivers of global changes with effects on ecosystem functions and human well-being. Green infrastructure is a new and promising approach in spatial planning contributing to sustainable urban development, but rarely considers spatial and functional potentials of utilizable agricultural land as an integral part. This talk presents the outcome of a doctoral thesis that addresses this gap and investigates how peri-urban farmland can promote green infrastructure and sustainable urban development. The results contribute to the conceptual understanding of urban green infrastructures as a strategic spatial planning approach that incorporates inner-urban utilizable agricultural land and the agriculturally dominated landscape at the outer urban fringe. Four strategies are introduced for spatial planning with the contribution to a strategically planned multifunctional network. Finally, this thesis sheds light on the opportunities that arise from the integration of peri-urban farmland in the green infrastructure concept to support transformation towards a more sustainable urban development. This work concludes that the linkage of peri-urban farmland with the green infrastructure concept is a promising action field for the development of new pathways for urban transformation towards sustainable urban development. Along with these outcomes, attention is drawn to limitations that remain to be addressed by future research.

## THE VALUE OF URBAN AGRICULTURE BEYOND FOOD PRODUCTION. FINDINGS FROM ALLOTMENT GARDENS IN GERMANY

Kathrin Specht<sup>1</sup> · Runrid Fox-Kämper<sup>1</sup> · Marco Dobrodolac<sup>1</sup> · Werner Heidemann<sup>2</sup> · Stefan Grote<sup>2</sup> · Caitin Kirby<sup>3</sup>

<sup>1</sup>Research Institute for Regional and Urban Development · <sup>2</sup>State Federation of Allotment Gardeners in Westphalia and Lippe · <sup>3</sup>Michigan State University

The interest in urban agriculture (UA) is growing. One type of UA that is often overlooked within the scholarly debate are the classical allotment gardens. Their establishment can be traced back to the 19th century, thereby counting on a more than 150 years old tradition of practices. Currently, there are approx. 1 million people who rent an allotment garden plot in Germany, where triggered by the COVID-19 pandemic an increasing demand can be observed. Most of the plot-holders are people who otherwise do not have access to own home gardens. While food production is a mandatory practice for the plot owners, recreation is another key reason to rent such a plot. Despite the popularity of allotment gardens and their high prevalence, very little is known about their actual food production capacities, growing practices, resource-use, and social impacts. The aim of our study was to measure the four key components of the urban nexus in allotment gardens, namely: food production, water consumption, energy use and social impacts.

Our data collection was performed over two years (in 2019 and 2020) through diaries, in which eleven allotment gardeners documented their daily harvest (in kg/produce), water use (in l/water source), energy use (by use of fuel, fertilizer) and transportation (by km/means of transport). We further conducted a standardized survey to gain information about the social impacts of the garden activities.

The analysis of the diary data reveals that the eleven gardens produced a total amount of three tons of food, which makes up a high share of the gardeners' entire food needs during the growing season. The study thereby illustrates that the real contribution to food self-sufficiency in the allotment gardens is higher than generally assumed. The analysis of the diary data further quantifies the environmental footprint of the production in terms of CO<sub>2</sub> equivalents and in terms of resource use attached to water and energy use. The survey results show that participation in allotment gardens is driven by a broad range of motives (such as the joy of being outside, personal desires for high-quality food and the opportunities for social interactions with other gardeners). The findings from the German allotment gardens are compared to data from other case studies in the same research project (the FEW-meter project), conducted in other countries, namely the US, Poland, France and the UK. The data helps to better understand UA practices, to show starting points for resource optimization and to improve the strategic embeddedness of allotment gardens in urban planning.



## ASSESSING FOOD SELF-SUFFICIENCY OF SELECTED EUROPEAN FUNCTIONAL URBAN AREAS VS METROPOLITAN AREAS

Marta Sylla · Małgorzata Świąder

Wrocław University of Environmental and Life Sciences

The resilience of the local food system is being underlined as one of the most important strategic goals for a sustainable future. However, since the question of what constitutes the local scale of food production depends largely on the type of product and supply chain, the associated foodshed can range from a site scale, city and city region up to wider region and country level. As a proof of concept whether functional urban areas (FUAs) can serve as references for local food systems, we provide evidence on their capacity to provide vegetarian diet supply to their residents. Applying the Metropolitan Foodshed and Self-Sufficiency Scenario (MFSS) model methodology we estimate the level of potential food self-sufficiency of the FUAs. We quantitatively compare the results for FUAs with the results of local planning documents of metropolitan areas. The approach is applied to nine city regions representing different European countries: Wrocław (PL), Ostend (BE), Berlin (DE), Avignon (FR), Copenhagen (DK), Bari (IT), Brasov (RO), Athens (EL), Barcelona (ES).

The results show that vegetarian and local food demand could be satisfied in first five FUAs of these city regions. However, if the same number of calories as current diet delivers is to be maintained only the first three FUAs have enough agricultural land to supply vegetarian ingredients to this diet. The results for metropolitan comparison return the same three cities plus Bari. We discuss the use of FUA in defining foodshed area and the role of consumers' dietary choices in regional food self-sufficiency.

## URBAN PASTORALISM AS VECTOR OF TRANSFORMATION OF ABANDONED LAND IN PRODUCTIVE GREEN INFRASTRUCTURE IN THE FRINGE OF POST-SOCIALIST CITIES

Roxana Triboi

Le:Notre Institute

The transition from the socialist to the capitalist regime was characterized by a set of rapid and complex changes that developed in parallel with chaotic development, solutions of dealing with uncertainty based on previous experiences of communist era by avoiding the public system while integrating informal food markets and network. The 'de-collectivization' process that took place at the beginning of the 1990s, which meant defragmentation of public state farms in small plots (as originally in the 1950s) and their retribution to the original owners led to a massive process of land abandonment. At the same time, the intensive and chaotic process of urban sprawl put pressure on the rural periphery and especially on the ancient state farms, that were only considered for their potential as the large open spaces suitable for urbanization. Through aggressive land speculation (because of lack of awareness, vision, and appropriate policies), the chaotic fragmentation of agricultural land at the fringe of the city, created a complicated patchwork of 'open' spaces that was considered as a reserve for future urbanization. The stabilization of the urban sprawl process, due also to the economic crises of 2008-2009, contributed to the installation and development of large-scale flocks in the interstices of 'pastoral urbanism'. The flock's mobility and flexibility of its scale, along with shepherd's know-how and informal food network contributed to this trend. Today, the domination of the food market by large scale distribution chains represent a major threat to the economic viability of urban pastoralism that along with the fragility of informal and marginal status represent the major pressure that could lead to the extinction of this phenomenon.

The quantitative research of this study concerned mainly the periphery of Bucharest, although some interviews, data analysis and visits were made also in the Parisian metropolitan area (France) and Wageningen (Netherlands). The analysis of different typologies of shepherding in the city and its periphery permitted the identification of patterns of activity that could be useful in order to develop and generalize a more sustainable and resilient model of urban pastoralism. Even if innovative aspects like building a complex management plan for the marketing and communication of the activity towards interested parties, co-constructing the project along with local actors, integrating it in local food networks that characterized the western model are important features that clearly need to be included. The main challenges in managing urban pastoralism will revolve around the dissemination of the 'know-how' and promoting pastoralism as a way of life and not just a work program that breeding animals in extensive system implies a way of life that should be compatible with today vision of work schedule and expectations of working conditions.

## MAPPING MULTIFUNCTIONAL GREEN INFRASTRUCTURE NETWORKS LINKING RURAL LANDSCAPES WITH URBAN SYSTEMS: HARNESSING NATURE TO MEET MULTIPLE SOCIETAL CHALLENGES

Lukas Egarter Vigl · Valentina Giombini · Heidi Simion · Thomas Marsoner

Eurac Research

The impact of human activities on, most notably, biodiversity and the carbon and nitrogen cycles are pushing humanity out of a safe operating space, undermining the resilience of many socio-ecological systems worldwide. The adoption and implementation of nature-based solutions (NBS) such as green infrastructure (GI), however, has the potential not only to foster the sustainable management of our resources, but also to enhance the delivery of benefits, or ecosystem services (ES), to society. Ecosystems and natural features can indeed provide several environmental, socio-economic, and biodiversity benefits which can help address the societal challenges of today. In this context, the concept of multifunctional GI networks fosters strategic planning at landscape level and the sustainable management of individual GI elements. By proposing a practical approach for mapping GI networks in several pilot regions across the Alpine Space cooperation area, we aim to highlight how the concept of GI can enable practitioners and researchers to enhance multifunctionality, develop tailored management strategies along a rural to urban gradient, and harness synergies between ES and policy goals. To this end, we spatially explicitly map several ES, assess ecosystem multifunctionality, and combine these findings with an ecological connectivity analysis to identify potential GI networks.

Our analyses provide high-resolution and targeted information showcasing key multifunctional features in urban, agricultural, forested, and open areas, highlighting critical corridors for regional and transboundary ecological connectivity. In agricultural landscapes, green linear elements and woody features support connectivity and important regulating services, such as pollination. The present mapping approach can support decision-makers and practitioners in conserving, restoring and sustainably managing our natural resources effectively and efficiently. The inclusion of not only provisioning, but also regulating and cultural ecosystem services provided by different landscape features allows to maximize the synergies but also to navigate the conflicts occurring between different ES, sectoral policies, and stakeholders' interests. In this context, the consideration of both ecosystem-based multifunctionality and ecological connectivity can support decision-makers in meeting the EU policy goals outlined in both the Farm to Fork and Biodiversity strategy for 2030.

## PRODUCTIVE URBAN LANDSCAPES IN BELGIUM AND DENMARK. A COMPARATIVE STUDY OF THE PROJECTS TUINEN VAN STENE (BELGIUM) AND TREKRONER (DENMARK)

Jeroen De Waegemaeker<sup>1</sup> · Lone Søderkvist Kristensen<sup>2</sup> · Elke Vanempten<sup>1</sup> · Elke Rogge<sup>1</sup> · Jørgen Primdahl<sup>2</sup>

<sup>1</sup>Flanders Research Institute for Agriculture, Fisheries and Food · <sup>2</sup>University of Copenhagen

For long agriculture was a blind spot in planning theory and practice. Today, planners are (re)discovering the (peri-)urban farmland and its significance for local food production, recreational facilities, biodiversity and climate. There is a growing call for innovative urban planning at the rural-urban fringe (RUF) that integrates farmland into the green infrastructure (GI) of cities. While extensions of a city's GI traditionally have been implemented at the expense of peri-urban farmland, new planning concepts such as Continuous Productive Urban Landscape (CPUL), Edible Green Infrastructure (EGI) and (bio)productive/agricultural park integrates both bio-based production as well as conventional urban park functions into integrated landscape design solutions.

The paper analyzes two innovative planning projects in the rural-urban fringe of two secondary cities: Tuinen van Stene in Ostend (Belgium) and Trekroner in Roskilde (Denmark). Tuinen van Stene is part of the local GI, known as the 'green ribbon', and aims to reconnect the city of Ostend to its rural surroundings by developing an agricultural park. Trekroner is a relatively new suburb, located in the periphery of the Copenhagen Finger Plan, where the local GI comprises extensively grassed pasture and small patches of cropland. Building on document analysis, interviews with key stakeholders, and site studies, the paper juxtaposes Tuinen van Stene and Trekroner and critically compares the objectives, the designs and the management of these RUF landscapes.

Our research highlights current challenges for urban GIs involving climate change, urban agriculture, public-private collaboration and community building. Both projects stem from the same needs: an aim to preserve open spaces at the RUF, changing aspirations for urban open spaces, creation of short food chains, and shortage of public funds for managing GI. Tuinen van Stene comprises publically as well as privately owned land and merges the agricultural activities, water management infrastructure and the park features (e.g. benches and pathways) into a singular design. To ensure flexibility and facilitate agricultural entrepreneurship, that design is a 'framework plan' rather than a traditional masterplan or a detailed design. Trekroner represents a sophisticated integration of residential areas and GI where a large proportion of the publically owned open space is managed by collective grazing groups of local residents that themselves manage sheep, cattle, and horses. The cropland in the area is cultivated by a commercial farmer. In conclusion the projects' successes and shortcomings are summarized and lessons learned for future productive urban landscapes at the rural-urban fringe are outlined.

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## COLLABORATIVE EMERGING PROJECTS OF URBAN AGRICULTURE IN ZÜRICH

Irene Yerro

Vienna University of Technology

This paper is a part of a PhD entitled “Impact of land use planning in emerging practices of urban agriculture. Case Study Zurich” obtained at the TU-Wien. The goal of this paper is to analyze how urban agriculture integrates in the urban fabric framed by policies and governance aspects and more specifically to explore the procedures and tools which support nature-based solutions as emerging practices of urban agriculture in urban areas. The study takes the city of Zurich (Switzerland) as a case study and focuses on the instruments and policies that promoted the development of emerging practices of urban agriculture as community gardens, rooftop gardens, intercultural gardens, etc. versus the more established urban agriculture practices as peri-urban agriculture or allotment gardens.

The paper explores and analyses in detail three different typologies of urban agriculture in the city of Zurich. A specific instrument for urban analysis has been developed in order to study spatial qualities and governance aspects (Lohrberg et al., 2015) of the emerging practices of urban agriculture. The analysis is displayed using texts, plans and images with a narrative dimension. The research methodology includes a literature review (bibliography, policy documents, reports), GIS maps and semi-structured interviews with the project participants and leaders.

The emerging practices of urban agriculture, where food security is usually not the main driver, offer other important social functions such as public relaxation, leisure, and educational activities (Becker et al., 2021). To what extent do they help the sustainable development of cities? How do land-use policies benefit the new types of urban agriculture? Detailed observation is necessary of the tensions generated between the different stakeholders participating in urban agriculture practices including bottom-up projects in the field of urban gardening, growing real estate pressure, and sustainable development policies, in particular land-use regulations (Grün Stadt Zürich, 2006).

The conclusions of the paper will be divided in two topics: the first one will show how emerging projects relate and fit in the spatial planning system, and will reveal the spatial qualities: localization, scale, visibility, urban function and perception. The second theme will discuss how urban agriculture integrates in the urban fabric governance aspects (Becker et al., 2021). The paper reveals as well the links and interactions between the “Grow it yourself” initiatives and the legal frame of city planning and how urban policies can incentive these kinds of projects and help local actors to take part in the city life.

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## 8. Urban and peri-urban landscapes

### *Landscape changes in times of urbanization: processes and projections*

#### **Symposium organisers**

Jasper van Vliet (Vrije Universiteit Amsterdam), Luis Inostroza (Ruhr University Bochum)

#### **Summary**

Urban land is growing rapidly, thus characterizing increasing shares of the landscape. Yet, this growth is manifested in different forms, including urban densification and compact development, but also urban sprawl, peri-urbanization, and rurbanization. Managing landscapes thus requires a thorough understanding of the multitude of urban change processes affecting these landscapes. This symposium welcomes contributions that centre on understanding the processes of multiple forms of urban development affecting landscapes as well as projections of future developments.

#### **Description**

A small but rapidly increasing share of the land is covered with built-up land. Some of this built-up land is concentrated in large cities, but a large share is also distributed over villages, towns, and infrastructure in otherwise rural landscapes. This holds true across the globe, but particularly so for Europe. As a result, a large and increasing share of the landscape is to some extent characterized by built-up land. This includes large areas often referred to as peri-urban areas and also relates to processes such as rurbanization and counterurbanization.

Sprawling urban areas and the increasing presence of built-up areas in rural landscapes are often seen as undesired, because of its direct and indirect impacts on other land uses as well as on biodiversity, hydrology, and a range of ecosystem services. As a result, there is a need to better understand these processes in order to be able to manage them. Such understanding requires to go beyond merely differentiating between urban and rural land and instead needs to focus on the gradient in between, on the multiple functions and services landscapes providing to different people, and also on the acknowledgement of the connections and mutual dependency of urban and rural areas, for example in terms of flows of products, money, and people.

This symposium welcomes contributions that address urban development, in all of its forms, in landscapes. These include analyses of historical changes (preferably with an aim of understanding these processes), as well as assessments of future developments. Furthermore, we welcome submissions that analyse the impacts of these urban development processes, especially in terms of ecosystem functioning and ecosystem services.

## THE POTENTIAL TO DELIVER ECOSYSTEM SERVICES AS A CHALLENGE FOR GREEN INFRASTRUCTURE POLICY IN SMALL AND MEDIUM-SIZED CITIES IN POLAND

Agata Cieszewska<sup>1</sup> · Renata Giedych<sup>1</sup> · Barbara Szulczewska<sup>2</sup> · Joanna Adamczyk<sup>1</sup>

<sup>1</sup>Warsaw University of Life Sciences · <sup>2</sup>Institute of Urban and Regional Development

**B**oth, globally and in Poland, the application of the concept of green infrastructure (GI) and ecosystem services (ES) in cities takes place mainly in large cities. In smaller cities, and especially in small towns, both concepts are – at least in Poland – still poorly known and implemented in planning and management practices. Also the size and nature of GI resources as well as the scope of ES delivered in those cities are not sufficiently recognized. In Poland, more than 61% of the population lives in cities, of which 12.4 million (32.3%) live in cities with less than 100,000 inhabitants, defined as medium-sized (between 20,000-100,000) and small (less than 20,000). According to the demographic prospects those cities should be considered as shrinking cities. However the vision of their future development embodied in spatial policies in most cases anticipate an increase of built-up areas. Considering this, it seems that policy for GI is needed. For this policy the recognition of ES delivery is essential.

The aim of the presented research is to map and estimate the ES provided by areas that could be classified as GI of the cities studied due to their cover vegetation and/or water. The study included 264 small and medium sized urban municipalities within the administrative boundaries. The mapping included the following land categories: forests, parks, allotments gardens, waters, fields, areas covered with low vegetation (grasslands, meadows, residential greenery), that have been analysed with various landscape indicators as well as statistical analyses. Identification of types and estimation of the importance of ES was carried out using CICES V5.1 classification.

The study revealed that the provision of regulating ES in general connected with a stable natural structure, good conditions to sustain natural processes is of greater importance in small cities with a significant share of areas covered with permanent vegetation cover (forests >50% or low vegetation >30%) or water – it occurs in half of small cities, and much less among medium cities – 35%.

Provisioning services are important in cities with a significant share (> 30%) of arable land – this applies to 32% of small cities and only 12% of medium cities. The rather low level of provision of cultural services is surprising. This is because of the small share of public parks – in more than 20% of the studied cities the share is 0%, and in 60% of them public green areas cover up to 5% of the area.

Based on the research conducted, it can be concluded that in studied cities cultural ES are provided at low rate. At the same time, regulating ES prevail. So, there are two basic challenges for future GI policy Polish small and medium-sized cities. The first of them is to create elements of GI, that provide cultural ES (particularly in small towns), and the second – to solve the problem of provisioning ES connected with a significant share of arable land.

## BEHIND DENSITY TRENDS: REVEALING THE SPATIAL IMPACTS OF DIFFERENT POPULATION CHANGES IN EUROPEAN CITIES

Chiara Cortinovia<sup>1</sup> · Davide Geneletti<sup>2</sup> · Dagmar Haase<sup>1</sup>

<sup>1</sup>Humboldt University of Berlin · <sup>2</sup>University of Trento

**D**ensity is a key parameter of urban systems and density trends have been considered key indicators to describe urban development. A persistent decline in density has been often adopted as an indicator of sprawl. Nevertheless, similar density trends can be the result of different underlying changes in population and residential area, which imply different impacts on both human well-being and the urban environment. In a context where urban population is still projected to grow, the 'no land take' strategy promoted by the European Union aims at reverting the prevailing de-densification trend and is expected to foster densification by halting the expansion of residential areas. However, cases of changes in density trends in European cities have not been well documented, and little is known about the underlying factors that made them possible.

The aim of this research is to analyze the recent density trends of European cities and the underlying trends in residential area and population, in order to reveal where changes in density trends occurred and which factors determined them, with special focus on the possible distinct role of natural population change and migration.

The analysis is conducted on the residential density trends and the underlying trends in population and residential area during the two periods 2006-2012 and 2012-2018. Land use and land cover maps are retrieved from the Urban Atlas database, while population data, including separated values for natural change and net migration, are mostly collected from national statistical offices. The sample comprises 331 cities: one third of urban centers with more than 50,000 inhabitants in the 28 countries of the pre-Brexit European Union.

De-densification was the prevailing trend involving 60% of the cities in the first period, but the ratio reversed between 2012 and 2018, with almost one out of three cities showing a change in density trend. The large majority of them moved from de-densification to densification. Residential area increased in almost all cities in both periods, even if at progressively lower speed. Population growth, instead, characterized 60% of the cities in the first period, and 75% in the second one. Changes in density trends, especially from de-densification to densification, are mostly determined by strong changes in population growth, more frequently due to migration than to natural change. At the same time, correlation analysis shows that the increase in residential area is significantly correlated to natural population change, but not to net migration.

The results suggest that, so far, population changes have been the main driving factor behind densification trends and that, besides their intensity, natural growth and migration have different spatial impacts that can shape the urban development of cities. The effects of the 'no land take' strategy will likely depend on the type of population growth that will prevail in the different contexts.



## ON THE ROLE OF EMOTIONS IN INFLUENCING PEOPLE'S STEWARDSHIP FOR PERI-URBAN LANDSCAPES

Adrienne Grêt-Regamey · Marcelo Galleguillos

ETH Zürich

**A**cross the world, urban areas are growing twice as fast as urban populations. This transformation takes places where urban and rural land uses closely blend and form a new type of landscape, which is neither rural nor urban, often called the peri-urban area. While this peri-urbanization process takes place in highly different contexts all over the world, globalization processes are fostering an uniformisation of these areas. Since landscape character, as the “distinct and recognizable pattern of elements, that makes one landscape different from another”, is known to be a key determinant for the tie between people and place, this uniformisation is lowering people's place attachment, place identity and place dependence. In turn, this decline in sense of place is known to reduce feelings of caring for the local community and will ultimately cause a loss in people's motivation to participate in the landscape-shaping process. In other words, uniformisation of peri-urban areas influences people's stewardship for their landscape and the services it provides, and finally people's ability for place-making, i.e., an intentional change of the landscape to generate a sense of place.

When judging an environment, both affective and cognitive reactions are engaged. People's affective evaluations of environments can be described by their immediate reactions. In contrast, cognition can be interpreted as the explicit evaluation of settings that requires mental processing. In this contribution, we thus investigate how peri-urban landscapes influence both emotional and cognitive reactions. On one hand, we exposed participants to various virtual acoustic-visual stimuli of urban, peri-urban and rural landscapes and measured the nervous system reactions using electrodermal activity. On the other hand, we administered an extensive questionnaire that included socio-demographic information as well as landscape quality and novel place-making measures, which we validated in a large online survey (n = 10,071).

First results of the 300 participants collected in 2020 in Olten and Aarau (Switzerland) and 2021 in Utrecht (the Netherlands) using a mobile visual-acoustic lab support our hypothesis that peri-urban landscapes trigger only weak emotions and that these emotions are much more negative than if participants are exposed to urban or rural environments. Furthermore, we observe that skin conductance responses are related to various indicators of place-making, place attachment, place dependency and place identity, as well as low visual features of the landscapes. Applied in various case studies in Europe, the same experiment will help improve our understanding for place-making in and stewardship for peri-urban landscapes.

## TOURISM DEVELOPMENT AND URBANIZATION OF FOOD SPACES: EXTENDED URBANIZATION PROCESSES IN MEDITERRANEAN COASTAL AREAS

Sebastian Felipe Burgos Guerrero

University of Milano-Bicocca

**H**ow have food systems shaped and been shaped by the urban, and what are the constitutive properties, geographies and socio-spatial transformations resulting from these processes under evolving tourism development? The profound socio-spatial transformations of 'rural' landscapes have been both the determinant factors and resulting expressions of ongoing urbanisation processes, embedded and materialized in contemporary urban food spaces. In fact, food systems have been at the base of the historical emergence of urban cores, providing the basic metabolic requirements to a growing non-agricultural population, while experiencing broader socio-spatial transformations in the way we produce, distribute, consume, and even think and talk about food. The widespread modification of landscapes connected to evolving tourism development, especially in Mediterranean coastal areas, have in turn giving rise to new forms of land-use practices, urban-rural relations and spatial-temporal movements and concentration of tourist and resources that highlight the complex interrelationship between the phenomenon of tourism and the production, reproduction, and differentiation of food spaces. The historical modification of such spaces connected to evolving tourism urbanization can thus be interpreted by the three moments of concentrated, extended, and differential urbanization, offering new epistemological orientations that go beyond the classic dichotomy of an urban-rural opposition. The food issue emerges in this context as an intrinsically urban question, with entrenched power dynamics, consumption patterns and specific socio-spatial configurations, determining the access, logistics, consumption, socialization, and production of food in evolving tourism landscapes.

This research operationalizes food spaces as a privileged lens through which to interpret, map, conceptualize and, ultimately, influence the social, economic, political, and environmental impacts of urban and tourism development, setting forth a systematic literature review and empirical study of the relationship between tourism urbanisation processes and food systems. Findings will provide evidence of extended urbanization processes in two Mediterranean coastal areas, highlighting the underlying processes and implications for public policy, planning and urban studies.

## HOUSING DEVELOPMENT WITHIN AND AROUND NATIONAL PARKS IN RAPIDLY URBANIZING LANDSCAPES – CASE STUDIES FROM POLAND

Michał Jakiel

Jagiellonian University

**P**rotected areas (PAs) are cornerstones of biodiversity conservation, but in present time they are in danger of becoming isolated islands in urbanizing landscapes. Land use changes, especially land development and their implications in the vicinity of PAs may have a significant impact on their ecological functioning and biodiversity and may cause landscape fragmentation and isolation (DeFries et al., 2007; Rodríguez-Rodríguez, Martínez-Vega, 2019). Many authors emphasize that PAs' vicinity are attractive for housing development (Radeloff et al., 2010; Borgström et al., 2012; Brambilla, Ronchi, 2016). Therefore, this study aimed at investigating whether the proximity to protected areas may increase the likelihood of residential development and how this development impacts landscape fragmentation and ecological connectivity.

The historical land use changes in 1920-2016 were analyzed based on various databases (historical topographic maps, aerial photographs, National Database of Topographic Objects, Land and Property Register). The analyses were carried out within the selected National Parks (NPs) boundaries and in their surroundings, i.e., in the concentric buffer areas (every 500 m) around NPs, in legally protected buffer zones and in areas outside the buffer zone. The studied areas have different levels of protection, so the effectiveness of buffer zone in reducing land development was assessed compared to the area not covered by any legal protection.

The results have indicated that the main change around NPs was the loss of open areas (mostly due to the housing development and abandonment of agricultural land), which was higher in the close proximity to NPs. These results pose significant questions regarding the effectiveness of current conservation efforts and legal instruments in the spatial planning system for reducing the intense housing development and urban sprawl process in the vicinity of PAs.

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## IMPACT OF POLITICAL LEGACIES ON THE PATTERN OF THE WILDLAND-URBAN INTERFACE IN POLAND

Dominik Kaim<sup>1</sup> · David Helmers<sup>2</sup> · Michał Jakiel<sup>1</sup> · Daniel Pavlačka<sup>3</sup> · Volker Radeloff<sup>2</sup>

<sup>1</sup>Jagiellonian University · <sup>2</sup>University of Wisconsin-Madison · <sup>3</sup>Palacký University Olomouc

**W**ildland-Urban Interface (WUI) is area where settlements are located near wildland areas (Radeloff et al., 2005). It is useful in detecting the areas of high wildfire exposures, human-animal coexistence incidents and other human-nature interactions. Since current WUI extent is mainly attributed to recent land use changes (Radeloff et al., 2018), the research indicating its persistence over time and dependence on the historical processes is largely missing. In this paper we present a first country-wide WUI map of Poland. It was created based on the database of nearly 15 million buildings and a Sentinel-2-based forest map.

Our analysis shows that substantial part of the country (35.1%) is located in WUI, while number of buildings in WUI exceeds 60%, which means that substantial part of the Polish rural buildings are located in WUI. Pattern of WUI is not uniform, and can be explained by the former political boundaries, which existed before 1945 much better than by the natural ecoregion diversity. Currently WUI hot-spots are located around the largest Polish agglomerations and in the Carpathian Mountains. It is a result of the land use changes, where farmland abandonment is leading to either forest cover increase or settlement development and both processes supports new WUI creation. So far WUI was not included in any spatial policies in Poland regarding fire risk, human-animal coexistence, or spatial planning. Our analysis introduces WUI concept in Poland, what will open new opportunities to test its applicability in many disciplines.

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## THE GLOBAL HOMOGENIZATION OF URBAN FORM. AN ASSESSMENT OF 194 CITIES ACROSS TIME

Richard Lemoine-Rodriguez · Luis Inostroza · Harald Zepp

Ruhr University Bochum

The spatial structure of cities, i.e. their composition, shape and degree of fragmentation or compactness, is a physical expression reflecting development efficiency. Identifying the evolution of urban systems in time and space is crucial towards sustainable urban development. In this paper, we assess the spatial structure of 194 cities from 1990 and 2015, in order to identify patterns, clusters of similar cities, trajectories, and the global distribution of urban form. We delineated the contiguous urban fabric, employed landscape metrics to quantitatively describe urban patterns, applied a Principal Component Analysis (PCA) to reduce the dimension of data to an uncorrelated set of variables and identified groups of cities with similar urban forms by means of hierarchical clustering.

We found four types of urban form: compact-grey, transitional, ragged-small and fragmented-complex cities. Globally, continentally and regionally, cities have followed a trend towards more homogeneous urban forms, most of them becoming transitional as a consequence of both, processes of fragmentation and compactness. The only exception of this trend is a group of large cities in Australia, New Zealand and the United States, which are still predominantly fragmented-complex. Under the persisting process of urban expansion, small to medium-sized cities showed to be the most dynamic in terms of expansion and change in urban form, which makes them key towards sustainable urban development. This analysis contributes to the understanding of the transformations induced by the process of urban expansion that shapes urban form. Such information is crucial for achieving urban sustainability.

## SPATIAL LOGIC OF PARK ACCESS IN GREATER DOHA, QATAR

Khalida Lifam Marthya · Madhavi Indraganti

Qatar University

**U**rban parks are public assets that unite communities and enhance livability of neighbourhoods. Spatial distribution of urban parks does not always adhere to people's needs or desires. In the context of Qatar, where social stratification in terms of ethnicity and economy is evident, equitable park distribution that meets the needs of the residents raises a social justice issue. Using established and new methodology, this paper identifies the green park distribution pattern in Greater Doha, Qatar using open source demographic data and park need variables. The paper uses two approaches for spatial analysis of green parks: (1) by using walkable service areas to highlight zones with lesser walkable accessibility to neighbourhood parks, and (2) by identifying zones with higher park need using variables such as population density, housing subtype and population subtype.

Results show that about 22% of the zones in Greater Doha and Al Daayen have less than 10% population within walkable access. These zones are majorly home to expatriate population and low-wage migrants in Doha Municipality. Need based analysis shows 'unpatterned inequality' with a greater need both in Doha and suburbs. Findings provide insight into drafting policies on planning parks based on the need to ensure equitable access to different demographic sections.

## ASSESSING SUSTAINABLE URBAN DEVELOPMENT – AN EXAMPLE OF INDICATOR SYSTEM

Denis Michalina · Peter Mederly

Constantine the Philosopher University in Nitra

Indicators are a useful tool for assessing the level of achievement of strategic objectives and the success in implementing the concept of sustainable development in cities. We aim to provide an overview of the sustainable urban development assessment methodology and its application in selected Slovak cities. We have designed the methodology based on reviewing and analysing selected international and European indicator systems, methodological guidelines and recommendations by various authors, the basis of which are 40 indicators considering the environmental, social, economic, and institutional dimensions of sustainable development. When selecting the indicators, we considered criteria such as their relevancy to development objectives of Slovak cities, availability and quality of data, and frequency of use and the importance of indicators in terms of their application for assessing sustainable urban development. The methodology also includes design of structure and content of indicator methodological sheets. The methodology was applied in the eight largest cities of Slovakia. To evaluate the indicators, we used the scoring method – we scored each indicator and subsequently compiled the integrated indicator through a weighted arithmetic mean of the total number of points scored for each indicator and for sustainable development dimension. Based on the integrated indicator, we then compared the overall performance of each city in terms of sustainable development. Using this approach of evaluation, the capital city Bratislava scored the highest while the city of Prešov the lowest. Finally, we summarized methodological findings and recommendations for the assessment of sustainable urban development. The results of this research can be used especially in the decision and policy making, planning and management process related to urban development in Slovakia, but can provide methodological inspiration also for other European countries.

## MAIN DIRECTIONS OF LANDSCAPE TRANSFORMATIONS IN POST-INDUSTRIAL URBAN AREAS

Katarzyna Pukowiec-Kurda

University of Silesia in Katowice

Contemporary dynamic space transformation, force to identify new factors that mainly shape the landscape. Landscape formation in post-industrial urban areas is influenced by the processes associated with the transformation of traditional industrial regions into metropolitan areas. Along with this transformation, their function and administrative status are also changing, but the biggest changes are spatial. Learning about contemporary landscape transformation processes allows us to define forecasts for their further development. The aim of this study was to identify landscape transformations in areas anthropogenically changed due to coal mining.

Traditional coal districts in two countries, Poland (Silesian Metropolis – GZM) and the Czechia (Ostrava-Karviná Region – OKR), were selected as study areas. Study areas from two countries allowed for the analysis of similarities and differences in landscape transformation and space management in both of them. The study was based on the LUCC+LTC (Land Use Cover Changes + Landscape Type Changes) model procedure. At the first stage using Corine Land Cover, on the basis of indicators of landscape changes, the dynamics of changes in the years 2000-2018 was determined. In addition, on the basis of orthophotomaps, landscape types in 2000 and 2020 were identified and compared with each other. Locations of changes were verified with planning documents.

The results indicate that the period 2006-2012 saw the most dynamic transformation in both GZM and OKR. The landscape change index indicates that greater landscape transformation occurred in Poland. The main process changing the landscape was suburbanization, which manifests itself in: increased acreage of residential, commercial, industrial areas and denser road network. In both areas, warehouses and logistics centers are massively built. At the same time the area of agricultural land is decreasing. Both in Poland and the Czechia there has been a closure of most mines and a changed into wastelands, recreational areas or young forests.

In conclusion, it should be pointed out that the transformation of landscapes is progressing, but becoming less dynamic. The progressing anthropization of landscape is visible. The landscape of both GZM and OKR is heading towards further urbanisation, or even metropolisation, with all the characteristics of such urban centers. Such manifestations are: expansion of airports, CBD with global corporations occurrence, densification of highway network, construction of skyscraper district and transfer the residential function to the suburbs. A characteristic feature is also the phenomenon of urban sprawl.

Further research and monitoring of landscape changes will verify the forecasts. Nevertheless, the identified landscape changes and the processes generating them, indicate further development of cities and an increasing need for their sustainable management.



## UNDERSTANDING REGIONAL URBAN SPRAWL AND DENSIFICATION PROCESSES THROUGH SETTLEMENT AND BUILDING NETWORKS

Yves Marc R  th · Maarten J. Van Strien · Adrienne Gr  t-Regamey

ETH Z  rich

**A** growing and urbanizing human population is leading to expanding and densifying settlements (i.e. villages, towns, and cities) worldwide. In Switzerland, the majority of the historical population growth occurred in the past 200 years. During this time period, the landscape has changed drastically as settlements expanded, densified, and became increasingly interconnected through roads, highways, and railroads. Yet, the processes governing urban expansion and densification are not well understood. In this study, the changes of the built environment are analyzed with time series of building and settlement networks. The small-scale building networks are constructed by linking building footprints, based on their orientation and distance to one another, and are used to detect intra-urban changes of urban morphology through network analysis. At the same time, the building networks serve to delineate the nodes for the large-scale settlement networks. The links in the settlement networks are based on spatially explicit commuter flows. These networks are derived from detailed historic maps and datasets.

We investigate the relation between the settlement network topology and the intra-urban morphology in the Swiss Plateau over the past 150 years through 16 time steps. It is expected that urban expansion and densification depends not only on settlement characteristic (e.g. economic or population growth) but also on the relations among settlements in the settlement network, i.e. the network topology (homogenous, polycentric, monocentric). This understanding can help to improve policies to better control urban sprawl in particular in countries where heavy urbanization is still ongoing.

## MAPPING CHANGES TO FUNCTIONAL URBAN GREEN SPACE GLOBALLY

Elizabeth Schrammeijer · Ziga Malek · Peter Verburg

Vrije Universiteit Amsterdam

Ongoing and rapid expansion of urban area often occurs at the cost of vegetation cover. As a result the essential benefits of green spaces can also be lost or deteriorated. Especially social functions, such as opportunities for psychological restoration or social interaction, cannot be replaced by human built infrastructure. To develop sustainable and liveable cities it is important that we understand the current state of urban green spaces (UGS) and how urbanisation changes their potential to provide essential social functions. To this end we develop a global map of urban green spaces that shows how their characteristics differ between regional urban landscapes and how they change over time. We analyse global and regional differences and past change in demand and supply of social functions. Our findings demonstrate clear regional differences that are closely linked to urban form and socio-economic situation. We also show that ecological context, such as biome type, has a clear influence on UGS characteristics. In some regions urban densification appears to be the cause of dramatic UGS fragmentation and loss and a corresponding increase in mismatch between demand and supply of social functions. In others extensive suburbanisation has similar effects. We emphasize that UGS play an integral role in sustainable urban development and that ecological and social contexts need to be considered in planning effective development strategies.

## CITIZENS' PERCEPTIONS OF LANDSCAPE CHANGES AND THEIR DRIVING FORCES: EVIDENCE FROM POLAND

Iga Kołodzyńska · Piotr Krajewski · Aleksandra Krzyżanek · Ada Garczyńska

Wrocław University of Environmental and Life Sciences

Landscape change is caused by a complex combination of technological, social, cultural, political and spatial processes. These processes are called drivers, or key processes in landscape change or driving forces of landscape change. They are mostly divided into five main groups – socio-economic, political, technological, natural and cultural – and are analyzed as proximate and underlying processes.

The way people perceive those changes is helpful to recognize and analyze the change in the social and cultural context. The perceptive approach helps to recognize people's attitudes and behaviors, which are highly significant direct drivers of local people's priorities and preferences in the context of landscape changes, and hold important information for planners and decision makers. The perception of landscape change may impact the perceived attractiveness of the living environment which is one of the most important factors affecting residential satisfaction. Whether we perceive landscape change as negative or positive may also impact our mood or contribute towards better quality of life. Therefore, the motivation for this study arose from the need to recognize how citizens perceive different types of landscape change and what driving forces are associated with this change in two different settings.

The main aim of our studies was to explore the driving forces of landscape change and their impact on the landscape as perceived by citizens. In our study, we use quantitative tools for unravelling processes of landscape change over time and a qualitative tool aimed at capturing people's perceptions about those changes. We use the two municipalities of Ostrów Wielkopolski and Kąty Wrocławskie as illustrative examples of urban and urban-rural municipalities in two time periods, 2006-2021 and 2012-2018, in Poland. We apply a three-stage approach: (1) to identify the main landscape changes based on land cover data, (2) to characterize those changes with the use of orthophoto maps, and (3) to identify the driving forces of landscape changes with the use of an online survey and interviews.

The results show a large agreement between the perceived and actual level of changes. We identified key landscape change processes in both municipalities, and we conclude that citizens' perceptions concerning those processes in both municipalities differed depending on the context, the level of changes, and the way this process was planned and implemented. In both municipalities the respondents pointed out political driving forces of landscape change as key underlying drivers. Future landscape planning should consider citizens' approaches towards landscape change to achieve better societal approval and improve the quality of life of the inhabitants.

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## ASSESSING THE LEVEL OF LANDSCAPE CHANGE IN POLAND – QUANTITATIVE STUDY FOR DISTRICTS AND PROVINCES

Iga Kołodyńska · Piotr Krajewski · Monika Lebedzińska · Karolina Birnbaum

Wrocław University of Environmental and Life Sciences

In the recent 20 years, an intensification of landscape changes and increasing pressure on landscape values have been observed. Landscape transformations are observed all over the world, especially in the countries of Central and Eastern Europe. The fall of communism was the beginning of landscape transformations in Poland. Another stage of landscape development started in 2004 after Poland's accession to the European Union and the activation of funds for changing the transport system or the reconstruction of degraded areas. Significant changes in the landscape also affected protected areas due to high tourism activities.

We aim to identify the main areas and direction of landscape changes in Poland using quantitative approach. We use Corine Land Cover database to analyse the intensity of changes in the context of districts and provinces in two time periods: 2006-2012 and 2012-2018 in terms of area change for each land cover type, number of changes, general changes per km<sup>2</sup> and Landscape Change Index (LCI).

Results show that the changes were more intense in the first analyzed period (2006-2012) than in the second (2012-2018). Changes per km<sup>2</sup> are most intense in Małopolskie province. The biggest loss is observed in agricultural land while settlement, industrial areas and forest grow in the first period. Similar tendencies are observed in the second period yet the grow of settlement areas is smaller. Biggest LCI is observed in central, northern, southern and south-west Poland in 2006-2012. While in 2012-2018 biggest LCI is observed in the south Poland (Małopolskie province).

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## PROTECTION OF PERI-URBAN OPEN SPACES AT THE LEVEL OF REGIONAL POLICY-MAKING: EXAMPLES FROM SIX EUROPEAN REGIONS

Marcin Spyra · Janina Kleemann · Alina Schürmann · Nica Calo · Christine Fürst

Martin Luther University Halle-Wittenberg

**P**eri-urbanisation is a dynamic process consisting primarily of the expansion of artificial areas into natural, semi-natural, and agricultural areas. This process is the backbone of diminishing of peri-urban open spaces, thus it is threatening peri-urban biodiversity and hampers the provision of ecosystem services. In this manuscript, we introduced the concept of peri-urban open spaces and exemplified it on the level of regional policy-making in the following six European case study regions: Basque Country (Spain), Flanders (Belgium), Gorenjska (Slovenia), Hajdú-Bihar (Hungary), Mazovia (Poland), and Saxony-Anhalt (Germany). Our study aimed (1) to analyse land cover changes related to peri-urban open spaces in the case study regions, (2) to identify and classify policy improvements that are useful to protect peri-urban open spaces, and (3) to provide recommendations for regional policy instruments to improve the protection of peri-urban open spaces. We designed a mixed-method approach combining Geographical Information Systems, an explorative questionnaire, and a semi-quantitative survey to fulfil our research aims.

Our results showed that peri-urban open spaces are decreasing in all case study regions but with different scale and dynamics over time. Mostly (non-irrigated) arable land was transformed into non-peri-urban open space. Moreover, we identify 15 policy improvements that are suitable to support the protection of peri-urban open spaces at the level of regional policy-making. Our results indicated a potential for improving the regulatory instruments and showed the usefulness of multi-level governance that better address the protection of peri-urban open spaces at regional level. Using our research results, we provided recommendations for regional policy-makers who are willing to pay more attention to the protection of peri-urban open spaces.

## SOCIAL-ECOLOGICAL INTERACTIONS BETWEEN COMPOSITION AND CONFIGURATION OF GREEN INFRASTRUCTURE ALONG RURAL URBAN SETTINGS OF BANGALORE, INDIA

Pramila Thapa<sup>1</sup> · Mario Torralba<sup>1,2</sup> · Tobias Plieninger<sup>1,2</sup>

<sup>1</sup>University of Kassel · <sup>2</sup>University of Göttingen

**G**reen infrastructures (GIs) are important elements to provide ecosystem services and connectivity in rural and urban landscapes. GIs often link rural to urban areas, but until now little is known about the specific ecosystem services contributions and the spatial, ecological, and socio-cultural connections of GIs in the rural-urban continuum. Bangalore, also known as the 'Garden City', is highly illustrative of urban GIs, as it displays a diversity of GI elements such as street trees, home gardens, parks, spiritual trees, and water bodies. This study aims to identify the social-ecological associations that explain the GI composition (quality and quantity) and configuration (geometric arrangement, isolation, and position of elements) of GIs in Bangalore. We ask how do the amount and configuration of GIs vary among urban, transitional, and rural areas? How do biophysical conditions (such as built-up area, density, asphalt road density, and distance from the city center) and socio-demographic conditions (such as income source, ethnicity, population density, knowledge on the natural environment, housing ownership, and an affiliation to a formal organization) relate to the GIs' distributions among the urban, transitional, and rural areas? To do so, we will use WorldView images. We will consider vegetation, forest, and water bodies as GI elements to assess their percentage cover, size, number, and fragmentation. We will run the Multiple Logistic regression to assess the relationship between the amount and configuration distributions of the GIs with the considered socio-demographic factors. Outcomes of such a social-ecological and spatial assessment of GIs in the rural-urban continuum would help regional planners and decision-makers visualize and plan to facilitate various GIs.

## THE SWISS LANDSCAPE MONITORING PROGRAM LABES THAT INTEGRATES BOTH PHYSICAL/SPATIAL AND SOCIAL DATA: RESULTS FROM THE SECOND RUN 2020

Lina Torregroza<sup>1</sup> · Marcel Hunziker<sup>1</sup> · Flurina Wartmann<sup>2</sup> · Felix Kienast<sup>1</sup>

<sup>1</sup>Swiss Federal Institute for Forest, Snow and Landscape Research · <sup>2</sup>University of Aberdeen

Most of the landscape monitoring programs in Europe and worldwide are limited to the physical and biological space despite the fact that land-use is strongly linked to the socio-cultural realm via people's perception, as it is stated by the definition of landscape of the European Landscape Convention. The Swiss Landscape Monitoring Program LABES is one of the first large-scale landscape observatories where not only physical/spatial data are included but landscape perception has been systematically monitored with representative surveys from the beginning of the monitoring program. The entire monitoring consisted of roughly 30 indicators. Approximately 25% of the indicators measured perception properties: respondents were instructed to base their statements on the landscape and places of their current home municipality rather than on pictures of specific landscapes. We distinguish two perception concepts: (1) an evolutionary determined perception component, and (2) a culturally determined interpretation component based on concepts such as place identity and place attachment.

In the first run of LABES 2010 the physical/spatial and the social preference data were gathered and analysed more or less independently resulting in separate clusters of indicators. However, first attempts to correlate physical/spatial indicators with social/preferential ones turned out to be highly promising. There was, e.g., a clear interdependence of high urban-sprawl values and low preference values. Nevertheless, the findings remained statistical correlations, and it lacked a theory-driven empirically supported explanation of this interdependences.

A method re-development project was, thus, conducted to close the gap between physical/spatial indicators and the social ones. We included indicators focusing specifically on the contents of what is measured by the physical/spatial indicators. In addition, the latter were extended by recreation suitability and use indicators to allow going beyond only landscape preferences. Multi-level and structural equation modelling then was applied to analyse the complex data in an adequate way. At the conference the results of this method re-development project will be presented as well as selected results of the second run of LABES 2020.

Finally, the question arises which approaches are most suitable for which task. On-site surveys of course are most adequate for regional studies and for exploring the mechanisms, photo-based online surveys help to include a large population but still stick to particular situations represented on the photographs. And finally, the general municipality evaluation regarding landscape and recreation quality is best to gather information about the public perception of large areas as countries or beyond (suitable to compare the situation in, e.g. the whole of Europe).

## ANALYSIS AND MODELLING OF CHANGES IN SETTLEMENT SYSTEMS

Jasper van Vliet<sup>1</sup> · Mengmeng Li<sup>1</sup> · Yuan Wang<sup>2</sup> · Peter Verburg<sup>1</sup>

<sup>1</sup>Vrije Universiteit Amsterdam · <sup>2</sup>Hebei Normal University

**B**uilt-up land has profound impacts on the landscape, for example in terms of aesthetics and ecological disturbance, even when it occupies only a fraction of the landscape. Yet, spatial analyses as well as future projections often represent landscapes based on their predominant land cover, thus often ignoring small patches of built-up land. Such simplification hampers our understanding of processes of landscape change, as well as our capacity to develop future projections with landscape ecological relevance.

In this study, we operationalize the concept of settlement systems to better analyze past landscape changes and explore future scenarios. Settlement systems in this case are operationalized as stages along the conceptual rural-urban gradient, from agricultural village landscapes to urban cores. They differ not only in the amount of built-up land, but also in terms of the predominant and cover, number of settlements and population density.

We first map settlement systems in China for the year 1990, 2000, and 2010 and analyze their changes over time. Not unexpectedly, we find that a large share of the landscape includes some settlements, and can thus be characterized accordingly, while only a small fraction is characterized by denser urban systems. Yet, more surprisingly, we find that the vast majority of all built-up land is included in village and town landscapes. Moreover, we find that over time, settlement systems change gradually along the rural-urban gradient, rather than suddenly from strictly rural to strictly urban.

Subsequently, we simulate future settlement changes, and under different planning strategies. Here, we find that the same population scenario can lead to drastically different settlement system outcomes, depending on whether intensification or expansion of built-up areas are promoted. This again affects the impact on cropland as well as natural areas, both of which are very much under pressure in China.

Our results show that large shares of the landscape can be characterized by the presence of human settlements of different types, and that these settlements change incrementally. In many spatial analyses this nuance is lost due to the simplification of landscapes, while our results show their relevance in both understanding and projecting landscape changes.



## ***Governance mixes for sustainable peri-urbanization: how can landscape ecology contribute?***

### **Symposium organisers**

*Marcin Spyra* (Martin Luther University Halle-Wittenberg), *Silvia Ronchi* (Polytechnic University of Milan), *Chiara Cortinovis* (Humboldt University of Berlin)

### **Summary**

Peri-urban landscapes (PULs) are often characterized by unsustainable development, conflicts, and fragmented governance, but they are also key places to address cross-scale issues such as water management, biodiversity conservation, and ecosystem service provision. In this session, we aim to investigate innovative governance mixes for PULs sustainability and to explore how the holistic approach of landscape ecology can contribute to them. We welcome both applicative cases and theoretical perspectives.

### **Description**

Peri-urbanization processes involving urban expansion through land take and soil sealing are massive, often taking place beyond any regulations, threatening the performance of ecosystems and the provision of ecosystem services. These processes lead to the emerging of peri-urban landscapes (PULs), transition territories connecting cities with their surrounding environment, where urban, rural and natural or semi-natural characteristics are mixed. The governance of PULs faces multiple challenges: vertically and horizontally fragmented governance and planning, increasing pressure of market forces, speed of peri-urbanization processes, and lack of awareness about their potential consequences, among others. At the same time, it needs to address urban, regional and (cross-) national development goals such as air pollution reduction, integrated watershed management, infrastructure planning and management, biodiversity conservation, provision of and accessibility to ecosystem services.

Fostering sustainable development requires to overcome the numerous conflicts that characterize PULs and to approach them as interfaces where opportunities for governance experimentation and new governance mixes can emerge. Such new governance mixes do not refer to a particular type of governance or a simple combination of policy instruments but indicate a thoughtful mix of different, top-down and bottom-up governance approaches, introduced at different administrative levels, discussed and implemented by a wide range of governance actors, and bringing different formal and informal outcomes.

We hypothesise that a holistic landscape ecology approach can offer a transdisciplinary platform to develop innovative governance mixes towards sustainable PULs. However, several limitations and barriers are likely to emerge in such complex landscapes. To explore those barriers and the opportunities emerging in PULs, we encourage researchers and practitioners to present case studies, exemplary applications, theoretical frameworks and perspectives, as well as proposals of innovative governance processes, policy instruments, decision-support tools and methodologies, which contribute to addressing the following questions:

- What kind of governance mixes could increase the sustainability of existing and future PULs, and how?
- What is/can be the role of landscape ecology and landscape approaches when developing innovative governance mixes towards sustainable PULs?
- What are the good practices related to the successful implementation of governance mixes in PULs?
- What are the challenges and barriers for implementing governance mixes towards sustainable development in PULs?

## RE-PLANNING OF GREEN INFRASTRUCTURE AND NATURE-BASED SOLUTIONS FOR SUSTAINABLE URBAN TRANSITION

Sigvard Bast<sup>1</sup> · Ulla Mörtberg<sup>1</sup> · Johan Högström<sup>1</sup> · Berit Balfors<sup>1</sup> · Lina Suleiman<sup>1</sup> · Chiara Cortinovia<sup>2</sup> · Blal Adem Esmail<sup>3</sup> · Jarumi Kato Huerta<sup>4</sup> · Davide Geneletti<sup>4</sup> · Christian Albert<sup>2</sup>

<sup>1</sup>KTH Royal Institute of Technology · <sup>2</sup>Ruhr University Bochum · <sup>3</sup>Humboldt University of Berlin · <sup>4</sup>University of Trento

Landscape approaches are important for planning of urban sprawl in peri-urban landscapes, continuously emerging in many metropolitan regions. In the case of Stockholm Region, land-take and incremental urbanisation is a continuous process, while the regional development plan has ambitions to steer the overall development in a sustainable direction. This plan contains a green infrastructure effort building on a set of green wedges, mainly serving as support to the needs of the city and suburbs and their citizens. This initiative differ from the later green infrastructure action plan provided by the county administrative board, related to the EU biodiversity strategy and guidelines. The latter has a different approach, mainly targeting biodiversity goals as well as ecosystem services. These approaches differ from each other in several ways while both have unclear roles when it comes to municipal planning on different levels. Furthermore, the municipalities have their own initiatives when it comes to green infrastructure and nature-based solutions and it is not clear how the different planning tiers are linked to each other, to planning and management, and to multifunctional landscapes. The aim of the REPLAN project is to investigate how the different green infrastructure initiatives are linked to planning, to each other on different scales, and whether they can serve multi-functional landscapes when it comes to biodiversity and different ecosystem services. The REPLAN project involves stakeholders and practitioners on different planning levels for co-producing knowledge, methods and strategies for green infrastructure and nature-based solutions to serve as tools for sustainable transition of metropolitan areas and their peri-urban landscapes.

## LANDSCAPE QUALITY AND ECOLOGY OF PERCEPTION THE IMPROVEMENT OF THE BUILT ENVIRONMENT AND URBAN SETTLEMENT IN MOUNTAIN AREAS

Lorena Fiorini · Camilla Sette · Bernardino Romano

University of L'Aquila

The appreciation of the qualities of the landscape by individuals has long been limited to perception relationships. Several notable examples could be cited: one of the best known is the reporting of the wonders of American nature made by Lewis and Clark after their expedition in 1806 and which led to the establishment of the world's first National Park in 1872, Yellowstone. But to this example we cannot neglect to associate that of the Italian legislation that introduced the landscape plans, that is the law 1497/39 "Protection of natural beauties". It is evident that social communities have always established functional relationships with landscape contexts, using and exploiting ecosystem services, but these concepts came rather late to the understanding of the general public thanks first of all to scientific production (Costanza et al., 1997) and then with the international research project Millennium Ecosystem Assessment supported by the UN in 2001 (MEA, 2005). In any case, it cannot be denied that perception remains central to this day and undoubtedly supports the large part of tourist motivations. From the above considerations emerges the need to protect the landscape, in particular with the care linked to the actions of redevelopment, conservation and restoration, finalizing the objectives to the maintenance of functional qualities towards the human component and biodiversity in general, but not neglecting the aspects more basal than perception quality.

The theme shows many emblematic characteristics in the Italian mountains, in particular in the settled parts of this, where, apart from some limited virtuous cases, interventions have followed one another over time that have dramatically damaged the historical features of ancient villages and relationship matrices.

Italy is currently experiencing a season of strong relaunch of the debate connected to the abandonment of the mountains, which follows the one already activated in the early 1970s. Specifically, very simplistic planning and promotion actions are envisaged aimed at generic 'repopulation' objectives, as well as intense infrastructuralization according to models that have now been failed in previous decades.

Very little is said and proposed instead on the topics of the profound improvement of the image of the settlements, and in the same protected areas it is very tiring to enforce rules that can lead, again in the span of at least twenty years, to the retrofit of these processes of alteration of the built heritage which, if it has any chance of resuming permanent functions, emerging from the spiral of economic neglect, it must first recover perception quality and become again an attractor for the interests of reuse and attribution of new functions.

Costanza R. et al. (1997). *The value of the world's ecosystem services and natural capital*. Nature, 387(6630): 253-260.

MEA (2005). *Ecosystems and Human Well-being: Synthesis*. Washington: Island Press.

## IDENTIFYING AND REGULATING PERI-URBAN AREAS BY A LANDSCAPE PLANNING APPROACH. THE CASE STUDY OF TURIN (ITALY)

Federica Larcher<sup>1</sup> · Claudia Cassatella<sup>2</sup> · Enrico Gottero<sup>2</sup>

<sup>1</sup>University of Turin · <sup>2</sup>Polytechnic University of Turin

Since the nineties, peri-urban areas have inspired many research and produced strong interest in the field of the territorial science, especially with the aim of governing conflicts between city and countryside, as well as finding valid and universal solutions to the phenomenon of peri-urbanization. According to several authors, the peri-urban is a specific space, neither urban, nor rural. It is an interface, a contact zone between urban settlements and closing rural areas. At the same time peri-urban areas undergo the urban pressure and provide socio-economic and cultural functions taking advantage from proximity to urban areas (Piorr et al., 2011). The complexity and different types of peri-urban areas are the main reasons that make a homogeneous interpretation, an unambiguous identification and designation, as well as the definition of land use rules, very difficult. The aim of this research is to develop a replicable method to identify and draw up peri-urban areas, as well as to define guidelines for statutory planning at different scale and in the European context. In order to a deeper understanding of the peri-urban concept and its dimensions, this method is applied to a case study of the Turin Metropolitan Area (TMA).

The proposed method includes: (1) the discourse analysis of plans and policy documents related to Turin peri-urban area in the last 20 years, (2) the identification of the peri-urban area, based on different criteria and conditions of peri-urbanization, including distance from urban centre and integration with functional urban area (FUA) (essential conditions), number of inhabitants, degree of urbanization and infrastructure (primary conditions), altitude and slope (secondary conditions), and (3) the definition of rules and guidelines for peri-urban open spaces.

This research produced a new perimeter of the Turin peri-urban area, defined transformation and conservation rules such as procedural guidelines, a scheme of peri-urban open spaces at local scale, implementing instruments (agro-urban projects, agricultural parks, integrated financial tools) at local and supra-local levels. The authors also highlighted the relevance of the landscape planning approach in governance and regulatory planning of peri-urban areas, considering the global drivers and new challenges such as food security and land use conflicts, the role of peri-urban areas in terms of maintaining and strengthening green infrastructures, feeding the city and preserving agricultural land, as well as strengthening urban-rural linkages and management of city-countryside relationship.

Piorr A. et al. (Eds.) (2011). *Peri-urbanisation in Europe. Towards a European Policy to sustain Urban-Rural Futures, Synthesis Report*. Copenhagen: University of Copenhagen /Academic Books Life Sciences.

## URBAN AND PERI-URBAN SHAPES FOR SUSTAINABLE GOVERNANCE

Alessandro Marucci · Chiara Di Dato

University of L'Aquila

In most countries worldwide, cities have developed following the path of 'sprawl'. This path is typical of urban settlements scattered over vast and very low-density areas. As a model of growth, the 'sprawl' phenomenon has become a standard and it has been studied as a territorial disease for years (Romano et al., 2017). Territorial diseases like 'sprawl' are difficult to manage over the Italian territory because decisions about urban development are very fragmented. In fact, urban and spatial planning are exclusive competence of almost 8000 different small municipalities. From strategical actions to projects on built areas, such as new infrastructures and welfare services, decisions are demanded to countless municipal councils. Along more than 300,000 km<sup>2</sup>, every administration governs very little plots of land, as little as polygons of few kilometres per side (Romano et al., 2019). Therefore, the study aims to focus on recurring settlements and to interpret them.

The result is a classification of different morphological settlements, from urban to peri-urban areas. Such a classification is relevant also for identifying natural areas, which are the counterpart of urban patterns. In fact, both urban settlements than natural areas are components of good multilevel urban planning. Urban and peri-urban areas are distinguished in different ways in literature. However, most of the definitions are subjective and ambiguous. In fact, they describe settlements from a qualitative perspective only. Then, the authors propose to analyse and classify some urban and peri-urban areas. The goal of this work is to formalize a methodology for the classification of peri-urban areas and provide a tool for new dynamic and sustainable forms of governance, using GIS-based technologies and artificial intelligence (AI). The integration of geography and machine learning can produce novel approaches in addressing a variety of problems occurring in natural and human environments (Dobesova, 2020). The proposed work is developed in the context of LIFE IMAGINE, an integrated LIFE project lasting 7 years (2020-2027). The project is created with the aim of supporting the development of an integrated, unified, coordinated, and participatory strategy for managing the Natura 2000 network in Umbria Region.

Dobesova Z. (2020). *Experiment in Finding Look-Alike European Cities Using Urban Atlas Data*. ISPRS Int. J. Geo-Inf., 9(6): 406.

Romano B. et al. (2019). *Molecular no Smart-planning in Italy 8000 Municipalities in Action throughout the Country*. Sustainability, 11: 6467.

Romano B. et al. (2017). *Land transformation of Italy due to half a century of urbanization*. Land Use Policy, 67: 387-400.

## GOVERNANCE AND ACTOR MIX SHAPES THE PATHWAY TO SUSTAINABLE AGRICULTURE IN A DUTCH PERI-URBAN REGION

Nynke Schulp<sup>1</sup> · Franziska Komossa<sup>1</sup> · Laura Scherer<sup>2</sup> · Emma van der Zanden<sup>3</sup> · Marta Debolini<sup>4</sup> · Annette Piorr<sup>5</sup>

<sup>1</sup>Vrije Universiteit Amsterdam · <sup>2</sup>Leiden University · <sup>3</sup>PBL Netherlands Environmental Assessment Agency · <sup>4</sup>INRAE, UMR 1114 EMMAH · <sup>5</sup>Leibniz Centre for Agricultural Landscape Research

**P**eri-urban areas in Northwest Europe tend to have an important component of intensive agricultural land. While the access to open space is an important public good for peri-urban residents, the intensive agricultural use also results in conflicts between agricultural use and the public good demands of residents. Sustainable future development of peri-urban areas that combine intensive agriculture with peri-urban demands requires an approach that helps reconciling this variety of agricultural and well-being goals.

A portfolio of sustainable intensification (SI) measures that aim at improving sustainability of farms, landscapes, as well as local value chains, might foster that reconciliation. However, it is unclear how the mix of governance actors and stakeholders in a peri-urban setting can trigger or restrain SI. In a case study in the Netherlands, we explored how SI of agriculture can contribute to a sustainable future of the region, and which actors are leverage points for implementing SI.

Our case study is located close to Utrecht, the fourth city of the Netherlands, and is characterised by a mix of dairy and fruit production. Building on interviews and workshops, we gathered insight in the potential futures for the region, reflecting both a business-as-usual as a preferred vision of a future pivoting around improving sustainability of agriculture. We did a stakeholder network analysis of the region to identify key actors. This was combined with empirical analysis based on surveys, interviews, and secondary data in a Bayesian Belief Network. We used the Bayesian Belief Network to explore options for SI implementation in the future. We linked the actor network to implementation of three SI measures (farm-level efficiency measures, small landscape elements, and direct sales), and used sensitivity analysis to identify which groups of governance actors or stakeholders are leverage points for implementation.

Dependent on the SI measure, farmers are the key actor towards a more sustainable agricultural system in our case study, or are triggered by other actors. The stakeholders preferred a future with a strong local value chain, improved landscape quality, and continuation of current farm-level efficiency improvements. This future requires broad support of all actors involved, with local actors without a formal role being a leverage point. Overall, trade-offs among public goods are almost inevitable when taking up SI measures.

## ENHANCING URBAN RESILIENCE TO FLOOD RISK THROUGH NATURE-BASED SOLUTIONS IN PERI-URBAN ECOSYSTEMS: THE CASE OF MEXICO CITY

Gloria Soto-Montes-de-Oca<sup>1</sup> · Gustavo M. Cruz-Bello<sup>1</sup> · Rosalind Bark<sup>2</sup>

<sup>1</sup>Metropolitan Autonomous University · <sup>2</sup>University of East Anglia

Floods are one of the most frequent natural hazards, and they occur in almost every country, with climate change exacerbating their frequency and intensity. Improvements in urban planning, governance, and the use of nature-based solutions (NBS) can be cost-effective ways to make human settlements more resilient to flooding. Retaining and slowing the upstream runoff of a peri-urban area with vegetation and soil management can play an important role in risk management. Ecosystems in the peri-urban interface might still be rich in natural capital that provision regulation ecosystem services, such as flood and erosion control. The resilience of the ecosystems per se may also provide insurance and option values that safeguard provision of ecosystem services under uncertainty and into the future. Paavola and Primmer (2019) explain that the challenge of capturing insurance value in governance arrangements is that insurance value is a co-benefit of natural resources management with the characteristics of public or club goods. Typically, urban planning in developing countries does not integrate NBS for flood risk management.

In our research, we used information on those areas that supply and demand regulating ecosystem systems to reduce flood risk in Mexico City. Specifically, we use the Soil and Water Assessment Tool (SWAT) to estimate the runoff amount and sediment retention and model interventions aimed to restore ecosystems in peri-urban areas. In the demand areas we approximated the spatial pattern of benefits of the likely runoff reduction, considering: (1) insurance compensation data based on a public insurance scheme, (2) econometric functions that consider flood depths and marginalization index of the affected areas, and (3) the preventive expenditure of infrastructure to offset negative impacts of ecosystem services delivery. We found evidence of low compensation via the public insurance scheme provided by Mexico City government; observed that the benefits of improving ecosystems in peri-urban areas are greater than alternative investments in grey infrastructure to reduce runoff and floods; also, we found that the areas that provide a greater potential to reduce runoff were mostly located in natural protected areas and that runoff coefficients increased in areas with no protection. We concluded that in addition to policies that protect natural areas other governance instruments could be explored to incentivise the provision of flood regulation ecosystem services, such as enhanced insurance policies. Furthermore, as most peri-urban land in Mexico is communally owned and managed in ejidos; the Mexican common property model, that working with ejidos will be critical to developing incentives that protect the insurance value of peri-urban ecosystems.

Paavola J., Primmer E. (2019). *Governing the provision of insurance value from ecosystems*. *Ecol. Econ.*, 164, 106346.

## GOVERNANCE MIXES FOR SUSTAINABLE PERI-URBAN LANDSCAPES: AN ANALYSE OF INTERNATIONAL POLICY APPROACHES USING A SURVEY OF PRACTICES

Marcin Spyra<sup>1</sup> · Chiara Cortinovis<sup>2</sup> · Silvia Ronchi<sup>3</sup>

<sup>1</sup>Martin Luther University Halle-Wittenberg · <sup>2</sup>Humboldt University of Berlin · <sup>3</sup>Polytechnic University of Milan

To foster sustainable development, peri-urban landscapes (PULs) can be approached as interfaces that, beyond many conflicts, can also create opportunities for governance experimentation and thus for innovative governance mixes to emerge.

Our research discusses spatial planning-oriented governance mixes, which do not refer to a particular type of governance. Governance mixes in our understanding are broader than an unstructured combination of different policy instruments/approaches and indicate a thoughtful mix of different, top-down and bottom-up policy and planning approaches, which are introduced at different administrative levels, bringing different formal and informal outcomes, discussed and implemented by the wide range of governance actors. The overall aim of the governance mix is to increase sustainability of PUL. The aim of our research is to analyse what kind of policy instruments, policy support tools, approaches and methodologies have been implemented to address specific planning challenges in the extent of PULs. This gives us a possibility to describe governance mixes responding to such challenges.

To fulfil our aims, we designed an on-line survey through which experts (either researchers, planners, or policy-makers) could describe specific policy instruments applied in a PULs. The survey is composed of seven sections covering an overview of the policy instrument, the objectives, the achievements, the resources for implementation, the actors involved, the critical aspects emerged, and the support tools adopted in the process. Almost all questions are close-ended, and the responses were binary coded (0-no, 1-yes).

During the last year, we received and collected 50 answers from 26 countries, describing 46 different policy instruments, some of which applied in more than one case study. The range of sustainability challenges addressed is very wide, among the many mentioned there are the climate change, the water management, and the built environment. Legal and regulatory instruments are the most popular, and their implementation is frequently supported by public resources. However, a wide variety of practices emerge in terms of actors involved, and support tools adopted during the process.

The results suggest that a thoughtful mix of different policy instruments could be a good strategy to overcome the criticalities of each specific instrument and to address the sustainability challenges of PULs in an effective way.



## *Tools for co-governance of nature-based solutions for sustainable cities*

### **Symposium organisers**

*Martina van Lierop* (Technical University of Munich), *Rieke Hansen* (Hochschule Geisenheim University), *Stephan Pauleit* (Technical University of Munich)

### **Summary**

In relation to nature-based solution (NBS), a transformation towards more fair and inclusive collaborative governance processes is emphasized increasingly. Yet, implementation of these processes is hampered by a lack of resources, time, skills and knowledge on co-design, co-implementation, co-management as well as co-assessment and co-monitoring. This session welcomes contributions, which explore instruments, procedures and tools to support co-governance of NBS: top-down government-led and bottom-up community-driven; formal and informal; short-term and long-term. At the close of the session, a round table discussion allows to derive key messages and recommendations.

### **Description**

The concept of nature-based solutions (NBS) has gained increasing interest as a means to make major contributions towards more liveable, sustainable and climate-resilient cities. In relation to NBS in urban areas, the need for a transformation towards more fair and inclusive collaborative governance processes is emphasized. Consequently, there is an increased interest in transdisciplinary research into the design and implementation of participatory planning processes, co-production of NBS in living labs or other co-creative processes, the involvement of underrepresented and marginalised groups and promoting social justice. Yet, knowledge on co-governance processes is still scarce, scattered and one-sided, while in practice lack of resources, time, convictions, and skills further hamper making these processes constructive and long-lasting.

This session aims to explore tools and instruments to support the co-design, co-implementation and co-management of NBS on different policy levels from EU, national to regional and local. As collaborative approaches require a diverse set of governance modes (i.e., mosaic governance), top-down as well as bottom-up strategies are considered. Instruments and tools supporting the integration of top-down government-led approaches and bottom-up community driven initiatives for NBS will receive however particular attention. Collaboration, participation and communication tools as well as planning, market-based and regulatory instruments are considered. The session will enhance our understanding how formal and informal procedures as well as short-term interventions and long-term thinking can be skilfully combined to foster NBS. Our interest extends to include co-assessment and co-monitoring of NBS and the related governance processes, as collaborative approaches should be involved across the whole spectrum of a planning process.

The session invites talks that present and reflect on collaborative approaches, such as living labs, from different environmental, economic and social-cultural contexts as well as the diverse perspectives from practitioners as well as researchers involved in the design, planning, management and governing of urban areas. Moreover, we welcome insights on innovative new tools to promote procedural and recognition justice from global development studies to be more inclusive, give marginal groups a voice, and define measures to countervail power imbalances. Contributions investigating the criteria of good governance practice for a better integration of different actors and sectors in the public domain are also encouraged to participate.

Key messages and recommendations for tools for the co-governance of NBS will be synthesised at a co-learning setting with speakers and participants in the open round table discussion.

## GREEN SPACE GOVERNANCE BETWEEN PARTICIPATION IN TOP-DOWN PLANNING AND CO-CREATION – EXAMPLES FROM ELEVEN EUROPEAN CITIES

Rieke Hansen<sup>1</sup> · Marleen Buizer<sup>2</sup> · Arjen Buijs<sup>2</sup> · Stephan Pauleit<sup>3</sup>

<sup>1</sup>Hochschule Geisenheim University · <sup>2</sup>Wageningen University & Research · <sup>3</sup>Technical University of Munich

**G**reen (and blue) spaces are considered as nature-based solutions that help to tackle pressing societal challenges such as climate change, biodiversity loss, or social injustice. This is often linked to a shift from top-down planning to more co-governance (Bulkeley, 2020). However, institutions such as public administrations dealing with urban planning and green space planning face barriers in transforming their routines and practices towards urban sustainability and new governance approaches. This is due to path dependencies resulting from investments in public infrastructure such as a car-centric design of public spaces, formalized planning approaches as well as a lack of budget for maintenance of urban infrastructure, including green infrastructure (Carroli, 2018; Boulton et al., 2020)

Our study builds on the EU research project GREEN SURGE (2013-2017), which investigated green space planning and governance in cities across Europe and developed concepts, recommendations and guidelines for the use of green infrastructure as an innovative approach (Pauleit et al., 2019). These data provide the most comprehensive and in-depth information on green space planning and governance of European urban areas to date. By re-examining eleven of the twenty cities in 2020 and 2021, we shed light on the question whether and how green space planning and governance has changed, having the unique opportunity for a comparison with the previous state of affairs.

The interviews conducted as part of this research revealed increased political support for green space planning as well as higher demand for green and attractive surroundings from citizens. At the same time, challenges such as restricted financial resources and staff remained prevalent. In addition, new tasks and cross-sector cooperation increased the workload in some cases. In terms of green space governance, most respondents reported an increase and provided examples of new discussion formats with stakeholders, approaches such as citizen budgets, or co-management of green spaces with citizen groups. We will present selected examples from these eleven cities and discuss different approaches to green space governance on the spectrum from public participation to co- and self-governance approaches.

Boulton et al. (2020). *Under pressure: Factors shaping urban greenspace provision in a mid-sized city*. Cities, 106: 102816.

Bulkeley H. (2020). *Nature-based solutions towards sustainable communities: Analysis of EU-funded projects*. Luxembourg: Publications Office of the European Union.

Carroli L. (2018). *Planning roles in infrastructure system transitions: A review of research bridging socio-technical transitions and planning*. Environ. Innov. Soc, 29: 81-89.

Pauleit et al. (2019). *Advancing urban green infrastructure in Europe: Outcomes and reflections from the GREEN SURGE project*. Urban For. Urban Green., 40: 4-16.

## INTEGRATION OF NBS IN LOCAL GOVERNANCE AND URBANISATION TRAJECTORIES IN EU AND CELAC CITIES

Beatriz Kauark-Fontes<sup>1</sup> · Cesar Ortiz-Guerrero<sup>2</sup> · Fabio Salbitano<sup>1</sup> · Jaime Hernández-García<sup>2</sup> · Livia Marchetti<sup>1</sup> · Maria Alejandra Cruz-Suarez<sup>2</sup>

<sup>1</sup>University of Florence · <sup>2</sup>Pontifical Javierian University

The concept of nature-based solutions (NBS) has been rapidly progressing in both Europe and Latin America reflecting a transition in the way that urban development is perceived. However, the attention given to NBS in urban governance and in the planning process is often limited by the fragmentation of responsibilities in technical and administrative services, in policy and planning, and across levels of government. This can drastically harm NBS implementation and the benefits they can provide. Integration is a key issue in the establishment of NBS. This study analyses the state of integration of NBS in governance and planning in seven case studies of Europe and Latin America part of the H2020 project, CONEXUS. This research aims to understand the current state of top-down and bottom-up integration in urban governance and NBS planning process within and across scales and dimensions. It intend to recognize entry points, in practices and policies, that hinder or can catalyze more agile forms of cross-sectoral multi-level governance to champion NBS projects.

The study follows a qualitative methodology composed of a review of official documents and literature from the municipalities, to take stock of the existing governance structure in place; collection of primary data through participatory workshops and expert interviews to confirm the knowledge acquired and gather further insights from the field; and a prospective analysis with cross learnings and challenges between the two regions. Findings show differences in contexts and on the state of NBS implementation, but also similarities regarding the barriers and opportunities for integration in governance and planning. The state of NBS integration in urban governance is still novel in both regions. There are initial dialogues among the public sector, academia, and local actors from different scales but with limited levels. Planning in silos still persists affecting potential confluence of actions and policies. Limited awareness about NBS benefits and limited levels of environmental education were found to be major barriers towards NBS advocacy and engagement with citizens both in EU and CELAC. CELAC case studies further face obstacles to participation such as high levels of inequality and urban violence, while in EU, the issue 'not in my backyard' were highly present. However, the study also displays that the cities find themselves in a good position to enhance their state of integration. In both regions, there is a concentration of national and international plans and policies that reflects in local NBS initiatives creating an enabling atmosphere for the continuity and integration of NBS. Municipalities and citizens show an increasing interest in reconnecting with nature and therefore to be engaged in NBS co-design. To frame it, our results indicate that the current conditions are suitable to further prioritize the integration of NBS within cities' agenda and to promote changes towards their co-design.

## PARTICIPATORY APPROACH EMPLOYING QUALITATIVE AND QUANTITATIVE METHODS FOR EXPLORATION OF CULTURAL ECOSYSTEM SERVICES ATTRIBUTED TO URBAN GREEN INFRASTRUCTURE – CASE STUDY OF THE CITY OF ZAGREB, CROATIA

Martina Kičić · Ana Marija Marin · Dijana Vuletić · Silvija Krajter Ostoić

Croatian Forest Research Institute

Participatory approaches in natural resource management are gaining momentum lately. When carried out properly, they produce important information, which can be used to inform planning and management based on the inputs from their direct users. The city of Zagreb has plenty of green spaces. However, insufficient public participation in green space planning and management leads to decisions that do not include public perceptions and opinions including those of green space users. This leads to green space management that does not meet public needs and expectations.

Cultural ecosystem services (CES) of urban green infrastructure are important for citizens' well-being. Focus group participatory mapping on the topic of CES perception and use was employed for all districts of the city of Zagreb. In total, the focus groups consisted of 94 participants. Explored CES were place attachment, recreation, aesthetic experiences, education, and cultural identity. Alongside focus group interviews, participatory mapping with participants had been conducted. Locations of certain CES were recorded on a physical map and later digitalized. The qualitative analysis detected the most important attributes for each CES category and tree-based urban green infrastructure type. The quantitative analysis further confirmed the results of the qualitative analysis, where place attachment, recreation and aesthetic experiences were more often mentioned, while education and cultural identity were less mentioned.

Participatory approaches, such as focus group participatory mapping, are a highly useful methodological approach and tools for gathering a rich array of data on a specific phenomenon in public spaces. Even though it could be time-consuming, arguably, it is an efficient approach when there is lack of previous research and there is a need for deeper understanding, how people perceive and use urban green space. For governance and planning processes in green infrastructure that means that complete information is obtained from direct users producing new knowledge that is usually hard to capture using indicators or proxies, therefore, leading to better decision making. Besides, including public opinion in the planning and governance process increases the likelihood that future decisions are perceived positively and the process itself honest and inclusive.

## VISUALISATIONS AS A TOOL IN PARTICIPATORY PROCESSES – LESSONS LEARNED FROM PRACTITIONERS

Martina van Lierop · Daniel Hildebrandt

Technical University of Munich

Visualisations are important instruments in the toolbox of spatial planners to communicate the spatial complexity of nature-based solutions (NBS). Yet, with the recognition of NBS, also comes an increased need for inclusive collaborative planning processes. If planning processes become more participatory to ensure inclusion of a broad range of actors and communication with non-professionals is required, what does this mean for the way spatial planners communicate with visualisations? Despite its importance, participatory planning is still often treated as a niche activity and finds only limited application in teaching curricula due to time and resource constraints. Knowledge in research is scarce and focuses mainly on the application of new digital visualisation tools. Knowledge on communication through visualisations beyond mere informing is often acquired through learning-by-doing in practice. Our aim was to make the tacit knowledge on visualisations in participatory planning processes explicit.

During the summer of 2020, semi-structured interviews with nine experts in participatory planning from Germany were conducted either in person or due to Covid-19 restrictions per phone or online platform (e.g. Skype, Zoom). Each of the experts had at least five years of professional experience. The interviewees were sent the questions in advance together with our working definitions of 'participatory planning' and 'visualisations'. The interviews were recorded, transcribed and subjected to a content analysis with the support of MAXQDA.

From the interviews became evident that visualisations bring a variety of benefits to participatory planning and can be used effectively when used thoughtfully. Although different visualisation techniques have been considered, the most relevant distinction is between analogue and digital techniques. Digital techniques allow for complex data to be presented: scale and temporal changes, select specific information and alternatives. However, digital techniques are hindered by technical hurdles and need for expertise. Here analogue techniques perform better. Instead of mere interaction with the visualisation, their simplicity and low-key access threshold offer more potential for social interaction among participants. Such interactions can lead to constructive discussion between participants and in turn to higher quality decisions, while promoting trust and acceptance in the planning process. In early stages of planning processes, analogue visualisations have a degree of openness for changes, which allows for discussion, while the level of detail and complexity in digital techniques support objective decision-making in later stages. Although the interviewees do see the benefits of visualisations, when carefully selected for the specific process, they do stress that visualisations are no panacea for successful participation processes. A well-managed pro-active facilitation is at least as important.

## GUIDING NBS CO-GOVERNANCE – AN OVERVIEW OF PRINCIPLES AND INSTRUMENTS FROM NBS GUIDANCE

Martina van Lierop · Andrea Skiba · Valentina Arros · Christin Ganserer · Alice de Mendes Freitas · Stephan Pauleit

Technical University of Munich

**N**ature-based solutions (NBS) are recognized as a means to transform cities into climate-resilient, biodiverse and healthy living environments. NBS guidance material, such as handbooks, guides, manuals and toolboxes shall support the mainstreaming and implementation of NBS in practice. Concurrently, there is an increased call for collaborative governance and planning processes to support an inclusive and just urban transformation. Yet, knowledge is still scarce on how processes of NBS intersect with social and environmental justice. We wanted to understand how well the procedural dimension of NBS co-governance and its related challenges have been addressed in the available guidance and review the recommended strategies, principles and instruments.

Working within the framework of the EU-funded CONEXUS project, we conducted a content analysis on NBS supporting guidance from European and Latin American contexts. Guidance material in either print or digital form (e.g. online PDF, website) was collected through expert knowledge, snowballing and a Google search with keywords. As we focus on material targeted at non-academic users, scientific databases were not consulted. Material was included in the languages English, German, Portuguese, and Spanish, which focused on (peri-)urban contexts and NBS or related concepts. Moreover, the results should be prescriptive. 132 research projects, individual publications or websites (70 English, 3 German, 6 Portuguese, 57 Spanish) were first reviewed for their focus on either the substantive or procedural dimension of NBS. Material addressing the latter dimension (55 English, 2 German, 5 Portuguese, 32 Spanish) was further analysed concerning process phases, scale levels and level of participation, transdisciplinary collaboration and inclusiveness. In addition, these guides were scanned for strategies, principles and instruments supporting collaboration, participation, and inclusiveness.

The challenges for NBS most frequently addressed are ‘climate resilience’, ‘health and well-being’ and ‘participatory planning and governance’, while ‘air quality’ is the least addressed. ‘Social justice and social cohesion’ have proportionally been more often mentioned in Spanish guidance than in English guidance. Most of the guidance focuses on the city/municipal and local level, while NBS on a global or continental scale are rarely considered. Around two-third of the guidance deal with the process phases of ‘planning and design’ and ‘assessment and analysis’, while ‘management’ is still only taken into account in around a quarter of the guidance. Frequently mentioned principles for governance and planning processes were ‘bottom-up’, ‘long-term’, ‘reflective’, ‘iterative’ as well as ‘room for experiment’. In addition, we identified and described 12 categories of instruments from formal regulatory to informal instruments for public participation.

## DESIGNING COLLABORATIVE PLANNING FOR NATURE-BASED SOLUTIONS. OBSERVATIONS FROM ROMANIA'S LOCAL ENVIRONMENTAL ACTION PLANS

Cristina-Gabriela Mitincu · Constantina-Alina Hossu · Mihai-Răzvan Niță · Ioan-Cristian Iojă ·  
Andreea Niță

University of Bucharest

**N**ature-based solutions (NBS) can help cities increase their resilience and sustainability. They represent those actions inspired, supported or copied from nature, which have a high potential to simultaneously provide multiple environmental, social, and economic co-benefits. Environmental planning acts as an indispensable approach to promote the integration of NBS in urban areas. Achieving integrated governance approaches and considering the participation of different stakeholders in implementing NBS were identified as key opportunities for successful organization and scaling of NBS across cities. Therefore, our study aims to identify the main stakeholders that could be considered in promoting NBS, as well as to understand the strengths and weaknesses of collaborative planning processes.

A sample of seven Local Environmental Action Plans (LEAPs) from Romania was selected to identify the stakeholders responsible for the planning and implementation of LEAPs policies that include NBS. Stakeholders were classified based on their type (i.e., institutional and participatory) and character (i.e., innovator, change agent, transformer, mainstreamer, laggard, reactionary, and controller). A network analysis approach was employed to identify the most involved and influential stakeholders and the relationship between them, besides to better understand the extent of the collaboration between different individuals or groups.

Our main findings show that the institutional stakeholders such as municipal administrations are the most involved in the environmental planning process, while the general public obtained low centrality scores. Moreover, our study highlights the deficiencies and opportunities of the planning process in order to promote NBS, considering, on the one hand, the relatively low influence of innovators, change agents, and transformers, as well as, and on the other hand, the potential for building collaborative relationships. Thus, for the successful implementation of NBS, it is necessary to establish a dialogue at all levels of public and private organizations. In conclusion, our study emphasizes the necessity for better coordination between the responsible stakeholders in order to support effective NBS diffusion.

## THE ROLE OF PARTICIPATORY COMMUNICATION FOR SUSTAINABLE CITIES – THE CASE STUDY OF TURIN (CONEXUS, PILOT PROJECTS WITH SCHOOLS)

Mariangela Pastorello

Urban Lab Torino / Malmö University

Nature-based solutions (NBS) are currently considered among the most effective tools available to city governments and urban planners to tackle climate-change issues in cities, as they enhance environmental resilience while providing social and economic benefits. Nonetheless, communicating the value of NBS to citizens is still a challenge. Toolkits, definitions and researches in the field multiply, trying to guide city officials, technical experts and urban practitioners through this complexity.

The implementation of NBS is also seen as an opportunity to actively engage with the local population. Yet, the resulting participatory actions often have limited long-term impact. In fact, the technical aspects of NBS, together with budget, project and time constraints, makes it difficult to coordinate with capacity building and substantial citizen participation throughout the policy cycle – also due to skill gaps of city authorities and lack of expert facilitators. As a result, NBS might be selected through top-down decision processes and only accompanied by collateral participatory activities. In this sense, long-term positive effects can be insufficient.

Given the above, the presentation will explore the role of participatory communication as a potential for long-term success of NBS initiatives by presenting a case study from the City of Turin (Italy) in the framework of the Horizon 2020 EU Project CONEXUS. Specifically, it will focus on a first round of pilot projects developed by the Urban Lab of Turin (partner of Turin for CONEXUS) with four local schools involved in the local living lab. From spring until the end of 2021, the Urban Lab worked closely with teachers on custom project-based learning pilots. From January to June 2022, groups of students learnt about NBS and local resilience policies through different workshops, site visits and practical activities, with the involvement of local stakeholders (leveraging on specific expertise). The final result is a co-designed public campaign (podcasts, videos, articles, guided tours, educational modules produced by students).

After outlining the context and analysing the outcomes of the schools projects, insights from a series of qualitative interviews (with city officials, school personnel, local stakeholders) will be presented, highlighting elements to be further developed, as well as potential pitfalls. It will also be explored whether a deeper, shared understanding among citizens and the local government is flourishing, which could possibly lead to future participatory actions.

Students (young citizens) can be innovative ambassadors of nature-based thinking, reaching undetected local players and favouring networking – inviting us to investigate further on the importance of building together contextual knowledge as a first step towards participatory governance for more sustainable and inclusive cities.



## FROM FORMAL TO INFORMAL: LEARNING FROM DIFFICULTIES AND OBSTACLES IN CO-GOVERNING AND CO-IMPLEMENTING NBS IN A LATIN AMERICAN PERI-URBAN NEIGHBOURHOOD

Nicolas Salmon · Grace Yopez

YES Innovation

In the framework of the CLEVER Cities project, a mixed approach of co-governance and co-creation was experimented in Quito, Ecuador, using the peri-urban neighbourhood of San Enrique de Velasco (SEV) as a study site. SEV is a typical Andean city neighbourhood, conformed on the slopes of the Pichincha volcano and between two urban ravines that are home to still largely preserved vegetation. However, the rapid and unplanned development of the neighbourhood has eliminated access to these spaces and largely eliminated the vegetation in the urban area – public spaces and streets – which excludes the residents from direct contact with nature and exposes them to multiple resilience and quality of life issues.

From an initial co-creation and co-design process formally established within the framework of the project and adapted to the local case with the Municipality of Quito, also a partner in the project, the experimentation quickly showed the essential role of informality in achieving the objectives. The co-governance process faced a multitude of barriers that we propose to explore here as lessons learned from the field. These barriers stem from the inherent informality of this type of neighbourhood, which is characterised by an irregular relationship with the authorities but also by difficulties of representation within the community itself. There are also difficulties with the relationship with and traditional perception of nature by the community, as well as with the expectations of integrating nature into their urban environment. In the neighbourhood, the capacity for consensus within the community was often limited, mirroring the obvious coordination difficulties between the different municipal entities involved. Finally, the detection of old and unknown municipal bylaws, which serve as references for the interventions of certain municipal entities in the urban space, upset the initial theoretical process.

Faced with these difficulties, the use of the traditional Ecuadorian participatory process of ‘minga’ allowed a strong dose of improvisation and pragmatism to be injected into the methodology, imposing direct and on-the-field dialogues between the community, the design team and the local authority, allowing in the end the conformation of a tripartite private-community-public financing and the implementation of an NBS (low-cost rain gardens in an unpaved street) which is original in the context of Quito.

## EXPLORING 'MIDDLE-UP' CO-GOVERNANCE TOOLS IN DRIVING THE TRANSFORMATION OF URBAN OPEN SPACES TOWARDS THE ADOPTION OF NATURE-BASED SOLUTIONS IN MALTA

Sarah Scheiber

University of Malta

**A**ppropriately planned and designed urban open spaces have the potential to contribute to sustainable urban areas. Planning for green infrastructure is recognised as a nature-based solution for achieving this. Despite this, urban open spaces in Malta are not acting as green infrastructure. In the local context, the potential barriers and implications that hinder moving towards the implementation of green infrastructure planning approaches can be organised into three main themes: socio-cultural tendencies, lack of resources, and inadequacies relating to planning and governance systems. Spatial planning and in-place planning instruments play an important role but are simply not enough. Ultimately, more inclusiveness into decision-making structures must be successfully demanded and achieved.

International best practice illustrates the potential role of grass roots initiatives. However, in a context where social demand is lacking and apathy towards common good, or activism in the voicing of opinions is evident, can such grass roots movements be the answer? In a socio-political context which lacks real commitment also stemming from socio-cultural tendencies which do not prioritise or appreciate the value of green open spaces, what are the answers? On the other hand, due the lack of real political commitment and the resultant lack of ownership which ensues, a top-down approach is not the answer in modern day planning. The answer, thus, lies in exploring the potential for 'middle-up' co-governance approaches as a way to operationalize integration and multifunctionality. These include active citizen approaches that are local but with the support of local governments/municipalities such that their efforts contribute to more strategic aim. However, if such support is lacking how can it be instigated?

A more collaborative approach of a 'middle-up' nature is advocated as a mechanism for driving change. In Malta, the platform, Dawra Madwarna: Connecting People, Connecting Places, can be seen as one such middle-up approach. Founded in March 2021, this organisation is an ever-growing network of interdisciplinary professionals working voluntarily to act as a catalyst for adopting more nature-based solutions such as a green infrastructure planning approach in driving the transformation of urban open spaces. Seeking ways to engage with the public and stakeholders at large, through research, proactive thought, co-leadership and collaboration with society, the platform aims to promote a new model for the planning and design of urban open spaces. The author is co-founder of this initiative and this talk will therefore present reflections based on the activities developed by the platform to date which may be seen as an example of such middle-up approaches.

## UNPACKING SELF-GOVERNANCE INITIATIVES OF URBAN NATURE-BASED SOLUTIONS IN CHILE: THE CASE OF SANTIAGO

Alexis Vásquez · Anya Breen · Muriel Flores · Elizabeth Galdámez · Emanuel Giannotti · Paola Velásquez · Victor Alegria

Universidad de Chile

A shift ‘from government to governance’ in the management of urban nature-based solutions (NBS) has been reported across Europe with an increase of citizens engagement in green spaces governance. However, NBS governance, especially self-governance initiatives, has been researched far less in Latin America, despite being one of the most urbanized regions on the planet and a biodiversity hotspot.

Green space planning and implementation in Chile are normally conducted by the Ministry of Housing and Urban Planning and municipalities through a very exclusionary and top-down process. This process has produced strong inequitable patterns in the distribution and quality of green and blue spaces, as well as a lack of context-sensitive design and management that lead to a poor community engagement and sense of place. As a response, in the last decade, citizens, NGOs and other civil society groups have become increasingly involved in the restoration, conservation and development of green spaces.

This study explores the spatial-temporal trends, aims, and socioeconomics of NBS self-governance initiatives in Chile using Santiago as a case study. The main enabling factors and challenges that this type of initiative face were also evaluated using in-depth interviews with selected self-governance initiatives. We identified more than 90 self-governance initiatives through an online survey and an active search on social media platforms. Most of them are related to urban gardening and around 20% work to improve the conditions of parks and squares that are not well maintained by the local government. Moreover, they tend to have an ephemeral nature (around 30% exists for less than five years).

These initiatives are relevant for participants as spaces for social cohesion, education, recreation and the supply of food in the case of urban gardens. Benefits related to air and water purification, biodiversity and aesthetics seem to be less important for the people involved. Unlike in other Global North cities, these initiatives tend to emerge spontaneously without institutional support of local governments or specific programs. Among the key challenges for the implementation and maintenance of NBS self-governance initiatives are participation, legal recognition and funding.

Although, there are a few self-governance initiatives contributing to relevant changes at the city level, they are most relevant as a way of contesting the prevailing forms of planning, implementation and design of NBS in Santiago. They shed light on how to make these processes more inclusive as well as on how to develop NBS better rooted in the social and ecological fabric of the neighbourhoods. The result of this study contributes to a better understanding and awareness of the growing number of NBS self-governance initiatives in Chilean cities, especially in Santiago, and to promote and include them in the co-production and transformative changes required to ensure a more just and sustainable city.

## SUCCESS FACTORS AND BARRIERS IN GREEN CITY CO-DESIGN. A CASE STUDY OF THE CITY OF ŁÓDŹ (CENTRAL POLAND)

Renata Włodarczyk-Marciniak · Agnieszka Bednarek · Kinga Krauze

European Regional Centre for Ecohydrology, Polish Academy of Sciences

Łódź is a typical European post-industrial and post-socialist city that struggles with environmental (heat waves, flash floods, smog), social (aging, depopulation, gentrification) and spatial (neglected and dense city center) challenges. These problems coexist with low availability, accessibility and attractiveness of urban greenery. Due to the limited space available to establish new, large, formal urban green spaces, efforts to improve the residents' quality of life needs to make the best use of small, local interventions, including nature-based solutions (NBS). Identifying the factors that determine the success and failure of implementation of the blue-green city concept, as well as those enabling shared responsibility for maintenance of existing and introduced greenery becomes crucial. In 2010 the City of Łódź adopted the concept of Blue-Green Network as a core of the life-sustaining system. Since then, a number of activities have been launched. These include top-down (initiated by the Municipality), bottom-up (initiated by either civil society or NGOs activists) and intermediate – facilitation and networking (led by scientists) activities, in order to: (1) gather information about stakeholders' needs regarding the functionality the city, (2) accessibility of blue and green infrastructure and its services, (3) role played by formal and informal green spaces, and (4) the most appreciated NBS types. Such tools were tested by the means of surveys, co-design workshops and interviews. Going through the subsequent failures and successes of our own and our collaborators and counterparts – residents, local activists, and city officials, we learned new lessons related to people's motivations, drivers of stakeholders engagement, and effectiveness/deficiencies of participatory tools. The presentation will share the experiences gained from this one-decade long process of urban green space design towards a sustainable city.

## *Multiple perspectives on green infrastructure and Nature-Based Solutions*

### **Symposium organisers**

*Werner Rolf* (Technical University of Munich), *Isabel Loupa-Ramos* (University of Lisbon)

### **Description**

Since the EU GI Strategy as adopted in 2013, GI planning has gained attention on the policy agenda. Further momentum is given by the European Green Deal. In this context also the role of nature-based solution has been gain emphasis on how to best contribute to transition towards sustainability.

This symposium aims to bring together multiple perspectives on green infrastructure (GI) planning and NBS applications in cities and beyond, regarding methodological approaches to mapping, assessment or valuation of services and benefits, as well as the novel toolboxes to support more integrated implementation across cultural and ecological contexts.

## ENHANCING GREEN INFRASTRUCTURE NETWORKS THROUGH NATURE-BASED SOLUTIONS: AN ASSESSMENT OF CHALLENGES AND OPPORTUNITIES IN A HIGH-DENSITY URBAN AREA

Mario Balzan

Malta College of Arts, Science and Technology

**N**ature-based solutions (NBS) in cities can be prioritised to expand existing green infrastructure while contributing to multiple sustainable development goals simultaneously. NBS have been used to address key societal challenges, including climate resilience, natural hazards, urbanisation and environmental pollution, inequalities in availability and access to green space, biodiversity and ecosystem service declines and public health concerns. However, various challenges remain, and recent reviews have identified the vague interpretation of NBS, the limited availability of examples of NBS implementation that includes stakeholder involvement, and the lack of quantitative and measurable targets or mandatory standards at the scale of implementation.

This presentation provides an overview of recent work carried out in Malta as part of the Horizon 2020 ReNature project on the planning and use of nature-based solutions to increase the quality and quantity of green infrastructure while addressing key challenges. Based on interviews and detailed conversations with stakeholders, we categorise barriers and opportunities for NBS implementation as falling into two main categories and are either political or knowledge based. Based on this analysis, we present a strategy that may be used at local scales to develop interdisciplinary collaborations, address existing knowledge gaps that hamper the effective implementation of NBS principles, and guide NBS co-creation and knowledge integration for improved NBS design and impact assessment. This strategy is tested within ReNature for the small Mediterranean island state of Malta, which is characterised by rapid urbanisation and strong climate-related impacts. Actions are carried out to address multifaceted societal challenges, develop the evidence base through knowledge integration and participatory methods applied at the scale of implementation, and inform NBS implementation through multidisciplinary impact assessment tools. This strategy can be applied to promote long-term collaboration across the science, policy, business and societal interfaces, whilst using implementation-oriented tools and methodologies to address existing knowledge gaps limiting NBS uptake and effectiveness.

## SOCIAL ASPECTS OF PRO-ENVIRONMENTAL TECHNOLOGIES IN POLISH SUBURBS

Jadwiga Biegańska · Elżbieta Grzelak-Kostulska · Jarosław Domalewski · Donata Wysocka ·  
Weronika Lis

Nicolaus Copernicus University

The research on suburban zones that has been carried out for many years allows us to draw interesting findings about their character and the changes taking place within them. This warrants a supposition that, as in the case of urban space, suburban zones are predestined to become smart spaces. A smart city, as proposed by Komninos (2019), is understood broadly, also as an urban region whose second component besides a big city is a suburban zone. However, while new technologies are inherently present in cities as centres of innovation, their spread may be much slower and much more diverse in suburbs which have been developing in Poland only since the system transition. The data forming the basis for the conclusions and insights was produced by a nationwide survey conducted in early 2021.

In this study we tackle the social aspects of new technologies, in particular those related to the environmental context. Firstly, we ask what pro-environmental technologies have been developed in the suburban communes in the context of the model of governance. Secondly, we analyze the development of pro-environmental technologies in Polish households. We have shown that more innovative model of governance is more often associated with the presence of pro-environmental technologies. In the more traditional model of governance the presence of the technologies is more rare. It can be quite problematic because according to the old and new inhabitants of Polish suburbs pro-environmental technologies are highly evaluated. They determine the commune's image, its long-term development, quality of life. In the long-term perspective they will also shape the landscape of suburbs.

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## POLLINATORS OF THE ORIENTAL PARK OF THE CITY OF PORTO. DESIGNING ECOLOGICAL MAINTENANCE TOWARD BIODIVERSITY

Cláudia Oliveira Fernandes · Catarina Patoilo Teixeira · Maria João Martins · Sónia Ferreira

University of Porto

**G**reen infrastructure and its constituent elements, urban green spaces (UGS), are established as fundamental for the ecological balance of cities and for the physical and mental health of their populations. Ecosystem services provided by urban green spaces have been extensively investigated and demonstrated, but some disservices have also been documented. Among the most frequent disservices are maintenance costs, irrigation, use of fossil fuels, and contamination by agrochemicals, including pesticides. Most of these disservices are related to the excess of lawns in UGS, especially in areas not tailored for active recreation.

UGS are man-made ecosystems frequently thriving in a delicate ecological balance, thus much prone to pests and diseases. These issues have gained relevance with some insect related plant pathologies reaching worrying proportions with significant ecological, economic, and landscape impacts. If, on the one hand, we are witnessing an increase in populations of harmful insects, we are also witnessing a decline of beneficial insects, namely pollinators and biocontrol agents. The decline of these populations has been seen as one of the most serious ecological crises of our times.

How to face the mentioned challenges and contribute to a more multifunctional, resilient, healthy, and aesthetically more pleasant green infrastructure?

In the context of promoting the Oriental park of the city of Porto as a potentiating element of the ecological and social dynamics of the eastern part of the city of Porto, the project Oriental Park of the City of Porto: Laboratory for Biodiversity and Landscape was created. This project aims to enable this park to promote and disseminate the natural and scenic values of the Porto Metropolitan Area, becoming a privileged stage for the enjoyment and appropriation of natural values and the development of environmental education activities both by the school population of the surrounding area, as well as by visitors to the park.

In the implementation phase, taking place in 2021-2022, we worked in an interconnected way with components linked to three areas of knowledge: landscape architecture, botany and entomology. The approach will therefore be conducted by a multidisciplinary team, involving national researchers, international consultants, and local partners. The work focus on the implementation of practices for the differentiated maintenance of herbaceous coverings, promoting biodiversity, and with a special focus on creating conditions for the attraction and sustainability of communities of pollinating insects. The diversity of these insect communities are being inventoried and monitored using the EU Pollinator Monitoring Scheme.

The project includes pivotal collaboration with local organizations, among which the Porto City Council stands out, which formally supports the project and actively participates by adjusting management practices, in close collaboration and guidance from the research team.



## WARSAW VERNACULAR FRONT GARDENS AS A MISSING SUBURBAN PUBLIC SPACE

Beata Gawryszewska · Izabela Myszka · Michał Banaszek · Axel Schwerk

Warsaw University of Life Sciences

**G**reen areas are important not only due to the climate crisis but also due to sanitary comfort. In the growing role of greenery in maintaining the quality of the living environment in the city, with the persistent tendency of the urban sprawl (Low, 2008; Pařil et al., 2021), the role of single-family housing and private gardens attached to them seem to be underestimated. Private plots with gardens constitute 11.5% of the area of the Warsaw agglomeration (BDOT10k). It is over five times more than Warsaw's public parks and squares (Sikorski et al., 2021). For comparison, the garden area in Stockholm is 16%, and in UK cities 22-27% (Colding et al., 2006; Dewaelheyne et al., 2018).

The work aimed to show that vernacular front gardens (VFG) can act as a missing public space and at the same time have the attributes of public green space, providing ecosystem services (ES). Methods of our research – an inventory of the attributes of VFGs and a survey with garden designers let us confirm these assumptions. The basis for building periurban streetscape in single-family housing estates is the visual inclusiveness of VFGs. They provide all ES groups, serving a representational function and both natural and recreational and even the production of edible plants. Streets in residential sites, because of VFG, can be treated as real green public spaces creating a type of green area accessible not only to owners but also to pedestrian eyes.

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## THE ACCESSIBILITY OF PUBLIC URBAN GREEN AREAS IN SELECTED TOWNS OF THE GDAŃSK-GDYNIA-SOPOT METROPOLITAN AREA

Barbara Korwel-Lejkowska

University of Gdańsk

**G**reen infrastructure (GI), as a network of high quality natural and semi-natural areas, is an essential element for the proper functioning of the city and largely affects the quality of life of its inhabitants. Well-planned, cared for and evenly distributed in the city's tissue, green infrastructure elements constitute its natural system. Simultaneously – as clearly demonstrated by the situation caused by the COVID19 pandemic – there is a strong social need to stay in public spaces developed with greenery. The process of cities development do not always entail the creation of new green areas, hence the access of residents to such places is varied, and the green areas themselves are often isolated from each other. The Gdańsk-Gdynia-Sopot Metropolitan Area (GGSMA) in northern Poland covers cities created in heterogeneous environmental conditions, which determined their original layout, and thus also the location of green areas.

The objective of this study is to assess the accessibility of selected public urban green areas in chosen GGSMA cities, resulting from their current location in the city, with the simultaneous identification of areas without such access, and identification of their types. The following methods will be used: spatial modeling with the use of GIS software (MapInfo/QGIS), statistical methods and field studies (local vision), mainly to verify and update digital data. Basic digital data has been obtained from the Database of Topographic Objects in the scale of 1:10,000 (BDOT10k), made available by the Central Office of Geodesy and Cartography (2021 data). The assessment will be performed for public green spaces, covering an area over 0.55 ha. The results will be related to the character of the of the building development located in the zone of the greatest accessibility.

This research has started in 2022, spring, and it is planned to the end of 2023. This is a pilot project, and the next goals are: (1) recognizing residents' needs for accessibility to green spaces and their characteristics, (2) identifying plans and opportunities for creating new green infrastructure elements (especially parks) in light of strategic documents and the planning situation in cities, and (3) identifying existing or potential connectivity with other GI elements of cities. The issues raised are in line with the current trend of research on green infrastructure in small and medium-sized cities in Europe.

## KEYLINE PLANNING AND ITS POTENTIAL ADOPTION IN WATER SENSITIVE URBAN DESIGN AND PLANNING

Kaan Ozgun

Özyeğin University

The spatiality and continuum of surface water show an ephemeral attribute because of the nature of cloudburst events. Overland flooding aka flash floods in an urban catchment is caused by several factors which have not been well-explored and remain hidden from landscape planning and urban design perspective in Australia. While efforts to integrate water management into urban environments – aka Water Sensitive Urban Design (WSUD) – began in the early 1990s, holistic urban catchment planning is still in its infant stages. It is only recently that notions such as urban liveability, daylighting underground infrastructure, and multi-functional public spaces have been included on the WSUD agenda, and most projects, as well as the whole inventory of WSUD interventions, are scattered at the lot, precinct, neighborhood scale, but remain somewhat disconnected at the catchment scale. This raises a crucial question about whether an urban physical network system can connect such interventions at these scales, creating more liveable spaces. Meanwhile, urban development, by definition urban spatial transformation has been so far progressed regardless of the continuum and spatiality of surface water.

Thus, the paper investigates the potential adoption of keyline planning – an Australian rural land and water management technique – into WSUD using digital mapping tools such as GIS and environmental design practices. Developed by Percival Alfred Yeomans in the late 1940s, the ‘keyline planning’ addresses the drought conditions in rural landscapes. The essence of the technique is basically about exploiting the gravitational energy of rural catchments and moving water from higher to lower elevations strategically. The technique slows down the velocity of stormwater, minimizes soil erosion, distributes surface stormwater evenly, and creates opportunities for harvesting and storage with conveyance and key dams throughout the landscape.

Norman Creek urban catchment in Brisbane at Subtropical Southeast Queensland is selected as a case study that has a cyclic flood and drought climate pattern observed over a hundred years. By using various urban, environmental, and socio-economic spatial data such as a high-resolution Digital Elevation Model (DEM) and a hydrological overland flow path analysis, green spaces, existing and past water bodies, road networks, land-use, development zones, groundwater table, aquifer types, the proposed method locates the most suitable areas to apply keyline principles. The keyline outcomes are then refined and turned into a plan presenting two design typologies, interconnected urban wetlands, and reclaimed creeks.

The paper demonstrates a new method through adopting an agricultural water management practice into WSUD. A possible future path is to translate knowledge from keyline planning practice sets of rules, key features in topography, and each step in the process of labor-intensive analysis into scripts and computer algorithms.

## FOSTERING THE RESILIENCY OF URBAN LANDSCAPE THROUGH THE SUSTAINABLE SPATIAL PLANNING OF GREEN SPACES

Donatella Valente · Irene Petrosillo

University of Salento

Urbanization is a complex process of land use transformation which has led to the identification of the local (urban) level as the right scale to achieve the 11th UN Sustainable Development Goal (SDG) “Sustainable cities and communities”, where urban green areas provide crucial urban landscape services improving the quality of life and the well-being. This contribution depends not only on their presence and amount, but also on their type, naturalness degree, size, shape, and their spatial pattern. In this context, the aims of this research are: (1) a systematic review to identify the main research items related to green areas, (2) the estimation of Urban Green Index at the urban and sub-urban scale, (3) the analysis of the spatial composition and configuration of urban green spaces, and (4) the estimation of Urban Landscape Services Index.

The ISI Web and Scopus have been used for the systematic review, then analyzed through a network analysis among the keywords acquired from the articles. The spatial analysis of green areas has been analyzed in the Municipality of Lecce where the Urban Green Index (UGI), the Green Connectivity Index (GCI) and the Landscape Service Index (LSI) has been estimated using landscape metrics and mapped in QGIS.

The green areas have characterized mainly the areas outside Lecce old town, which are more interested by recent urban sprawl. Some sub-urban areas have shown a percentage of UGI, representing the amount of urban green areas, and GCI, representing their spatial configuration, that overpassed the values for the whole study area. These results have contributed to the estimation of LSI, by identifying the sub-urban areas that more provide them.

The positive role of greenery in the enhancement of human well-being in urban contexts is already widely recognized, however this research makes it evident that the ability of urban green areas to provide landscape services is correlated strongly to their structural and functional connectivity. The spatial configuration of green areas plays an important role, as it helps to understand if a single large green area is better than several small interconnected green areas. The so-called SLOSS debate, well-known in nature conservation theory, may be relevant also in the case of green area planning.

Sustainable planning and management of green spaces can play a crucial role in improving the well-being of citizens. Urban green spaces can provide landscape services that contribute to the quality of urban environment and then, to the quality of life, making the cities more resilient.

## WHAT IS THE EFFECT OF CULTURAL GREENWAY PROJECT IN HIGH-DENSITY URBAN MUNICIPALITIES? ASSESSING THE PUBLIC LIVING DESIRE NEAR THE CULTURAL GREENWAY IN CENTRAL BEIJING

Haiyun Xu

Beijing University of Civil Engineering & Architecture

Cultural greenway projects (hereon, CGPs) are widely regarded as an urban planning approach that connects open green spaces and sites of socio-cultural value to provide access to living, working, and recreational spaces and enhance local social well-being (Xu et al., 2019). This paper examines the impact of such CGPs on public living desire before and after a given project is completed through analyzing housing prices in the surrounding area. We deployed a hedonic pricing model (HPM) and differences in differences (DID) model to analyze and record any changes in housing market trends that may have been caused by such a cultural greenway project. Via analysis of single-family home sale transactions in central Beijing from 2013 to 2017, we found substantial evidence that proximity to a cultural greenway project is positively linked with rising property prices. Once complete, CGPs were similarly associated with positive increases per HPM and DID modeling.

Our results revealed that, once a CGP was open to the public, it increased the price of properties within one kilometer by 13.3%. Seller and buyer expectations per the development of local, green public infrastructure also began to factor into housing prices prior to the greenway opening to the public. Post completion, the positive trend in property pricing due to local CGPs indicates that the public still has an increasing desire to live near the greenway project. These results will help policymakers better understand how cultural greenways affect neighborhoods in high-density urban contexts and will support the development of urban greenway policies for cities in China that reap the maximum economic benefit (Xu et al., 2022).

Xu H. et al. (2019). *A Systematic Comparison of Cultural and Ecological Landscape Corridors in Europe*. Land, 8(3): 41

Xu H. et al. (2022). *What Is the Effect of Cultural Greenway Projects in High-Density Urban Municipalities? Assessing the Public Living Desire near the Cultural Greenway in Central Beijing*. Int. J. Environ. Res. Public Health, 19(4): 2147.

## TARGETING PLANNERS. A TOOLBOX FOR THE ASSESSMENT OF ECOSYSTEM SERVICES WITHIN THE PLANNING OF GREEN INFRASTRUCTURE

Harald Zepp<sup>1</sup> · Matthias Falke<sup>1</sup> · Lars Gruenhagen<sup>1</sup> · Malte Bührs<sup>1</sup> · Zakhar Toma Anufriyev<sup>1</sup> · Luis Inostroza<sup>1,2</sup>

<sup>1</sup>Ruhr University Bochum · <sup>2</sup>Autonomous University of Chile

While aspects of urban ecology (e.g., description of ecosystem elements, landscape structure, ecosystem functioning, and landscape functions) are addressed in European regulatory urban planning, such conceptual frameworks neither cover the full range of ecosystem services (ES) nor are they able to evaluate the possible change of ES provision under alternative planning variants. Stakeholders would clearly benefit from a transparent and empirically based ES assessment instead of subjective and contested estimations of impacts and benefits perceived by various actors. Prior to urban development planning, actors from civil society, planning and politics should be adequately informed about the full spectrum of ES that are present in the area. The planning of quarters and neighbourhoods can greatly benefit from sophisticated and differentiated ES evaluation methods targeting biophysical variables.

This contribution presents the state of development of a toolbox that makes selected ES assessment methods available for urban planners. The second objective is to demonstrate the benefit of applying ES assessments in decision-making in a real planning context.

In our current  $\alpha$ -version, we have implemented five regulating services into the toolbox: PM10-mediation, carbon sequestration, temperature regulation, water flow regulation, and visual screening. We provide the IMECOGIP-toolbox in an open-source and cross-platform GIS-application (QGIS). First, the user provides the necessary data, which the assessment methods ask for. These consist of spatially explicit data as well as model parameters. Whereas only a few soil parameters are necessary, the options to choose among biotope types or land use/land cover classes are manifold. Then, the user has to match the land use/land cover classes that exist in his area to the default classes, in order that the toolbox assigns appropriate parameters to the spatial units, such as leaf area indices, and crop coefficients for evapotranspiration. He may alternatively put up his own specified parameter tables. The user can delineate the area of interest and select the ecosystem services to be assessed. Having run the models, the output consists of maps and summarizing statistics. For orientation, the distance from a hypothetical, optimal ES provision is additionally supplied.

We illustrate the toolbox using a case study, an urban development area in Bochum, for which three planning consortia prepared alternative urban design plans. Applying the toolbox, we compare both the existing ES provision and the anticipated ES provision. Additionally, we evaluate the effects of some planning variants on the expected ES performance. Our toolbox shows that an ES-informed planning gives benefits in comparison to standard concerns of nature and landscape conservation. Under a governance perspective, it facilitates communication among stakeholders.

*IMECOGIP (2022): <https://www.sustainable-urban-regions.org/project/imecogip> [24 March 2022]*

## 9. Regions in the spotlight

### *Landscape Approaches in the Mediterranean region – bridging landscape science and practice*

#### **Symposium organisers**

*José Muñoz-Rojas* (University of Évora), *Emilie Smith-Dumont* (University of Évora / Bangor University), *Teresa Pinto-Correia* (University of Évora)

#### **Summary**

Landscape approaches aim to reconcile agriculture, nature and competing land-uses. Its relevance has been recognized for tropical regions, but not as much in the Mediterranean, which is also a hotspot for biodiversity facing key climate change, ecological and socio-demographic challenges. This symposium will act as a forum for addressing the following questions: (1) what principles of a Landscape Approach are relevant to the key challenges in the Mediterranean? (2) what lessons can be drawn from experiences of Landscape Approaches in the region? and (3) what prospects for advancing strategically?

#### **Description**

Integrative Landscape Approaches have risen over the past few decades, aiming at the integration of the ecological, cultural and productive components of land management and planning. Their main objectives focus on the reconciliation of agricultural production, nature conservation and competing land-uses. Ultimately, they are expected to contribute to help meet global, regional and local sustainability goals. To achieve this, multiple Landscape Approaches are being tested aimed at setting landscape restoration targets, strategies for climate change adaptation and mitigation, and for biodiversity conservation. Furthermore, they are also being advocated as more effective procedures for the coordination and cooperation of different actors and institutions that are frequently bounded by competing interests over land-use decisions.

As a framework to help operationalize Landscape Approaches more consistently, ten principles have been identified. So far, these principles have been applied and tested over a number of case studies, a vast majority of which are located in Tropical areas and developing countries. This is largely due to the work of international development agencies that have joined efforts under the Global Landscapes Forum (<https://www.globallandscapesforum.org>). The main reason for such focus on tropical areas is the urgent need to tackle wicked processes of deforestation and related complex social-ecological effects. Despite the few critiques identified, Landscape Approaches are resulting in valuable lessons that suggest they ought to be of use across many different contexts. This could well be the case of the Mediterranean region, which is a hotspot for biodiversity, climate change and socio-demographics. Indeed, it is also a region where the key aims defined for Landscape Approaches tightly align with the challenges currently being faced.

In response, this symposium will invite contributions responding to the following questions:

1. What are the key aspects of a Landscape Approaches that may render them adequate for tackling key challenges in the Mediterranean?
2. What are the valuable experiences of applying Landscape Approaches in the region?
3. What are the potential pathways forward, and also the barriers, for advancing towards the implementation of Landscape Approaches in the Mediterranean region, bridging together research and practice?

## ANALYSING NATURE-BASED SOLUTIONS ADDRESSING SOCIAL-ECOLOGICAL AND CLIMATIC DRIVERS IN MEDITERRANEAN LANDSCAPES

Mario V. Balzan

Malta College of Arts, Science and Technology

Land and conversion to settlements was the dominant land-use change in the Mediterranean region between 2000 and 2015, and today 60% of the region's population lives in cities while the Mediterranean urban population is projected to increase by another 22.5 million by 2030. At the same time, annual mean temperatures have increased faster than the global average and several climate-related impacts on Mediterranean social-ecological systems have been identified. Nature-based solutions (NBS), are defined as “actions to protect, sustainably use, manage and restore natural or modified ecosystems, which address societal challenges, effectively and adaptively, providing human well-being and biodiversity benefits” (IUCN, 2020). The increasing scientific recognition of NBS accompanies a growing understanding by practitioners and public awareness of the co-benefits provided by NBS in Mediterranean landscapes but various bottlenecks, associated with existing knowledge needs of practitioners about the definition, scope, costs and benefits and the practical implementation of NBS, hamper uptake in planning and practice.

Following a call for submission of NBS case-studies and the establishment of the Horizon 2020 project ReNature NBS Compendium and Toolkit which hosts 95 case-studies from a Mediterranean climate, we present here an analysis of the submitted NBS case-studies to evaluate the current implementation of NBS. For each case study, data about the key characteristics of the NBS, including the location, city size, the timeframe of implementation, budget and interventions carried out were obtained. Additionally, different categories were applied to determine the addressed Sustainable Development Goals (SDG) and societal challenges, and the benefits associated with the NBS intervention and allow statistical analysis to answer the research questions.

Results indicate that NBS were used to address multiple societal challenges, including tackling drought and heat risk, low place aesthetic value, low green infrastructure availability, and biodiversity and knowledge loss, simultaneously but implementation gave rise to a wider range of benefits. These observations are discussed in the context of existing barriers and opportunities for a strategy that enhances NBS uptake within the region through integrated, iterative, and multidisciplinary approaches.



## REVERSING THE DECLINE OF MOUNTAIN LANDSCAPES: CAN THE LANDSCAPE APPROACH AND VALUE CHAIN APPROACH BE SUCCESSFULLY COMBINED?

Catarina Esgalhado · Élia Marques · Elvira Sales Baptista · Teresa Pinto Correia

University of Évora

**S**erra da Estrela is a mountain of the South: the highest and most important mountain range in Portugal. As many other mountain landscapes in Europe, it is a landscape of a particular character and diversity, support of multiple ecosystem services and public goods that society valorises – but threatened. In the face of the upcoming transitions (green, digital, trade, work organization), European mountains are specifically exposed and face limitation in adapting/switching to other productions. The impacts of climate change are particularly severe for mountain regions and their ecosystems. Also, demographic decay and marginalization can be a generalised challenge. Therefore, mountain regions have specific attention in EU policy, as expressed in Art. 174 EU treaty on territorial cohesion, in the CAP (ANCs), quality policy (quality term) and regional policy regulations. Research and innovation are needed to: (1) revisit and upgrade policy and governance approaches, (2) empower mountain actors to innovate for change and goal achievement.

The landscape in Serra da Estrela is changing dramatically due to a combination of factors, mainly abandonment of altitude pastures, leading to a decay of the scattered settlements, increase in shrub area and density, increase in fire risks, and a consequent degradation of the forest patches. In the H2020 MOVING project (2020-2024), the analysis of the landscape value chains has revealed the potential of the specific Serra da Estrela cheese, a PDO (Protected Designation of Origin) product, as an asset to the valorisation of the territory. However, activating the cheese value chain alone does not lead to the maintenance of the core landscape of Serra da Estrela. Especially not in altitude where sensitivity to change is highest, as the origin of the milk is accepted from a much larger area of lowland pastures around the mountain. More, forests in the mountain are managed not by farmers or private landowners, but by associations in charge of the forest areas which are commons – bringing possibilities but also limitations to the integrated management of the landscape. The challenge here is how to halt landscape encroachment and start an integrative and adaptive process to secure the preservation of at least a core landscape area.

We will present the landscape changing trends registered in Serra da Estrela, as well as the complex web of actors that are involved in managing natural resources, as thus also the landscape. These were revealed through an extended value chain approach. We will present the functioning of the value chain, and what we can learn about landscape management, from assessing the value chain beyond its economic value. We will discuss the possibilities untied by the Landscape Approach and the challenge to conceptualize and operationalize the combination of the landscape and the value chain approach.

## REIMAGINING THE MEDITERRANEAN COASTAL REGION: A COASTAL LANDSCAPE GOVERNANCE MANIFESTO

Carla Gonçalves · Paulo Pinho

Research Centre for Territory, Transports and Environment (CITTA)

In the literature, landscape approaches are discussed as the next generation of integrated approaches. Reed et al. (2020) claim that the two main premises that differentiate them are working at the landscape scale and the trade-offs identification, negotiation and accounting. Various international institutions (e.g. FAO, IUCN, WWF) have been encouraging landscape approaches implementation on the ground to conciliate preservation and development, especially in developing countries (Arts et al., 2017). Indeed, the debate has mainly been centred in the Global South on forest landscape restoration, revealing the need to expand the discussion to other geographical contexts (Ros-Tonen et al., 2018). This symposium is an opportunity to broaden this debate to the Mediterranean Region. However, addressing the close relationship between landscape approaches and the landscape governance debate is also fundamental. The systematic conceptualisation of landscape governance was introduced in the literature in 2007 (Görg, 2007). The synergies between the concepts were rapidly recognised, and, today, landscape approaches are the predominant approach to operationalise landscape governance.

This article takes this relation as a starting point to conceptually explore the synergies between both debates, expanding and linking the discussion with the coastal planning debate. Mediterranean coastal landscapes are highly susceptible and vulnerable to a range of driving forces and pressures with a complex governance structure. Climate change projections intensify it. It is time to reimagine Mediterranean coastal landscape governance and the institutions that govern them to effectively and efficiently address the societal challenges ahead. Indeed, the scientific literature on coastal landscape governance is almost non-existent. This article explores the concept of coastal landscape governance, and it presents a manifesto to stimulate a commitment for its research on a theoretical and empirical domain to safeguard and enhance the coastal socio-ecological system.

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Reed J. et al. (2020). *Integrated landscape approaches in the tropics: A brief stock-take*. *Land Use Policy*, 99: 104822.

Ros-Tonen M.A.F. et al. (2018). *From Synergy to Complexity: The Trend Toward Integrated Value Chain and Landscape Governance*. *Environ. Manag.*, 62: 1-14.

## LESSONS LEARNT FROM AN EXPERT-BASED VALIDATION OF LAND SYSTEM DYNAMICS (2005-2015) IN THE MEDITERRANEAN BASIN

Elisa Marraccini<sup>1</sup> · Mina Sadeghzadeh<sup>2</sup> · Marta Debolini<sup>3</sup>

<sup>1</sup>University of Udine · <sup>2</sup>University College Dublin · <sup>3</sup>INRAE, UMR 1114 EMMAH

Several studies have focused on the assessment of land system (LS) dynamics in the Mediterranean as a proxy of landscape dynamics and as main driver of changes in ecosystem services provided by these systems. Few studies have focused on the whole Mediterranean basin through data-driven analysis of LS dynamics. Within the DIVERCROP Arimnet2 project, an analysis of short-term LS changes has been conducted in the Mediterranean basin (Fusco et al., 2019). The analysis highlighted 20 LS classes in 2005 and 2015 along with three relevant trends: (1) intensification, due to the shift from mixed systems, e.g. agroforestry to intensive arable systems and the increasing new agricultural areas at the border of arid regions, (2) specialization, due to the shift from mixed agriculture to specialized fruit groves, and (3) periurbanization, affecting cereal crops-oriented plains (36%) and mixed arable/fruit groves (6%) or arboriculture-oriented (10%) hilly plateau areas. Feedbacks from the project partners in case study regions allowed to adjust the thresholds of the variables used and to identify areas where the classification or the dynamics were not reliable. In a further step, an expert-based validation was performed. In 2020, 21 scholars having published on Mediterranean landscape dynamics answered to an online survey that also included access to project data and maps. The survey was organised around five themes: variables for distinguishing LS, thresholds for classifying LS, LS classes, LS trajectories and underlying drivers. Results of the survey highlighted a general agreement in the variables for distinguish LS, in the identified LS and the main trajectories. On the contrary, we had a large heterogeneity of answers concerning both the thresholds for classifying LS and the underlying drivers. We found no significant differences between experts from both sides of the Mediterranean basin or according to the country of origin, suggesting that the knowledge in terms of local landscapes or drivers of change could influence the perception on the thresholds of each LS variable and on the drivers of changes. According to the experts' answers, the LS classification has been changed and this modification had an impact in particular on the assessment of the intensification processes on the most of the areas at the border with the arid zones, which was overestimated during the first assessment, as well as some specialization trajectories on the eastern and southern part of the Mediterranean. We will conclude with some lessons from this research in terms of multi-scale assessment, expert implication along with learning and adaptive management.

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## IMPLEMENTING INNOVATION FOR ENHANCED SUSTAINABILITY AND RESILIENCE IN MEDITERRANEAN AGRI-FOOD SYSTEMS VIA A LANDSCAPE APPROACH; THE WINES OF ALENTEJO SUSTAINABILITY PROGRAM (PSVA), PORTUGAL

José Rafael Muñoz-Rojas Morenés<sup>1</sup> · María Rivera-Méndez<sup>1</sup> · João Luís Barroso<sup>2</sup> · José Francisco Ferragolo da Veiga<sup>1</sup>

<sup>1</sup>University of Évora · <sup>2</sup>Alentejo Regional Winegrowing Commission

Landscape approaches (LAs) aim to foster sustainable land management that reconciles agriculture, nature conservation and competing land-use. Such approaches are useful to meet global and local sustainability goals. To achieve this, LAs have been implemented for landscape restoration, climate change adaptation and mitigation, and biodiversity conservation purposes. They have also been advocated as strategic tools for the coordination and cooperation of different actors and institutions bounded by competing interests over land-use. As a framework to operationalize Landscape Approaches, ten principles have been identified in literature. So far, these principles are being tested over an increasing number of case studies. However, few of these studies are found across the Mediterranean area. Starting in 2015, the Wines of Alentejo Sustainability Program (PSVA) has acted as an innovative overarching framework bridging together wine producers and other key actors across the region. This program has managed to enhance the sustainability standards and performances of the sector, while overcoming challenges related to short-term public funding.

In this paper we examine to what extent the PSVA can be considered as a LA. Looking at alignment between the PSVA and the 10 LA principles, and extracting the key lessons learnt over the initial five years of the PSVA, we discuss more broadly the conditions, benefits, limitations and opportunities to extend these principles more broadly across other regions of the Mediterranean where the wine sector may be considered as strategic. An in-depth analysis was conducted of the institutional, organizational, structural, financial and strategic conditions set by the PSVA. Finally, the results obtained throughout these exercises were paired with the 10 LA principles to disentangle any mutual overlaps.

Results point out to three key factors that distinguish the PSVA from other similar programs and projects (see table), and that explain its success in Agri-Food Sustainability. These three factors have been pared to the 10 LA principles as follows:

PSVA Findings	Shared Values	Dynamic Leadership	Multi-Actor Networks
Number of Landscape Approach Principles	6	4	6

Results obtained so far indicate a clear overlap, and although preliminary, we can conclude the following: (1) clear examples of (implicit) LAs to enhance the sustainability and resilience of agri-food systems are already being implemented across the Mediterranean macro-region, and (2) the success of the PSVA indicates to the potential of LAs to help other wine producing regions and networks across the Mediterranean move in a similar direction.

## RESULTS-BASED PAYMENTS: A NEW TOOL TO INCREASE THE INTEGRATION OF DIFFERENT LANDSCAPE COMPONENTS IN FARM MANAGEMENT

Teresa Pinto-Correia<sup>1</sup> · Maria Helena Guimarães<sup>1</sup> · Isabel Ferraz de Oliveira<sup>1</sup> · Maria de Belém Costa Freitas<sup>2</sup>

<sup>1</sup>University of Évora · <sup>2</sup>University of Algarve

The EU Common Agriculture Policy has an increasing focus on the greening of the policy objectives, and performance based payments in the agri-environmental schemes is one of the selected policy tools. It foresees tailor made solutions focused on results (i.e. environmental outcomes), not processes, benefiting farmers who go beyond the minimum required, in terms of environmental performance. Farmers need to step out of their comfort zone and adapt their management along the way so that the results to be valued, are obtained. The focus on payment by results implies an increased effort by farmers that, with proper technical guidance, take management decisions that will lead, in their specific case, to the results defined. This calls for farm, or even field, based indicators which are easily applicable, for environmental results which depend on farm practices, and make it possible to assess and monitor changes in outcomes along time. And it implies, as the triggering factor, engagement of public authorities to make the results-based payments a possibility within the agri-environmental schemes in place – not just to create such measures but also to create the required advisory conditions for them to flourish.

For the preservation of the Montado silvo-pastoral landscape, with more than 1 million ha in Southern Portugal, and 3 million ha of the similar Dehesa in Spain, these new tools may be a way to boost a renewed integration of all components of a complex system. Despite the multiple public goods supported by the Montado and its role as a High Nature Value farming system, its extension has been regularly under decay since 1990, mostly due to loss of vitality of the system, with decreasing carrying capacity and weakening of tree renewal. Assessments reveal non-adapted grazing and soil management, openings in the tree density and decline in pastures diversity.

Since 2017 the authors have developed a process of joint construction with farmers and technical staff of public administration, of a set of results-based payment scheme for the Montado. The process has not been labelled as Landscape Approach, but follow the same principles. In this paper we present (1) how an active network involving farmers, technical staff of the administration and collective organizations, and researchers, has been build up, (2) how results to be achieved were consensualised, (3) how the system of field based indicators was developed, and (4) how the process has led to the adoption of a results-based pilot scheme in the Portuguese CAP – to be set in place 2023. We discuss the potential and the limitations of our participatory approach for the long-term sustainability transition of these silvo-pastoral landscapes, with more integrated management approaches by those involved.

## BIOCULTURAL CONSERVATION SYSTEMS IN THE MEDITERRANEAN REGION: THE ROLE OF VALUES, RULES, AND KNOWLEDGE

Tobias Plieninger

University of Göttingen / University of Kassel

The Mediterranean Basin is a global biodiversity hotspot, but formal conservation approaches have not been wholly effective to halt species and ecosystem losses in this world region. There is wide agreement that maintaining traditional and diverse land-use systems is key to conserving biodiversity across the Mediterranean region. Biocultural approaches provide a perspective to understand and manage the interplay of nature and culture in various contexts. To develop biocultural systems as positive alternatives to unsustainable land use systems requires an understanding of the decision-making contexts that enable such approaches. The aim of this synthesis presentation is therefore to compare how four biocultural conservation systems in the Mediterranean are shaped by values, rules, and knowledge.

Our study is based on a synthesis of the literature published on agdal (Morocco), communal forests (Spain), sacred natural sites (Greece), and hima (Lebanon). Our synthesis shows that instrumental, intrinsic, and relational values are all fundamental components of the systems studied. Instrumental values, such as the provision of grass or firewood, are central, and are often result of a careful adaptation to the uncertainty inherent to Mediterranean climatic conditions. Systems like agdal and hima have originally been shaped by informal rules (often with the primary motivation to ensure equitable resource use and frequently involving taboos) and were then formalized to varying degrees. All four systems are strongly driven by local knowledge. We conclude that biocultural systems in the Mediterranean represent 'people and nature' approaches that support linkages between nature and human well-being. Fostering biocultural conservation in the Mediterranean requires navigating multiple interlinkages between values, rules, and knowledge in decision-making.

## ASSESSING AND UP-SCALING SOIL EROSION IN MEDITERRANEAN OLIVE ORCHARDS WITH DIFFERENT FARMING SYSTEMS

Sergio Prats · Ana Rita Correia Sanches · Clarisse Brigido · Antonio Rodriguez Sousa · Teresa Pinto Correia · José Muñoz-Rojas

University of Évora

**E**U Mediterranean countries produce 70% of the world's olive oil production, constituting one of the main components of its socio-economic and cultural life. The increase in olive oil demand is triggering the intensification and expansion of olive groves, by means of the systematic use of chemical fertilizers, pesticides, and aggressive weed control and soil management practices, such as herbicide, tilling, ferti-irrigation, increased tree density and mechanical harvesting. This intensification process led to simplified landscape patterns with low-nature-value olive groves, which often results in negative environment impacts in the form of soil erosion, soil fertility loss and habitat degradation, and a profound change in landscape character. In the framework of SUSTAINOLIVE project ([www.sustainolive.eu](http://www.sustainolive.eu)), efforts had been addressed to increase sustainability of these farming systems, and to reduce the impacts in the landscape. The implications of these practices in each one of the soil erosion processes at the different spatial scales are still to be addressed.

The main aim of this research is to assess the effects of seven farming systems, differing tree age (100-15-2 years), olive density (traditional-intensive-superintensive; respectively 50-250-1800 tree ha<sup>-1</sup>) and weed control in the tree lines (herbicide-superficial tilling-trimming) on the different soil erosion processes governing at each spatial and temporal scales. The specific objectives are: (1) field monitoring of soil erosion using sediment fence plots at point-landscape scales (1-600 m<sup>2</sup>), (2) assessment of soil and sediments C contents and key factors (cover-, climate-, soil-related factors) affecting each of the erosion processes (rain-splash, interrill, rill) at the different spatial scales.

Preliminary results for seven months show that in spite of the low rainfall amount (140 mm) soil erosion on the landscape scale was the highest in herbicide farms (20 Mg ha<sup>-1</sup>), followed by new plantations (1.6 Mg ha<sup>-1</sup>). Superficial tilling farms as well as trimming weed control farms achieved negligible erosion (0-0.04 Mg ha<sup>-1</sup>). Herbicide and the establishment of new plantations promote soil erosion by rills mainly due to the increase of bare soil. On the other hand, the point scale plots (1 m<sup>2</sup>) revealed contrasting results, with superficial tilling farms showing greater erosion (5.6-2.2 Mg ha<sup>-1</sup>), as compared to the herbicide farms, which showed only 0.4 Mg ha<sup>-1</sup>. The small plot scale shows the negative effect of tilling in the mobilization of the soil via rainsplash and interrill erosion. Assessment of soil erosion is increasing farmer's awareness on the overall landscape simplification process and open the pathways for bridging together research and practice. Future research will monitor during two years and address the implication of soil mobilization in carbon losses by mineralization and possible mitigation techniques to reduce soil erosion and improve the landscape management approaches.

## RECONCILING DIFFERENT SOCIAL INTERESTS THROUGH INTEGRATIVE LANDSCAPE APPROACH: EXAMPLE OF THE RIVER NERETVA VALLEY, CROATIA

Dora Tomić Reljić<sup>1</sup> · Petra Pereković<sup>1</sup> · Monika Kamenečki<sup>1</sup> · Ines Hrdalo<sup>1</sup> · Lara Bogovac<sup>2</sup> · Sonja Butula<sup>1</sup>

<sup>1</sup>University of Zagreb · <sup>2</sup>Green Infrastructure Ltd.

The basic motivation for the present research was the lack of landscape planning approaches within the spatial planning process in Croatia. In practical terms, it entails several dissimilar deficiencies which were addressed in this research. The most important is integral inclusion of the public opinion into the planning process. Within landscape planning, public participation is taken into account through dealing with the conflicts between diverse social groups which may arise. Since spatial planning has a key role in the harmonization of the needs and management of the resources it often faces the conflict between requirement for the development and need for the protection, especially if it comes to conflicting demands of different social groups. However, due to inadequate tools and methods that would point to optimal and sustainable solutions that take into consideration all the criteria simultaneously, decisions are made 'ad hoc'. So, the landscape approach defined by Sayer et al. (2013) can harmonize protection and development through interventions in the different components of the landscape.

In areas like River Neretva Valley, that was chosen as the research area, often lacked an integrated approach to landscape planning (Roe, 2000), which usually resulted in conflicts between users and thus the lack of inclusion of all interest groups in planning and decision making. The sectors of nature protection, agriculture and hunting were chosen as target social groups of the empirical research, because they were identified as most affected (Čaldarović, 2006). So, the main objectives of the research were (1) to determine the need of harmonizing the various interests in the planning of sustainable spatial development and (2) to identify criteria for landscape evaluation within different social groups in the area of Neretva Delta. Theoretical and practical parts were conducted simultaneously which has enabled comparison and data updating and has resulted with more accurate and objective results. Transformation of the public opinion, whether it is expert or lay public, into the evaluation models which can be cartographically represented and implemented into the spatial planning procedure is very important step forward the sustainable development.

Roe M. (2000). *Landscape Planning for Sustainability: Community Participation in Estuary Management Plans*. *Landsc. Res.*, 25(2): 157-181.

Čaldarović O. (2006). *Social aspects for acquiring the conditions for declaring a part of the Neretva estuary a Nature Park – a sociological study*. Zagreb.

Sayer J. et al. (2013). *Ten principles for a landscape approach to reconciling agriculture, conservation, and other competing land uses*. *Proc. Nat. Acad. Sci.*, 110(21): 8349-8356.



## LINKING CORK TO CORK OAK LANDSCAPES: MAPPING THE VALUE CHAIN OF CORK PRODUCTION IN PORTUGAL

Irene Holm Sørensen<sup>1</sup> · Mario Torralba<sup>1,2</sup> · Cristina Quintas-Soriano<sup>3</sup> · José Muñoz-Rojas<sup>4</sup> · Tobias Plieninger<sup>1,2</sup>

<sup>1</sup>University of Kassel · <sup>2</sup>University of Göttingen · <sup>3</sup>University of Almeria · <sup>4</sup>University of Évora

**T**raditional farming landscapes in South and Central Portugal, known as montados, are affected by global socio-economic and biophysical pressures, putting the sustainability of the systems in jeopardy. Cork oak trees (*Quercus suber* L.) are characteristic features of these complex agro-silvo-pastoral agroforestry systems, delivering a globally important product, cork. The increasingly distant, global scale of decision making and trade can consequently be observed on the local, landscape, scale.

In this study, we use a value chain approach to test the concept that landscape products can ensure sustainable management of the landscape of origin. We interviewed agents – cork producers, intermediaries, industrial transformers, and winemakers – about the challenges they perceived in the business and how these were connected to the landscape of origin. We illustrate the network of agents and sub-actors involved in the sector and highlight the most prominent concerns. By combining methods from value chain analysis and theories from landscape science, we conclude that this landscape approach can reveal the major points for determining the future of the montado. Furthermore, we suggest that collaboration amongst value chain agents can be a pathway to landscape sustainability.

## IMPACT OF DIFFERENT FARM MANagements ON THE SUSTAINABILITY OF OLIVE GROVE LANDSCAPES IN ALENTEJO (PORTUGAL) USING A SIMULATION MODEL

Antonio Alberto Rodríguez Sousa<sup>1</sup> · José Muñoz-Rojas<sup>2</sup> · Jesús M. Barandica<sup>1</sup> · Alejandro J. Rescia<sup>1</sup>

<sup>1</sup>Complutense University of Madrid · <sup>2</sup>University of Évora

Olive groves form socio-ecological landscapes in the Mediterranean, reaching 350,000 ha in Portugal. Specifically, 57.14% of these crops are in Alentejo region, forming heterogeneous landscapes (Allen et al., 2018). In Alentejo, there are several olive management systems, with the traditional model standing out, as well as multifunctional models such as integrated and organic farms (Egea, y Pérez, 2016). On the other hand, by increasing plant density, there are intensive or highly-intensively crops (Fraga et al., 2020). The contribution of ecosystem services (ES) of these crops, together with the variability of managements, demand the need to design simulation models to assess the impacts of each management, constituting tools to assess olive grove sustainability. Using Alentejo as a study area, a dynamic model was implemented based on experimental and bibliographic data, in which the influence of erosion on productivity was evaluated in the long term. Comparative analyses were carried out between existing management models in terms of the productive-economic and environmental dimensions of the crops, taking farm abandonment as indicator of agricultural impact.

Although the results showed a higher short-term production of intensives groves, cumulative production over the simulated time was lower than in other managements, due to a higher impact of erosion, which encouraged a higher rural abandonment and economic losses. However, in intensive farming, the effects of erosion could be minimised by correct soil management with plant covers, increasing its sustainability. Integrated and organic managements showed a more sustainable production over time, highlighting the low impacts of organic agriculture, where a minimum abandonment was estimated together with high economic benefits derived from the valorisation of the products obtained under this model. Taking into account the novel nature of olive growing in Portugal, the model implemented is a very useful tool that allows the evaluation of the sustainability of the olive grove in Alentejo, enabling management recommendations to be made to professionals with the aim of optimising olive farms and, at the same time, promoting their multifunctionality.

Allen H. et al. (2018). *Satellite remote sensing of land cover change in a mixed agro-silvo-pastoral landscape in the Alentejo, Portugal*. *Int. J. Remote Sens.*, 39(14): 4663-4683.

Egea P., y Pérez L.P. (2016). *Sustainability and multifunctionality of protected designations of origin of olive oil in Spain*. *Land Use Policy*, 58: 264-275.

Fraga H. et al. (2020). *Olive tree irrigation as a climate change adaptation measure in Alentejo, Portugal*. *Agric. Water Manag.*, 237: 106193.

## A REMOTE SENSING-BASED LANDSCAPE APPROACH TO OPTIMISE MULTITAXA ROADKILL MITIGATION PLANS OVER LONG TERM

Francesco Valerio · Sérgio Godinho · Pedro Salgueiro · Denis Medinas · Giovanni Manghi ·  
António Mira · Nuno Pedroso · Eduardo Ferreira · João Craveiro · Sara Santos

University of Évora

**F**or landscape approaches, innovative concepts and tools are increasingly required in areas where agriculture and other land uses may be in conflict with environmental and biodiversity protection. In comparison with other land uses, linear infrastructure is identified as landscape element that can be particularly problematic to biodiversity, mainly due to the significant mortality they often cause to wildlife populations. Although roads are expanding in many natural, semi-natural and biodiverse areas, there is a need to focus for conservation approaches on the Mediterranean context, being considered a biodiversity hotspot that is facing relevant changes. Secondly, although a growing body of research is looking at landscape approaches to mitigate wildlife mortality, there have been few attempts to comprehensively integrate such approaches into multi-species road mitigation plans.

In this research, we identify high-risk road sites for 19 forest vertebrate species from three taxonomic groups (non-flying mammals, birds and bats), with the ultimate intention of prioritising and optimising road mortality mitigation plans. To reveal road risk sites, in the Alentejo region (southern Portugal), we make use of a long-term monitoring study (15-year dataset) composed of species occurrence data, road fatality records, and high-resolution satellite imagery. We differ from traditional landscape approaches by identifying remotely sensed habitat metrics for each taxonomic group, then weighting their effects together with functional connectivity models and road metrics to estimate the vulnerability of road kills for each species. By these means, the variation in road kill probability is further estimated within and between each group to check the consistency of the prediction, which ensures flexibility in mitigation planning. We could prioritise road planning units with high accuracy in predicting multiple species mortality, and acceptable variation in probability within each group. However, some discrepancies in consistency of prediction emerged following group comparisons, in particular concerning bats.

Overall, this study demonstrates that spatial convergence in mortality patterns for multiple species is achievable by modelling habitat suitability and identifying dispersal pathways. Such tools, developed using remote sensing information, allowed us to highlight persistent corridors, which is of special relevance in dynamic landscapes. The corridors identified are capable of covering species with different ecological characteristics and movement capacity, and when intersecting roads, may greatly improve the identification of where allocate resources for conservation. The applicability of this study will facilitate the definition of road sites that are more prone to multispecies collision with vehicles, endowing road agencies and practitioners to strategically define long-term, flexible and cost-efficient multitaxa mitigation plans.

## *Latin American and European cities: partnership approaches to co-producing nature-based solutions*

### **Symposium organisers**

*Tom Wild* (University of Sheffield), *Sandra Naumann* (Ecologic Institute), *Juan David Amaya-Espinel* (Pontifical Javeriana University), *Diana Marcela Ruiz Rios* (The Alexander von Humboldt Biological Resources Research Institute)

### **Summary**

This symposium, organised by Horizon 2020 projects CONEXUS and INTERLACE, provides a trans-disciplinary space for exchange of perspectives on nature-based solutions from cities in Latin American contexts and/or relevant collaborations between Latin American and European researchers. Emerging findings, experiences of partnership development and fully elaborated research results are all welcomed. In particular, inputs are sought about research, innovation and practical actions seeking to bridge different sectors of society (public, private, 3rd and voluntary/community) in joint efforts to respond using NBS to global challenges such as biodiversity loss, climate change and inclusion.

### **Description**

Rapid, messy and poorly planned transformation of natural habitats into urbanised areas in Latin America and Europe represents a serious challenge for environmental sustainability. Currently, urbanisation in both regions is a major anthropogenic driver of environmental change, and loss of native biodiversity as well of severe ecosystem services degradation. As a consequence, around 60% of the population settled in cities in these world regions are facing adverse situations related to a worsening in the living conditions in terms of its air quality, food, and water security or the spaces for recreation availability.

The conceptualisation, design, and implementation of actions to mitigate the negative impacts of urbanisation under the framework of nature-based solutions (NBS) indicates how cities can progressively reverse some deleterious effects on human well-being via the restoration and effective functioning of urban and peri-urban ecosystems and the services they provide. However, there persists a lack of knowledge about differing perspectives of NBS, the economic and social benefits they can generate in different contexts, and how to ensure their long-term impacts.

The purpose of this symposium is to facilitate a space to recognise advances, as well as opportunities in the use of NBS to address several challenges in Latin American and European cities associated with improving public health, urban liveability, climate change resilience, social inclusion, and environmental justice. It is expected that this symposium will catalyse NBS partnerships between European and Latin American cities, and beyond, in order to promote access to the shared and contextualised knowledge needed to help drive the required step-change in urban policy and practice to co-create NBS and restore ecosystems. The symposium is organised by the Horizon 2020 projects CONEXUS and INTERLACE.

In this symposium, we envisage that authors will present detailed cases examining societal and global impacts of NBS programmes and projects in Latin American and European cities. These initiatives may be at different scales (macro, meso, and micro) or may cross-cut multiple levels. We therefore call for proposed symposium papers to provide detailed contextual analyses around NBS interventions, the surrounding governance and institutional frameworks, and the realised or intended benefits and trade-offs of NBS interventions (including discussions of what we mean by success or otherwise). Our aspiration is that this discussion forum will provide a sounding board for further development and refinement of case studies and lessons learned, to support their wider communication via new and existing platforms (such as [www.oppla.eu](http://www.oppla.eu)). Contact has been made with the Open Access Journal Nature Based Solutions with a view to pursue a special issue on this theme. Efforts are made to encourage and support the participation of Early Career Researchers.

## THE CONSTRUCTED WETLANDS KNOWLEDGE PLATFORM FOR SUSTAINABLE DEVELOPMENT (CWETLANDSDATA)

Tomasz Bergier

AGH University of Science and Technology

80% of all wastewater worldwide is released untreated into the environment, leading to deteriorating water quality. Achieving universal access to sanitation while improving water quality by halving the proportion of untreated wastewater and increasing its safe reuse are targets 6.2 and 6.3 of the Sustainable Development Goals. Constructed Wetlands (CW), a nature-based solution (NBS), can contribute to these targets. Currently, there is little knowledge about the contribution of CWs to the global amount of treated wastewater. The global Constructed Wetlands Knowledge Platform (CWKP), including a database and a web-based geographic information system (WebGIS), is one-stop shop solution provider for CW-related data and mechanisms for fostering research, policy development and financing. The goal of this platform is also to assess the volume of wastewater treated by CWs worldwide. It shall support researchers, representatives of international organizations, consulting engineers, implementers, funding bodies, further experts and civil society in CW-related research, policy-making, financing, implementation and operation.

During the IALE Symposium CWKP platform will be presented, as well as the state of its development, and especially the content of its database. The potential users of the platform will be encouraged to use, both by using its content, but especially by uploading information they possess to the platform. The approach of co-creation of CWKP content will be also presented, as well as other innovative methods of data acquisition and involvement of the users. Thus the serious game will be presented, which aim is to show the players the dynamics of decision making on application of CWs and other NBS as the solution for wastewater management, as well as to provide them with the real experience of social dilemmas and barriers. The additional resources will be also briefly presented and discussed, especially the case studies and other publications available as the supporting materials on the platform.

*All of these above-mentioned activities are the part of the project "Towards the 'Constructed Wetlands Knowledge Platform' for sustainable development" (CWetlandsData), financed under the ERANet-LAC mechanism, and realized by the European-CELAC partnership (Leibniz University Hannover, Germany; AGH University of Science and Technology in Kraków, Poland; Cultura Ambiental, Uruguay; Universidad Nacional Agraria La Molina, Peru, University of San Carlos, Guatemala).*

## IDENTIFYING CO-LEARNING OPPORTUNITIES THROUGH A COMPARISON BETWEEN LATIN AMERICA AND EUROPEAN NBS GUIDANCE

Martina van Lierop · Andrea Skiba · Valentina Arros · Christin Ganserer · Alice de Mendes Freitas · Stephan Pauleit

Technical University of Munich

A multitude of research and innovation projects funded and directed by the European Commission has supported a swift uptake of the nature-based solutions (NBS) approach in the research community. These projects also aim to support mainstreaming of NBS into local practice of urban development. The knowledge and perspectives on NBS gained within these projects is often transferred through guidance material such as handbooks, guides, manuals and toolboxes in either print or digital form (e.g. websites). Compared with the European context, in Latin America, there are interventions from communities that could be categorized as NBS, but they are not defined as such, and the lessons learned are only to a limited extent recorded. In addition, funding opportunities for NBS projects in Latin America are fewer and more diverse. Our aim is to use these differences in guidance material from NBS programs in Europe and Latin America to identify opportunities for co-learning.

We conducted a content analysis on NBS supporting guidance from Latin American and European context. Guidance was collected through expert knowledge, snowballing and a Google search with keywords. As the analysis only includes materials targeted at non-academic users, scientific databases were not consulted. For the analysis, we included results English, Portuguese, and Spanish materials, which focused on (peri-)urban contexts and NBS or related concepts. Moreover, the results should be prescriptive. This resulted in 132 research projects, individual publications and websites (69 English, 6 Portuguese, 57 Spanish), which were analysed in a qualitative and quantitative manner for four topics: (1) their content related to whether and to which degree they covered substantive and procedural aspects of NBS, (2) the inclusiveness of NBS creation, (3) the knowledge transfer based on quality of presentation and target group specific information, and (4) credibility and legitimacy based on the inclusiveness and quality of the guidance development process. For each context, highly assessed guidance were selected for an qualitative in-depth analysis related to the four topics (22 English, 6 Portuguese and 20 Spanish).

The results obtained identify that the guides have a high level of similarities beyond the region. For instance, for both regions the main target users are municipalities, which is in line with the fact that the scale level is in both cases the city and municipal level by far. However, we also observe that English language guides to a greater extent address built environment professionals as a user group, while Spanish guides focus proportionally more on citizenship and community. All guidance are oriented on the process phase of planning and design, while the phases of problem identification and management are being the least considered. By reflecting on these results and others related to the four topics, we discuss potentials for meaningful exchange and learning across continents.

## INCLUSIVE AND TAILORED STAKEHOLDER ENGAGEMENT IN NBS PLANNING AND IMPLEMENTATION

Sandra Naumann<sup>1</sup> · Ewa Iwaszuk<sup>1</sup> · Kuba Kopecki<sup>2</sup> · Xavier Romero Hildago<sup>3</sup> · Maria Piątkowska<sup>4</sup> · Ericka Calderon<sup>5</sup> · Sara Maestre<sup>6</sup> · Marcela Gutiérrez Miranda<sup>7</sup>

<sup>1</sup>Ecologic Institute · <sup>2</sup>The Sendzimir Foundation · <sup>3</sup>City of Granollers · <sup>4</sup>Krakow Metropolis Association · <sup>5</sup>El Corredor Biológico Interurbano María Aguilar (CBIMA) · <sup>6</sup>Autonomous University of Barcelona · <sup>7</sup>National University of Costa Rica

**N**ature-based solutions (NBS) are nature-supported interventions to address societal challenges. To avoid NBS reproducing social exclusions and inequalities, it is essential to incorporate differences in views and beliefs and valuations of green space and nature in designing, planning, and executing NBS.

Creating inclusive cities is among key aims of INTERLACE, a research project supported by the EU's Horizon 2020 programme. The project triggers and supports a variety of socio-environmental actions in partner municipalities in Europe and Latin America, ranging from urban river restoration, increasing access to safe green spaces for recreation to promoting local agriculture through activities aligned with the eco-social transition. INTERLACE adopts a highly participatory approach, which aims to also specifically target vulnerable and marginalized groups. To this end, we developed a Guidance on cultural, gender and ethics-related considerations to ensure an inclusive approach to facilitate an inclusive, transparent and fair stakeholder participation in the diverse local contexts. In addition, the project seeks to exploit a variety of engagement forms tailored to the targeted stakeholders. These may include, arts, gaming, citizen science workshops and working groups as well as hands-on experience. The implementation of carefully planned, inclusive approaches to citizen engagement generates social benefits as well as ownership, acceptance and uptake of the promoted NBS interventions.

Experiences from three INTERLACE municipal partners in Europe and Latin America showcase the motivation to implement inclusive and tailored stakeholder and citizen engagement approaches, challenges faced as well as benefits and lessons learned in this process. The three case studies include Corredor Biológico Interurbano María Aguilar (CBIMA), an association of five municipalities located in the vicinity of San Jose, Costa Rica; Metropolia Krakowska, an association of 15 municipalities in the metropolitan region of Kraków, Poland; as well as Granollers, a municipality in Catalonia, Spain.

The approaches and activities developed in the three case study areas include:

- implementing a stakeholder engagement process to incorporate views and preferences of various local groups in the process of planning local NBS interventions to strengthen existing green infrastructure and river restoration actions (Granollers, Spain);
- developing a methodology to raise awareness about the role NBS can play in addressing local challenges such as climate change and its impacts on local water cycle by building a small-scale NBS during a hands-on workshop with urban dwellers (Metropolia Krakowska, Poland)
- a complex programme combining citizen engagement, environmental education, capacity building and combating social exclusion which includes community reforestation projects, citizen science, community arts and urban agriculture among other activities (CBIMA, Costa Rica).

## EDUCATION – INVOLVEMENT – ACTION: THE SYSTEM APPROACH TO INITIATE THE LOCAL ACTIVITIES FOR CLIMATE CHANGE MITIGATION AND ADAPTATION

Ewelina Pękała · Tomasz Bergier

The Sendzimir Foundation

One of the major challenges in initiating local actions for climate protection is to engage all stakeholders, overcome the silosity and sectoral approach, and finally to create resilient and sustainable partnerships. The Sendzimir Foundation has been successfully applying and developing a systemic approach in this area, successfully combining goal-oriented education, networking partners from various sectors and social groups, and finally building the strong partnerships initiating practical projects, especially those employing nature-based solutions (NBS) for climate protection.

The present experiences of The Sendzimir Foundation in the above-mentioned area will be presented. This presentation will be also illustrated with the current case study – the model center for education on mitigation and adaptation to climate change, which we are currently creating in Wawer (one of the districts of Warsaw, Poland), in cooperation with the municipality and international partners. Within the project a comprehensive and diverse NBS system will be created at the premises of the primary school (totally 45 NBS, including rain gardens, flower meadows, green walls and pocket parks). We anticipate the active participation of the school community in the planning and constructing the facilities. This investment will be the basis for conducting educational and information activities on the role of NBS in adapting urban areas to climate change, preventing flash floods, heat islands, etc. A number of lesson scenarios and informal activities will be developed, thanks to which the center, apart from the vivid example of NBS, will be the important place for educating teachers, local activists, even officials and professionals, not only from Warsaw or Poland. The project will also provide the comprehensive trainings for target groups, and also the unconventional activities aimed at students and representatives of the local community.

We will briefly present this project, its technical, social, educational and promotional aspects, but the main focus will be placed on its genesis, especially on the approach described in the first paragraph of this abstract and in the title, because we started with educational activities, i.e. the trainings on NBS carried out in Wawer as part of the project “Climate NBS Polska” (implemented with the Ecological Institute, financed by EUKI). A participatory approach and involving the trained NBS designers on the one hand, and the recipients of their work, i.e. the commune of Wawer on the other, resulted in a high-quality vision and design, which was then developed and refined in collaboration in this partnership (broadened in the meantime), and turned into the comprehensive vision, described in the previous paragraph, which was funded by Iceland, Liechtenstein and Norway Funds, under the Environment, Energy and Climate Change Program. We would like also to address the perspectives and plans for applying and developing such the system approach within Interlace project (in the Krakow Metropolis and other partner cities) and beyond it.



## SANTIAGO+ GREEN INFRASTRUCTURE PLAN: BUILDING BRIDGES IN A LATIN-AMERICAN FRAGMENTED CITY

Alexis Vásquez · Paola Velásquez · Emanuel Giannotti · Elizabeth Galdámez · Victor Alegria · Cynnamon Dobbs

Universidad de Chile

Latin American cities are currently facing several challenges that put at risk the quality of life and the well-being of their inhabitants. Santiago (Chile) is subjected to issues related to air quality, social segregation, equity, loss of biodiversity, and climate change, which are exacerbated by the strong social, environmental, and administrative-institutional fragmentation. This fragmentation derives from the conurbation of 36 autonomous municipalities administered by local governments with their own mayor, council, and budgets without the leadership of a city mayor. In addition, public institutions, policies and regulations have narrow sectoral targets, normally developed within an insulated institutional environment, thus causing serious coordination problems.

This has led Santiago to an urban expansion that has been poorly regulated and has accentuated strong social-environmental patterns of segregation, characterized by a decrease of physical distances between different socioeconomic areas, which consequently produces a reduction of the spatial scale of urban segregation. All this is coupled with the environmental conditions in the city, leading to inequities in the distribution of green areas, heat-islands, and basic services.

The development and implementation of a green infrastructure plan in Santiago offers an opportunity to catalyse the collective interest in different types and scales of green infrastructure which can aid the city in facing its current challenges. The plan is also an opportunity to identify and engage different public, private, and citizen stakeholders to incorporate their initiatives with a strategic vision of integrated planning. Since 2017, we have begun the process aimed to develop the Santiago+ Green Infrastructure Plan, leading to the participation of 20 public institutions, 16 civil society organizations, 6 academic institutions and 3 private organizations.

Through a participatory approach, including multiple stakeholders workshops and collective mappings sessions, we were able to identify key problems that support the development of the plan, goals related to those problems, and key spatial components that enable problem solutions. Barriers for the implementation of the plan were also identified, detecting that the principle of multifunctionality for green infrastructure projects and plans requires an intense intersectoral dialogue and coordinated interventions. Another challenge was the funding of green infrastructure, especially relevant given the deficit of resources for construction and even more relevant for the maintenance of the green and blue spaces in Santiago. This becomes particularly true for low-income municipalities and for initiatives carried out by community organizations.

The development of a green infrastructure system in Santiago can considerably contribute to mitigating the socio-ecological segregation and environmental problems, a commonality of cities from the Latin America region.

## DO NATURE-BASED SOLUTIONS STUDIES INCLUDE ECONOMIC ANALYSES AND MONETARY VALUATIONS?

Tom Wild<sup>1</sup> · Daniel Kozak<sup>2</sup> · Demián Rotbart<sup>3</sup> · Hayley Henderson<sup>2</sup> · Jaime Hernandez Garcia<sup>4</sup> · Juan David Amaya Espinel<sup>4</sup> · Juan Miguel Kanai<sup>1</sup> · Jost Wilker<sup>5</sup> · Maria Alejandra Cruz Suarez<sup>4</sup> · Mariana Baptista<sup>1</sup>

<sup>1</sup>University of Sheffield · <sup>2</sup>National Scientific and Technical Research Council · <sup>3</sup>Municipality of San Martin · <sup>4</sup>Pontifical Javeriana University · <sup>5</sup>Ministry for Environment, Agriculture, Conservation and Consumer Protection of the State of North Rhine-Westphalia

**F**indings are presented from an investigation of nature-based solutions (NBS) research and case studies. We examine how projects address ‘co-benefits’, and particularly, their coverage of economic impacts. A key issue for the evolution of NBS is how their impacts are evaluated (Dumitru, Wendling, 2021). Central to our study is whether NBS projects involve monetary valuation and if they addressed wide-ranging multiple benefits, or relatively few. This is now a central focus for NBS implementation (Whiteoak, 2020).

To provide a framework for understanding types of assessments, we reviewed abstracts of over 400 published cases drawn together through the H2020 Conexus project (Amaya-Espinel et al., 2021). To complement this, data collated through an EC-funded review (Wild et al., 2020) was re-examined. The ‘Conexus review’ revealed 66 peer-reviewed journal articles reporting economic assessment results, using 13 different economic valuation methods. The ‘EC review’ revealed 29 documents reporting economic assessments. The most striking finding is the wide variety of NBS benefits reported overall. The Conexus review identified >50 different types of co-benefits. Most of these studies did not report economic analyses; relatively few provided details of monetary valuation methods. Most papers focussed on not many co-benefits (c.f. Raymond et al., 2017). Why does this matter? Dumitru and Wendling (2021) offers “a comprehensive NBS impact assessment framework... indicators and methodologies to assess impacts of NBS across 12 societal challenges”. Notably, 2 of those 12 criteria have an economic theme (‘place regeneration’: 47 indicators; ‘economic opportunities & green jobs’: 34 indicators).

Our reviews indicate that few published studies applied or reported economic assessment of NBS impacts. Vasquez and Dobbs (2021) identify the lack of economic valuation of NBS benefits as a key barrier in their development and implementation. The present study indicates that the published literature may not provide a particularly rich source of applied NBS economic valuation methods addressing multiple co-benefit indicators.

Dumitru A., Wendling L. (Eds.) (2021). *Evaluating the impact of NBS: A handbook for practitioners*. Luxembourg: Publications Office of the EU.

Whiteoak K. (2020). *Market challenges and opportunities for NBS*. Luxembourg: Publications Office of the EU.

Wild T.C. et al. (2020). *NBS: state of the art in EU-funded projects*. Luxembourg: Publications Office of the EU.

Amaya-Espinel J.D. et al. (2021). *State of the art, good practices and NBS typology* (Conexus deliverable D2.1).

Raymond C. et al. (2017). *A framework for assessing and implementing the co-benefits of NBS in urban areas*. *Environ. Sci. Policy*, 77: 15-24.

Vasquez A., Dobbs C. (2021). *The Santiago Green Infrastructure Plan: towards a green infrastructure system*. In: J.D. Amaya-Espinel et al. (Eds.), *State of the art, good practices and NBS typology in European Union and Latin America cities*. Report D2.1 v1.1.

## PLANNING AND COOPERATION PROCESSES FOR URBAN RIVER RESTORATION WITH NBS IN PORTOVIEJO, ECUADOR

Grace Yopez · Nicolas Salmon · Sheika Aragundi

YES Innovation

Latin America cities are in direct contact with natural areas of great value with extraordinary ecological diversity. The management of these areas has been modified over time in function of the urban and not the natural. Local knowledge about these natural spaces has been lost, ignoring their functions as well as the role of their components in the ecosystem and their benefits for the cities with which they border or cohabit. These areas are also facing rampant urbanisation that is transforming their unique ecosystems and landscapes almost irreversibly.

The loss or degradation of these natural areas confronts Latin American cities with the challenge of understanding what to do with these areas in poor condition, what role they play in the future of cities in the context of climate change, and how to value the ecosystem services that these areas can generate. On the other hand, most cities in Latin America are facing aggravated effects of climate change that amplify risks and increase the vulnerability of their population.

It is in this context that the INTERLACE project proposes to strengthen the restoration of urban ecosystems in the European Union and Latin America. Ecuador participates with the city of Portoviejo, located in the coastal region and crossed by the Portoviejo River, which gives its name to the city. In this case, the local consortium has focused on establishing collaborative and complementary work with agile processes for a participatory and inclusive diagnosis from the economic, social and environmental sectors of the city. A total of 61 studies were identified on urban, social and environmental issues related to the river. 20 associations and NGOs that have been or are working on programmes and projects on the river were counted. Environmental education projects have been identified in schools and colleges in the city that show the importance of the river in the culture of the population. However, all this work is not related to each other and is not included in official documents or programmes. There is no link between these studies and other related initiatives and the possibility of a local co-production of ideas for the river and its restoration is lost. INTERLACE-Portoviejo is working to generate participation in the diagnosis, tools and proposals for the river from a collective process for the sustainability of the project beyond INTERLACE. The aim is for this process to allow us to respond in advance to what these international collaboration projects can concretely serve and how to transfer locally what has been found and developed in this project. By relying on collective intelligence, we seek to identify key elements to be considered in the developments foreseen in INTERLACE for the participating cities with the objective of supporting the ecological restoration of Portoviejo's river.

## 10. Education in landscape ecology

### *Teaching and learning landscape ecology and planning in times of growing uncertainties. Challenges ahead during and after the COVID-19 pandemic*

#### **Symposium organisers**

*Veerle Van Eetvelde* (Ghent University), *Werner Rolf* (Technical University of Munich), *Camila Gomes Sant Anna* (Federal University of Goiás)

#### **Summary**

This symposium aims to address experiences and reflections about teaching landscape ecology during the COVID-19 pandemics. Based in these experiences we want to look forward and discuss how these can help us to further develop teaching contents and methods in future. The symposium is welcoming contributions from colleagues in the different levels of education and degrees. What are the challenges and opportunities ahead? What are the appropriate ways of working together in a blended teaching format? Can the online version replace the real landscape? How to create new blended spaces and places for learning landscape ecology? What multiscale approaches in landscape ecology can be used in landscape planning and design projects in the current era?

We are looking for contributions with practical examples but also with critical and theoretical reflections about teaching landscape ecology and planning during and after the COVID-19 pandemic.

#### **Description**

To be a teacher or a student in a changing society and environment is challenging. This means that the content, learning outcomes and competences of the programs and curricula need to be updated to the new demands from society. Graduate students have to be prepared to tackle future research questions in landscape ecology to formulate solutions for a more sustainable and liveable world for all species. Also the educational system is challenged and encouraged to use new technologies and research methods. Innovating teaching and evaluation methods are encouraged. This leads to a continuous updating of courses to ensure the overall qualities of the different levels in teaching, from the primary schools to the graduate level. Teaching programmes and courses might need to handle these challenges, also taking into account how students can be prepared for a future that is characterised by growing societal and environmental uncertainties.

However, no one could have predicted the situation the whole world was getting into due to the COVID-19 pandemics since March 2020. Schools and university were closed, teaching had to be organised in a different manner, and contacts between students and teachers could only take place virtually. These other ways of interaction with and among students appeared to be both different and difficult. The different and wide variety of our traditional teaching and evaluation methods had to be adapted. Both teachers and students had to be flexible, creative and adaptive.

When teaching about and in the landscape, specific teaching methods are used such as going in the landscape (excursions and fieldwork), the use of imagination (representations and visualisation) and observations (recording and analytical skills), learning together and working interdisciplinary, and the iterative learning process and integration between indirect desktop and direct field observation. Now we were challenged to bring the landscape and its different perspectives into a virtual world.

The aim of this symposia is to discuss how we can progress in teaching and learning landscape ecology in the post-corona period. What are appropriate ways to respond to drastic changes in the future? What insights can be learned and could be integrated into the teaching programs of the

future? Are we still using the appropriate concepts and teaching methods? Is blended learning the future of academic education? How can we get students interested in landscape ecology in a hybrid approach combining learning in school/on campus with distance learning (including online learning)? What are the appropriate ways of working together in a blended teaching format? Can the online version replace the real landscape? How to create new blended spaces and places for learning landscape ecology?

A specific focus will go to systemic and strategic methodologies of Landscape Ecology Teaching and learning in planning and design study programmes, including methodological strategies and tools in the field and virtually as well as the interdisciplinary approach that gathers architects, urbanist, biologists and geographers.

The symposium will be built on different experiences from the participants in the different levels of education and degrees and discuss both practical examples as well as theoretical reflections.

## HOW CAN THE UNIVERSITIES' CAMPUSES SUPPORT AN INTERDISCIPLINARY LANDSCAPE ECOLOGY EDUCATION? LESSONS LEARNED FROM THE AMERICAN UNIVERSITY OF BEIRUT

Beata Dreksler · Monika Fabian

American University of Beirut

Studies and research of landscape ecology are interdisciplinary by its nature. Academic institutes play an important role in enhancing the science and the practice of landscape ecology by integrating institutional and academic goals.

The American University of Beirut (AUB) campus, located at the heart of the urban Ras Beirut area, incorporates a unique natural environment. Since its establishment in 1866, AUB has been celebrated for its academic programs and its campus. The campus was also designated as a Botanical garden in 2016 by BGCI to protect its natural environment and its diverse flora and fauna. Currently, the AUB campus (61 acres) is one of the very few green areas left in Beirut. It is located by the sea and surrounded by dense urbanization. The campus was always used as an outdoor classroom for many courses throughout the faculties. It became a hub for architects, landscape architects, urbanists, biologists, geographers – just to mention some of them. New interactions between different groups of AUB users with different backgrounds created a unique opportunity to collaborate and exchange ideas and experiences.

The research questions were: Can the campus – given its limited area – become a ground to promote and enhance an interdisciplinary approach to teaching the courses with the landscape ecology elements? How can it be relevant to teach and learn about both natural and urban ecosystems? How can the students and faculty members from different specialties work together on landscape ecology topics? What is the best way to encourage interdisciplinary teaching and student research in landscape ecology on campus? How can the campus become a hub to promote landscape ecology as a science topic in Lebanon?

AUB Campus is used by University students, faculty, staff as well as visitors. Current educational activities were analyzed to investigate the possibility of the creation of multiple users' networks dedicated to landscape ecology. Inquiries were sent to all faculties of the American University of Beirut, except those that are located outside of the campus. Collected data was analyzed and compared with courses included in the AUB Catalog. Additionally, academic faculty were asked to identify possible further activities under the landscape ecology umbrella.

During the research 1486 courses offered by different entities of AUB were analyzed. Two different types of interaction were identified: direct – related directly to topics related to landscape ecology and indirect – related to other activities that eventually can include or promote landscape ecology topics. The remaining courses have been analyzed for the possibility of incorporating landscape ecology elements into their curricula and matched in terms of possible, further synergies. As an outcome, new opportunities for interdisciplinary collaboration in landscape ecology were identified. These included: joint courses, combined training programs, and mutual research.

## POTENTIALS OF THE FLIPPED CLASSROOM APPROACH FOR LANDSCAPE EDUCATION – EXPERIENCES BEYOND COVID-19

Isabel Loupa-Ramos<sup>1</sup> · Werner Rolf<sup>2</sup>

<sup>1</sup>University of Lisbon · <sup>2</sup>Technical University of Munich

**W**hen considering educational aspects, the COVID-19 pandemic has created significant challenges that cannot be ignored. Worldwide educational communities were asked to transition to remote teaching. In general, this took place by moving the traditional teaching mode and existing contents to an online environment. Assessment of experiences are needed also to identifying opportunities on how newly gained digital competences of the educational community can be used as a gateway to new teaching formats and enhancing educational quality by blending digital toolboxes with face-to-face interaction in a more purposeful way.

In this wider context, in this presentation we aim at introducing to the concept and the educational model of Flipped Classroom, and at sharing two experiments conducted in courses of green infrastructure planning in higher education, both at the Universities of Munich and Lisbon, remotely and face-to-face. Three aspects are explored: (1) the communication of knowledge and how concepts and theoretical frameworks are provided to the students, (2) the interaction with student focusing on the apprehension of the knowledge by applying it to a specific landscape, and (3) how to approach and understand the landscape notably focusing on arising challenges in remote teaching setting.

Ultimately, we aim at conducting structured interactive discussion with the congress participants about the strength and weaknesses of this teaching concept and explore its potential of applicability in other contexts. This, beyond COVID-19 restrictions and by taking advantage of the steep learning curve and newly acquired skills of the educational community.

## “IMAGINE THE LANDSCAPE” – CHALLENGES OF ONLINE TEACHING AND LEARNING OF LANDSCAPE

Iwona Markuszczyńska

Adam Mickiewicz University

This paper presents experiences and reflections about teaching and learning on landscape-oriented courses during the COVID-19 pandemic. The paper discusses how the different teaching and learning methods which were used can help online and/or blended techniques for landscape-related teaching in the future. In addition, this article reflects on students' perception of unconventional techniques of teaching about landscape. This paper also discusses the usefulness of teaching methods that were adopted due to the virtual manner of teaching and learning processes, and the pros and cons of learning about landscape in a virtual world.

The study involved bachelor's and master's students of Environmental Management at Adam Mickiewicz University in Poznań, and participants on 'Development and Planning of Rural Areas', 'Cross-border Environmental Management' and 'Landscape Ecology' academic courses. These three courses were held at different times during the pandemic; in the spring semester 2019/2020 during the COVID-19 lockdown, and in the continuing pandemic period: during the summer holidays/break and in the academic year 2020/2021. Both qualitative and quantitative research methods were used to collect the data. Structured and semi-structured questionnaires were carried out, the aim of which was to establish, inter alia, Whether online teaching can replace the real landscape, How students perceive online learning of landscape, and What values students gained from online landscape teaching.

The results show that online education was a key factor in changing students' perception of landscape, e.g., pandemic isolation has revealed a greater social role in shaping landscape. On the other hand, the survey findings inspired modifications to teaching approaches. Some recommendations about virtual, hybrid, and face-to-face methods of teaching and learning about landscape were suggested.



## TRANSDISCIPLINARY AND PARTICIPATORY LEARNING AND RESEARCH APPROACH FOR FOOD SYSTEM RESILIENCE AESOP4FOOD: SUSTAINABLE FOOD PLANNING SEMINAR AND A FOOD LOOP LIVING LAB IN WARSAW

Roxana Triboi<sup>1</sup> · Jeroen de Vries<sup>1</sup> · Aleksandra Nowysz<sup>2</sup> · Maciej Łepkowski<sup>3</sup>

<sup>1</sup>Le:Notre Institute · <sup>2</sup>Warsaw University of Life Sciences · <sup>3</sup>Lab of the Commons

Sustainable food planning is a thriving transdisciplinary research and policy field bringing together policymakers, academics, community workers, NGOs, and practitioners across the globe. There is evidence of serious gaps in knowledge and transformative competences to address the challenges in a multi-disciplinary way and the recognition of the essential role of graduates of (spatial) planning course in developing integrated territorial plans in a democratic way, and understanding an inter-sectoral, multi-level, and multi-stakeholder approach. Therefore, the Erasmus plus Action for Education, Spatial Organisation and Planning for Sustainable Food (AESOP4Food) aims to answer the need for sustainable food planning by creating a joint interdisciplinary European learning activity. Core target groups are university staff and students from architecture, urban planning, landscape architecture, agronomy, environmental sciences, as well as sustainability studies. Secondary audiences are NGOs and communities involved in local food systems, municipalities and the wider public, in order to break down barriers and foster collaboration, while encouraging knowledge development at all levels: personal, professional, communal and political.

AESOP4Food engages in a dialogue between the different actors working on the issue of sustainable food systems and aims to link expert and local knowledge which not only helps to make better decisions but also ensures plans and policies which are both grounded in state-of-the-art knowledge and local communities' perceptions.

The paper examined the Food Loop living lab in Warsaw (case study) as a result of cooperation between the Warsaw University of Life Sciences (SGGW) and the NGO Lab of the Commons, since 2021. The aim of the living lab is to develop a Circular Economy Food System project for the SGGW campus, involving various actors. It consists of multiple educational, research, design and implementation activities on urban food production, community building and composting at two venues – Hoe and the Sun Community Garden and the SGGW campus. This collaboration enables knowledge sharing between academics and practitioners. The ongoing living lab consists of three stages: (1) open workshops on sustainable urban agriculture and circular economy in the Hoe and the Sun Community Garden, (2) open research and design workshops at SGGW campus, and (3) results dissemination – open conference and at both venues. It is a pilot project and concerns community garden and selected units on the campus (canteens and dormitories). The developed research and design model can then be used for other units on the campus and in the future for other campuses, community gardens and institutions in Warsaw.

The paper presents the outline of the online seminar in connection with the Food Loop Warsaw living lab and the principles for carrying out a rigorous process of participatory action research.

## **SMALL URBAN WATER BODIES AND THE FACTORS INFLUENCING THEIR DIVERSITY. A CASE OF LAKES AND PONDS OF WARSAW, POLAND**

Michał Fedorczyk · Monika Kosińska · Kacper Kreczmer · Martyna Poławska · Rafał Stachyra ·  
Wojciech Dobrosz · Karolina Czajka · Iwona Szumacher · Maria Zachwatowicz

University of Warsaw

**T**he urban water bodies, such as lakes and ponds, substantially contribute to the urban green and blue infrastructure. Especially small ones, due to their size and various human impacts, are vulnerable and exposed to several threats. We aimed to characterise the selected Warsaw's small lakes and ponds, and to understand the environmental, as well as anthropogenic factors influencing their diversity. To address this problem we examined 29 such objects. With help of fieldwork, laboratory work, literature review and cartographic sources, we collected data on their origin, environmental conditions, water quality, land management, and functions they provide. The resulting database serves for further analyses on the factors influencing the diversity of lakes and ponds. The study is a good example of a successful science education in landscape and urban ecology, where an academic course evolves into research carried jointly by the students and the academic teachers.

## Congress Programme

Date	Time	Session Title	Speaker
<b>Plenary session</b>			
07/11/2022	10:30 AM-10:45 AM	WELCOME	Veerle Van Eetvelde; Marek Degórski; Andrzej Affek
07/11/2022	10:45 AM-11:15 AM	<b>KEYNOTE:</b> Landscape Ecology in Poland - Development and Perspectives	Andrzej Richling
07/11/2022	11:15 AM-11:30 AM	<i>Short break</i>	
<b>Learning from nature</b>			
07/11/2022	11:30 AM-05:15 PM	<b>Symposium N6. Assessing and monitoring connectivity restoration and conservation at local and regional scales</b>	Ulrich Walz; Jochen Jaeger
07/11/2022	11:30 AM-11:40 AM	<i>Introduction</i>	
07/11/2022	11:40 AM-11:55 AM	N6_O_05. How to approach the habitat connectivity – comparison of four methods	Jan Purkyt
07/11/2022	11:55 AM-12:10 PM	N6_O_09. Connectivity estimation methods: A comparative approach for conservation planning	Marie Soret
07/11/2022	12:10 PM-12:25 PM	N6_O_01. Focal patches isolation and the role of transit patches in studies on landscape connectivity	Jerzy Solon
07/11/2022	12:25 PM-12:40 PM	N6_O_04. Assessing the strategic importance of vegetated areas in multi-dwelling units to restore ecological connectivity in the French metropolitan area of Lyon	Marc Bourgeois
07/11/2022	12:40 PM-12:55 PM	N6_O_15. How are landscape fragmentation and connectivity related? Comparing methods for measuring landscape connectivity	Jochen Jaeger
07/11/2022	12:55 PM-01:00 PM	N6_P_02. A green-blue infrastructure to improve connectivity in Bizkaia	Lorena Peña
07/11/2022	01:00 PM-02:00 PM	<i>Lunch Break</i>	
07/11/2022	02:00 PM-02:15 PM	N6_O_18. Concept for measuring connectivity for spatial reference units taking barriers into account	Martin Schorcht
07/11/2022	02:15 PM-02:30 PM	N6_O_06. Spatio-temporal networks for wetland biodiversity conservation	Nivedita Varma Harisena
07/11/2022	02:30 PM-02:45 PM	N6_O_03. Ecosystems as complex networks: A study of the network topology of two contrasting ecosystems, such as dryland and river-floodplains	Sonia Recinos
07/11/2022	02:45 PM-03:00 PM	N6_O_16. The influence of the spatial development on the ecological network management at a local and regional scale. Case studies in Wielkopolskie Province	Marta Kubacka
07/11/2022	03:00 PM-03:15 PM	N6_O_02. Assessing the influence of terrestrial pesticide exposure on amphibian population networks	Greg Churko
07/11/2022	03:15 PM-03:30 PM	N6_O_13. Conservative arboriculture: perspectives for enhancing landscape connectivity and promoting biodiversity in urbanized landscapes	Davide Corengia

07/11/2022	03:30 PM-03:45 PM	<i>Short Break</i>	
07/11/2022	03:45 PM-04:00 PM	N6_O_07. Connectivity of Protected Areas in Colombia: Identification and prioritization of potential linkages	Sara Pineda Zapata
07/11/2022	04:00 PM-04:15 PM	N6_O_14. Functional and taxonomic structure of carabid beetle assemblages in forest fragments and hedges in heterogeneous agricultural landscapes	Ronan Marrec
07/11/2022	04:15 PM-04:30 PM	N6_O_10. The consequences of ash dieback on functional and genetic connectivity	Fiona Plenderleith
07/11/2022	04:30 PM-04:45 PM	N6_O_11. Validation of graph-based connectivity models using genetic data	Alexandrine Daniel
07/11/2022	04:45 PM-05:00 PM	N6_O_12. Assessing the influence of the amount of reachable habitat on genetic structure using graphs	Paul Savary
07/11/2022	05:00 PM-05:15 PM	<i>Conclusions</i>	

### Learning from people

07/11/2022	11:30 AM-05:15 PM	<b>Symposium P1. Assessing intangible landscape values for landscape planning and design [part 1]</b>	Irena Niedźwiecka-Filipiak; Elżbieta Raszeja; Krzysztof Młynarczyk; Agnieszka Ozimek
07/11/2022	11:30 AM-11:33 AM	<i>Introduction</i>	Irena Niedźwiecka-Filipiak
07/11/2022	11:34 AM-11:46 AM	P1_O_17. The role of landscape distinguishing marks and visual analyses in the planning and design of new building investments in areas of high landscape values	Irena Niedźwiecka-Filipiak
07/11/2022	11:47 AM-11:59 AM	P1_O_10. Integrated analysis of social-ecological functions of urban green spaces in traditional village of Penglipuran, Bali, Indonesia	Sadahisa Kato
07/11/2022	12:00 PM-12:12 PM	P1_O_04. Understanding changing landscapes: the intangible side of rural gentrification on a Swedish island	Hanna Elisabet Åberg
07/11/2022	12:13 PM-12:25 PM	P1_O_19. Perception of change in rural landscapes on Shar Planina, North Macedonia	Daniela Jovanovska
07/11/2022	12:26 PM-12:38 PM	P1_O_02. Classification and assessment of Cultural Ecosystem Services Distribution Channels (CESDC) for landscape planning and tourism development. Case study: Kazimierz Landscape Park (Poland).	Malwina Michalik-Śnieżek
07/11/2022	12:39 PM-12:51 PM	P1_O_16. Guidelines for developing an in-situ expert visual quality assessment on agricultural landscapes	Ana Medeiros
07/11/2022	12:52 PM-01:00 PM	<i>Discussion</i>	
07/11/2022	01:00 PM-02:00 PM	<i>Lunch Break</i>	
07/11/2022	02:00 PM-02:03 PM	<i>Introduction</i>	Agnieszka Ozimek
07/11/2022	02:04 PM-02:16 PM	P1_O_15. Digital view analysis from the top of the Łysica hill with identification of regional landscape specificity of the study area using new data structures	Agnieszka Ozimek
07/11/2022	02:17 PM-02:29 PM	P1_O_07. Using social media photographs deep learning to assess cultural ecosystem services of urban green spaces for high-density urban management: Case form the central Beijing	Haiyun Xu
07/11/2022	02:30 PM-02:42 PM	P1_O_05. Application of landscape capacity assessment to verify spatial development plans of protected landscapes	Piotr Krajewski
07/11/2022	02:43 PM-02:55 PM	P1_O_03. How many views in the landscape - a GIS framework for landscape parks visual resources assessment	Szymon Chmielewski

07/11/2022	02:56 PM-03:08 PM	P1_O_21. Combining subjective and objective data to explore demand and supply of social functions in Urban Green Spaces	Bep Schrammeijer
07/11/2022	03:09 PM-03:21 PM	P1_O_11. Mapping landscape visual quality in the Basque Country of north-west Spain	Ruth Swetnam
07/11/2022	03:22 PM-03:30 PM	<i>Discussion</i>	
07/11/2022	03:30 PM-03:45 PM	<i>Short Break</i>	
07/11/2022	03:45 PM-03:48 PM	<i>Introduction</i>	Krzysztof Młynarczyk
07/11/2022	03:49 PM-04:01 PM	P1_O_08. How green spaces need to change to address the public post-covid expectations	Daria Sikorska
07/11/2022	04:02 PM-04:14 PM	P1_O_23. Flowering meadows for people, bees and biodiversity	Beatrice Schüpbach
07/11/2022	04:15 PM-04:27 PM	P1_O_13. Investigating the level of attachment to different urban parks; a cross-cultural study	Mahsa Bazrafshan
07/11/2022	04:28 PM-04:40 PM	P1_O_22. Sense of place in river landscape management – a progressive perspective	Iga Kołodzyńska
07/11/2022	04:41 PM-04:53 PM	P1_O_25. Eco-Aesthetics, Social Acceptance and Environmental Concerns of the Current Landscape Practices in Global South Cities	Merham Keleg
07/11/2022	04:54 PM-05:15 PM	<i>Discussion</i>	

### Regions in the spotlight

07/11/2022	11:30 AM-03:30 PM	<b>Symposium R1. Landscape Approaches in the Mediterranean region – bridging landscape science and practice</b>	José Rafael Muñoz-Rojas Morenés; Teresa Pinto-Correia
07/11/2022	11:30 AM-11:40 AM	<i>Introduction and purposes of the symposium</i>	José Rafael Muñoz-Rojas Morenés; Teresa Pinto-Correia
07/11/2022	11:40 AM-11:50 AM	R1_O_01. Linking Cork to Cork Oak Landscapes: Mapping the Value Chain of Cork Production in Portugal	Irene Holm Sørensen
07/11/2022	11:50 AM-12:00 PM	R1_O_11. Implementing innovation for enhanced sustainability and resilience in Mediterranean agri-food systems via a Landscape Approach; the Wines of Alentejo Sustainability Program (PSVA), Portugal.	José Rafael Muñoz-Rojas Morenés
07/11/2022	12:00 PM-12:10 PM	R1_O_09. Reconciling Different Social Interests Through Integrative Landscape Approach; Example of the River Neretva Valley, Croatia	Dora Tomić Reljić
07/11/2022	12:10 PM-12:20 PM	R1_O_02. Reversing the decline of mountain landscapes: can the landscape approach and value chain approach be successfully combined?	Catarina Esgalhado
07/11/2022	12:20 PM-12:30 PM	R1_O_06. Assessing and up-scaling soil erosion in Mediterranean olive orchards with different farming systems	José Rafael Muñoz-Rojas Morenés
07/11/2022	12:30 PM-12:40 PM	R1_O_08. Impact of different farm managements on the sustainability of olive grove landscapes in Alentejo (Portugal) using a simulation model	Antonio Alberto Rodríguez Sousa
07/11/2022	12:40 PM-12:50 PM	R1_O_07. Analysing nature-based solutions addressing social-ecological and climatic drivers in Mediterranean landscapes	Mario Balzan
07/11/2022	12:50 PM-01:00 PM	R1_O_03. A remote sensing-based landscape approach to optimise multitaxa roadkill mitigation plans over long term	Francesco Valerio
07/11/2022	01:00 PM-02:00 PM	<i>Lunch Break</i>	

07/11/2022	02:10 PM-02:20 PM	R1_O_04. Results-based payments: a new tool to increase the integration of different landscape components in farm management	Teresa Pinto-Correia
07/11/2022	02:20 PM-02:30 PM	R1_O_12. Reimagining the Mediterranean coastal region: a coastal landscape governance manifesto	Carla Gonçalves
07/11/2022	02:30 PM-02:40 PM	R1_O_10. Biocultural conservation systems in the Mediterranean region: The role of values, rules, and knowledge	Tobias Plieninger
07/11/2022	02:40 PM-02:50 PM	R1_O_05. Lessons learnt from an expert-based validation of land system dynamics (2005-2015) in the Mediterranean basin	Elisa Marraccini
07/11/2022	03:00 PM-03:30 PM	<i>Open discussion and synthesizing conclusions</i>	José Rafael Muñoz-Rojas Morenés; Teresa Pinto-Correia

### Planning future landscapes

07/11/2022	11:30 AM-05:15 PM	<b>Symposium F4. Integrating landscape science into development, conservation and natural resources planning</b>	Samuel Cushman
07/11/2022	11:30 AM-11:40 AM	<i>Introduction</i>	Samuel Cushman
07/11/2022	11:40 AM-12:00 PM	F4_O_07. Spatial planning and shared action for climate and land use change in the Southeastern United States	Rua Mordecai
07/11/2022	12:00 PM-12:20 PM	F4_O_09. Forest fragmentation at multiple scales in Spain	Sergio González-Ávila
07/11/2022	12:20 PM-12:40 PM	F4_O_01. Landscape ecological approach to quantify the change of land-use regimes: example of Russian steppes	Alexander Prishchepov
07/11/2022	12:40 PM-01:00 PM	F4_O_11. Hydrological resource and health tourism of Val di Sole (Italy): key elements for sustainable development of inner territories	Chiara Chioni
07/11/2022	01:00 PM-02:00 PM	<i>Lunch Break</i>	
07/11/2022	02:00 PM-02:20 PM	F4_O_05. Effect of habitat fragmentation on biodiversity: a laboratory experiment focusing on soil microarthropods	Karolina Argote
07/11/2022	02:20 PM-02:40 PM	F4_O_03. Evaluating effects of different management strategies on beneficial arthropods in agroecosystems: landscape-scale population modelling approach	Elżbieta Ziółkowska
07/11/2022	02:40 PM-03:00 PM	F4_O_04. Impact of climate and land use change on selected fish species in mountainous streams of Czechia	Stanislav Ruman
07/11/2022	03:00 PM-03:20 PM	F4_O_08. Developing global high-resolution land-use datasets for biodiversity modelling	Tamsin Woodman
07/11/2022	03:20 PM-03:30 PM	<i>General discussion</i>	
07/11/2022	03:30 PM-03:45 PM	<i>Short Break</i>	
07/11/2022	03:45 PM-04:05 PM	F4_O_10. Ecosystem service indicators as a spatial planning tool in the urban landscape across scales (national, regional and local)	Marek Degórski
07/11/2022	04:05 PM-04:25 PM	F4_O_06. Evaluation of equitable access to urban green spaces in Santiago, Chile	Víctor Alegría
07/11/2022	04:25 PM-04:45 PM	F4_O_12. A review of ecosystem condition indicators to support urban ecosystem accounting	Francesco Sica
07/11/2022	04:45 PM-05:15 PM	<i>General discussion</i>	

## Urban and peri-urban landscapes

07/11/2022	11:30 AM-05:15 PM	<b>Symposium U1. Landscape changes in times of urbanization: processes and projections</b>	Jasper van Vliet; Luis Inostroza
07/11/2022	11:30 AM-11:35 AM	<i>Introduction</i>	Jasper van Vliet
07/11/2022	11:35 AM-11:50 AM	U1_O_05. Social-ecological interactions between composition and configuration of green infrastructure along rural urban settings of Bangalore, India	Pramila Thapa
07/11/2022	11:50 AM-12:05 PM	U1_O_07. Understanding regional urban sprawl and densification processes through settlement and building networks	Yves Räth
07/11/2022	12:05 PM-12:20 PM	U1_O_03. Citizens' perceptions of landscape changes and their driving forces: evidence from Poland	Iga Kołodzyńska
07/11/2022	12:20 PM-12:35 PM	U1_O_02. The global homogenization of urban form. An assessment of 194 cities across time	Luis Inostroza
07/11/2022	12:35 PM-12:50 PM	U1_O_13. Tourism Development and Urbanization of Food Spaces: Extended Urbanization Processes in Mediterranean Coastal Areas	Sebastian Felipe Burgos Guerrero
07/11/2022	12:50 PM-12:55 PM	U1_P_03. Main directions of landscape transformations in post-industrial urban areas	Katarzyna Pukowiec-Kurda
07/11/2022	12:55 PM-01:00 PM	<i>General discussion</i>	Jasper van Vliet
07/11/2022	01:00 PM-02:00 PM	<i>Lunch Break</i>	
07/11/2022	02:00 PM-02:05 PM	<i>Re-Introduction</i>	Luis Inostroza
07/11/2022	02:05 PM-02:20 PM	U1_O_08. Impact of political legacies on the pattern of the Wildland-Urban Interface in Poland	Dominik Kaim
07/11/2022	02:20 PM-02:35 PM	U1_O_11. Analysis and modelling of changes in settlement systems	Jasper van Vliet
07/11/2022	02:35 PM-02:50 PM	U1_O_17. Assessing sustainable urban development – an example of indicator system	Denis Michalina
07/11/2022	02:50 PM-03:05 PM	U1_O_12. Spatial logic of park access in Greater Doha, Qatar	Khalida Lifam Marthya
07/11/2022	03:05 PM-03:20 PM	U1_O_10. The Swiss landscape monitoring program LABES that integrates both physical/spatial and social data: results from the second run 2020	Lina Torregroza
07/11/2022	03:20 PM-03:25 PM	U1_P_01. Assessing the level of landscape change in Poland – quantitative study for districts and provinces	Iga Kołodzyńska
07/11/2022	03:25 PM-03:30 PM	<i>General discussion</i>	Luis Inostroza
07/11/2022	03:30 PM-03:45 PM	<i>Short Break</i>	
07/11/2022	03:45 PM-03:50 PM	<i>Introduction</i>	Jasper van Vliet
07/11/2022	03:50 PM-04:05 PM	U1_O_04. Protection of peri-urban open spaces at the level of regional policy-making: examples from six European regions	Dr. Marcin Spyra
07/11/2022	04:05 PM-04:20 PM	U1_O_15. On the role of emotions in influencing people's stewardship for peri-urban landscapes	Adrienne Grêt-Regamey
07/11/2022	04:20 PM-04:35 PM	U1_O_06. Housing development within and around national parks in rapidly urbanizing landscapes – case studies from Poland	Michał Jakiel
07/11/2022	04:35 PM-04:50 PM	U1_O_09. Behind density trends: revealing the spatial impacts of different population changes in European cities	Chiara Cortinovis
07/11/2022	04:50 PM-05:05 PM	U1_O_01. The potential to deliver ecosystem services as a challenge for green infrastructure policy in small and medium-sized cities in Poland	Agata Cieszewska

07/11/2022	05:05 PM-05:10 PM	U1_P_04. Mapping changes to functional urban green space globally	Bep Schrammeijer
07/11/2022	05:10 PM-05:15 PM	<i>General discussion</i>	Jasper van Vliet

### Agricultural and productive landscapes

07/11/2022	11:30 AM-05:15 PM	<b>Symposium A4. Productive urban landscapes – benefits, co-benefits and new modes for planning</b>	Werner Rolf; Simona R. Grădinaru
07/11/2022	11:30 AM-11:35 AM	<i>Introduction</i>	
07/11/2022	11:35 AM-11:45 AM	A4_O_11. How much people abandoned agricultural lands in peri-urban areas can feed?	Simona R. Grădinaru
07/11/2022	11:45 AM-11:55 AM	A4_O_07. The Value of Urban Agriculture beyond Food Production. Findings from allotment gardens in Germany	Kathrin Specht
07/11/2022	11:55 AM-12:05 PM	A4_O_01. Classifying hybrid collaborative models for regional short food supply chains - providing a basis for assessing sustainability transformation in the rural-urban nexus	Annette Piorr
07/11/2022	12:05 PM-12:15 PM	A4_O_14. Delivering a Healthy and Sustainable Food Economy in Letchworth Garden City	Amelie Andre
07/11/2022	12:15 PM-12:30 PM	<i>Discussion</i>	
07/11/2022	12:30 PM-12:40 PM	A4_O_09. Productive urban landscapes in Belgium and Denmark. A comparative study of the projects Tuinen van Stene (Belgium) and Trekroner (Denmark).	Jeroen De Waegemaeker
07/11/2022	12:40 PM-12:50 PM	A4_O_17. Peri-urban farmland as part of urban green infrastructure – four modes for planning	Werner Rolf
07/11/2022	12:50 PM-01:00 PM	<i>Discussion and Outlook</i>	
07/11/2022	01:00 PM-02:00 PM	<i>Lunch break</i>	
07/11/2022	02:00 PM-02:10 PM	<i>Introduction</i>	
07/11/2022	02:10 PM-02:20 PM	A4_O_16. Changes in the diversity of urban soil landscapes: An example from a medium-sized city	Sylwia Pindral
07/11/2022	02:20 PM-02:30 PM	A4_O_13. Linking food and land system research along urban-rural linkages in Europe	Markus Meyer
07/11/2022	02:30 PM-02:40 PM	A4_O_05. Mapping multifunctional Green Infrastructure networks linking rural landscapes with urban systems: harnessing nature to meet multiple societal challenges	Lukas Egarter Vigl
07/11/2022	02:40 PM-02:50 PM	<i>Discussion</i>	
07/11/2022	02:50 PM-03:00 PM	A4_O_02. Ecosystem services in the Milan south-eastern edges. An interdisciplinary monitoring approach	Valentina Capocéfalo
07/11/2022	03:00 PM-03:10 PM	A4_O_08. Evaluating the sustainability of different types of urban agriculture – an integrated participatory approach	Henriette John
07/11/2022	03:10 PM-03:20 PM	A4_O_15. Urban pastoralism as vector of transformation of abandoned land in productive green infrastructure in the fringe of post-socialist cities	Roxana Maria Triboi
07/11/2022	03:20 PM-03:30 PM	<i>Discussion and Outlook</i>	
07/11/2022	03:30 PM-03:45 PM	<i>Short Break</i>	
07/11/2022	03:45 PM-03:50 PM	<i>Introduction</i>	
07/11/2022	03:50 PM-04:00 PM	A4_O_03. Getting there: learning from engagement practice on convivial urbanism to develop productive urban landscapes	Susan Parham



07/11/2022	04:00 PM-04:10 PM	A4_O_10. Collaborative emerging projects of urban agriculture in Zurich	Irene Yerro
07/11/2022	04:10 PM-04:20 PM	A4_O_06. From agropark to agropark network: exploring stakeholder perspectives in the Metropolitan area of Lisbon	Lina Maria Hoyos Rojas
07/11/2022	04:20 PM-04:30 PM	<i>Stage for the Posters of this Session</i>	
07/11/2022	04:30 PM-04:40 PM	<i>Discussion, Sum Up and Outlook</i>	

### Regions in the spotlight

07/11/2022	03:45 PM-05:30 PM	<b>Symposium R3. Latin American and European cities: partnership approaches to co-producing nature-based solutions</b>	Tom Wild
07/11/2022	03:45 PM-03:55 PM	<i>Introduction</i>	Tom Wild; Ewa Iwaszuk
07/11/2022	03:55 PM-04:05 PM	R3_O_01. Planning and cooperation processes for urban river restoration with NBS in Portoviejo, Ecuador	Nicolas Salmon
07/11/2022	04:05 PM-04:15 PM	R3_O_02. Santiago+ Green Infrastructure Plan: Building bridges in a Latin-American fragmented city	Alexis Vásquez
07/11/2022	04:15 PM-04:25 PM	R3_O_06. Identifying co-learning opportunities through a comparison between Latin America and European NBS guidance	Martina van Lierop
07/11/2022	04:25 PM-04:35 PM	<i>Q&amp;A discussion</i>	
07/11/2022	04:35 PM-04:45 PM	<i>Short Break</i>	
07/11/2022	04:45 PM-04:55 PM	R3_O_04. Do nature-based solutions studies include economic analyses and monetary valuations?	Tom Wild
07/11/2022	04:55 PM-05:05 PM	R3_O_05. Inclusive and tailored stakeholder engagement in NBS planning and implementation	Ewa Iwaszuk
07/11/2022	05:05 PM-05:15 PM	R3_O_03. Education – Involvement – Action: the system approach to initiate the local activities for climate change mitigation and adaptation	Tomasz Bergier
07/11/2022	05:15 PM-05:30 PM	<i>Q&amp;A discussion</i>	

### Plenary session

07/12/2022	10:30 AM-11:00 AM	<b>KEYNOTE:</b> Visioning our future landscape: translating spatial planning into scenariomodelling	Anna M. Hersperger
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### Poster session I

### Learning from data

07/12/2022	11:00 AM-11:45 AM	D1_P_02. A GIS-based procedure for physico-geographical regionalisation with usage of Spatial Big Data in multi-criteria environment analysis	Witold Piniarski
07/12/2022	11:00 AM-11:45 AM	D3_P_03. The use of UAV in the analysis of changes in Digital Surface Models for peatland catchment areas	Sebastian Czapiewski

### Planning future landscapes

07/12/2022	11:00 AM-11:45 AM	F2_P_01. Mapping ecosystem services in the area of planned Turnicki National Park	Mariusz Boćkowski
07/12/2022	11:00 AM-11:45 AM	F4_P_01. Cultural ecosystem services of urban green space in Warsaw: assessing and mapping potential, use and unmet demand	Anna Kowalska
07/12/2022	11:00 AM-11:45 AM	F4_P_02. Regulating ecosystem services of urban green space in Warsaw: assessing and mapping potential, use and unmet demand	Andrzej Affek
07/12/2022	11:00 AM-11:45 AM	F4_P_05. Revitalization of Botanical Garden in Split, Croatia – challenges of implementation and legislation	Monika Kamenečki
07/12/2022	11:00 AM-11:45 AM	F4_P_06. Landscape-ecological contribution to the Concept of integrated development of the city of Melitopol	Olexander Golubtsov

### Learning from nature

07/12/2022	11:00 AM-11:45 AM	N3_P_01. Soda ash dumping grounds: are they attractive habitats for bees and wasps (Aculeata)?	Lucyna Twerd
07/12/2022	11:00 AM-11:45 AM	N5_P_01. Spatio-temporal distribution of wildlife–vehicle collisions in the Polish Carpathians between 2015 and 2021	Wojciech Haska
07/12/2022	11:00 AM-11:45 AM	N6_P_02. A green-blue infrastructure to improve connectivity in Bizkaia	Lorena Peña
07/12/2022	11:00 AM-11:45 AM	N8_P_01. The effects of planting birch forests on earthworm community in post-arable soils	Edyta Regulska
07/12/2022	11:00 AM-11:45 AM	N8_P_02. Extent and species composition of forests developed after 1940s-human displacement in the NE Carpathians	Zofia Jabs-Sobocińska
07/12/2022	11:00 AM-11:45 AM	N8_P_03. Regeneration processes of forest stands of the Tuchola Forest (Rytel Forest District, Poland) after hurricane winds in 2017 - preliminary research results	Barbara Waldon-Rudziołek
07/12/2022	11:00 AM-11:45 AM	N8_P_04. Assessing the effect of fire severity and mulch strips in mitigating soil erosion and carbon losses after the Sierra Bermeja megafire (2021)	José Rafael Muñoz-Rojas Morenés
07/12/2022	11:00 AM-11:45 AM	N8_P_05. Why understanding stakeholder perspectives and emotions is important in upland woodland creation – A case study from Cumbria, UK	Sara Vangerscov Iversen
07/12/2022	11:00 AM-11:45 AM	N8_P_06. Application of SIG (Trophic Soil Index) in ecosystem services of > post-arable soils afforested with silver birch	Bogusława Kruczkowska
07/12/2022	11:00 AM-11:45 AM	P1_P_01. Participatory Mapping of Demand for Ecosystem Services in Agricultural Landscapes	Annette Piorr
07/12/2022	11:00 AM-11:45 AM	P1_P_02. Landscape design of zones with large-scale structures located in peri-urban areas using Sectoral Analysis of Landscape Interior (SALI) - case study of Wrocław, Poland	Irena Niedźwiecka-Filipiak
07/12/2022	11:00 AM-11:45 AM	P1_P_03. The changes of landscape ecological and the effects on cultural ecosystem services in rural area	Onkamon Nilanon
07/12/2022	11:00 AM-11:45 AM	P1_P_04. Impacts of woodland planting on Nature-Based Recreational tourism in upland England – a case study	Sara Vangerschov Iversen
07/12/2022	11:00 AM-11:45 AM	P1_P_06. Cultural ecosystem services in determining valuable biocultural landscapes	Zuzana Baránková

07/12/2022	11:00 AM-11:45 AM	P2_P_01. How do young people perceive human-wildlife-interactions?	Andreea Ionescu
07/12/2022	11:00 AM-11:45 AM	P2_P_03. Optimizing the landscape portfolio for the provision of ecosystem services in Eastern Panama	Karla Pintado
07/12/2022	11:00 AM-11:45 AM	P2_P_04. How to identify ecosystem services and disservices with supply and demand	William Sidemo Holm
07/12/2022	11:00 AM-11:45 AM	P2_P_05. Water management in rural area with Nature-based solution: A case study of Ban Pi, Ban Luang district, Nan province, Thailand	Nakrob Saithep
07/12/2022	11:00 AM-11:45 AM	P2_P_06. A multi-criteria method for assessing the value of ecosystem services for catchment protection in northeastern Poland	Marta Sokół

### Social event

07/12/2022	11:45 AM-12:30 PM	Student/ Professional Networking Event
07/12/2022	12:30 PM-01:30 PM	Lunch break

### Learning from nature

07/12/2022	01:30 PM-04:45 PM	<b>Symposium N1. How to develop a "successful" environmental governance for the protection of biodiversity?</b>	Christine Fürst; Luis Inostroza; Dr. Marcin Spyra
07/12/2022	01:30 PM-01:40 PM	<i>Introduction</i>	Christine Fürst
07/12/2022	01:40 PM-01:55 PM	N1_O_01. Warsaw Biodiversity Index – towards new urban biodiversity governance instruments	Gabriela Maksymiuk
07/12/2022	01:55 PM-02:10 PM	N1_O_02. 'Nature and tourism' versus 'nature or tourism'. Searching for the right balance through the cultural ecosystem services approach	Sylwia Kulczyk
07/12/2022	02:10 PM-02:25 PM	N1_O_03. Forest landscape under involuntary biodiversity conservation approach: landowner's attitude towards biodiversity conservation in private forests	Girts Baranovskis
07/12/2022	02:25 PM-02:40 PM	N1_O_04. How grassland farmers relate to biodiversity: a case study from the northern Italian Alps	Alma Moroder
07/12/2022	02:40 PM-02:55 PM	N1_O_05. Designing biodiversity friendly landscapes as a promising approach to increase effectiveness of agri-environmental schemes	Gisela Lüscher
07/12/2022	02:55 PM-03:00 PM	<i>Urgent questions / Short interrim wrap up</i>	Christine Fürst
07/12/2022	03:00 PM-03:15 PM	<i>Short Break</i>	
07/12/2022	03:30 PM-03:45 PM	N1_O_06. Management Framework Development for Small Island Ecosystems, Case of Polillo Islands Seascape	Leajim Villanueva
07/12/2022	03:45 PM-04:00 PM	N1_O_07. A new model of pollination services potential using a landscape approach: A case study of post-mining area in Poland	Damian Łowicki
07/12/2022	04:00 PM-04:15 PM	[cancelled] N1_O_08. Sustainable Landscape Management Methods at the Marine Dunes of Agigea, Romania	
07/12/2022	04:15 PM-04:30 PM	[cancelled] N1_O_10. Spatial-time assessment of the variability of the natural values of the Biebrza Valley	
07/12/2022	04:30 PM-04:45 PM	<i>Questions and Discussion</i>	Christine Fürst; Luis Inostroza

### Learning from people

07/12/2022	01:30 PM-03:00 PM	<b>Symposium P1. Assessing intangible landscape values for landscape planning and design [part 2]</b>	Irena Niedźwiecka-Filipiak; Elżbieta Raszeja; Krzysztof Młynarczyk; Agnieszka Ozimek
07/12/2022	01:30 PM-01:33 PM	<i>Introduction</i>	Elżbieta Raszeja
07/12/2022	01:34 PM-01:46 PM	P1_O_01. Perception - identification - interpretation. Integrated landscape assessment for planning and design at the local level	Elżbieta Raszeja
07/12/2022	01:47 PM-01:59 PM	P1_O_06. Landscapes and identities in transformation: construction of the project from the social assessment of the landscape. The case of Pichilemu, a coastal city of central Chile.	Paola Velasquez
07/12/2022	02:00 PM-02:12 PM	P1_O_18. "7S" Digital View Component Parameterisation Method as a landscape assessment and planning tool	Agnieszka Ozimek
07/12/2022	02:13 PM-02:25 PM	P1_O_12. Correlation between place attachment and regional significance of CES in peri-urban areas – A ppGIS case study in Budapest Metropolitan Region	Istvan Valanszki
07/12/2022	02:26 PM-02:38 PM	P1_O_09. Comprehensive tools for urban green spaces assessment: A review of measuring systems	Ieva Misiune
07/12/2022	02:39 PM-02:51 PM	P1_O_20. Feelings about quarries: measuring the sense of place in a limestone landscape	Kamila Svobodova
07/12/2022	02:52 PM-03:00 PM	<i>Discussion</i>	

### Learning from past landscapes

07/12/2022	01:30 PM-04:45 PM	<b>Symposium H1. When history meets future – future challenges for historical landscape research</b>	Stig Roar Svenningsen; Dominik Kaim; Gregor Levin; Geoff Groom; Krzysztof Ostafin
07/12/2022	01:30 PM-01:35 PM	<i>Introduction</i>	
07/12/2022	01:35 PM-01:55 PM	H1_O_02. Can we compare 19th century topographical and modern geodata when assessing land dynamics? – Reflections on a Danish case study	Gregor Levin
07/12/2022	01:55 PM-02:15 PM	H1_O_05. Combining remote sensing data with local knowledge	Franziska Mohr
07/12/2022	02:15 PM-02:35 PM	H1_O_01. Land area categories in large-scale historical topographic maps in relation to analysing land use and land cover changes	Stig Roar Svenningsen
07/12/2022	02:35 PM-02:45 PM	H1_O_07. Key techniques applied in delivering machine-readable geodata from a scanned set of late 1800s Danish historic maps	Geoff Groom
07/12/2022	02:45 PM-02:50 PM	H1_P_01. Water in the landscape as an indicator of changes in the Elbe River lowlands	Pavel Richter
07/12/2022	02:50 PM-03:00 PM	<i>Summary</i>	
07/12/2022	03:00 PM-03:15 PM	<i>Short Break</i>	
07/12/2022	03:15 PM-03:35 PM	H1_O_03. Segmenting historical maps to build time-series of settlement and habitat networks across Switzerland	Maarten van Strien
07/12/2022	03:35 PM-03:55 PM	H1_O_04. Potential of airborne LiDAR data in detecting cultural landscape features in Slovakia	Juraj Lieskovský

07/12/2022	03:55 PM-04:15 PM	H1_O_06. Historical geoportal of Galicia and Austrian Silesia 1857 – 1910	Krzysztof Ostafin
07/12/2022	04:15 PM-04:25 PM	H1_O_08. Landscapes in Landscape	Iztok Erjavec
07/12/2022	04:25 PM-04:30 PM	H1_P_02. Anthropogenic landforms as indicators of past land use in marginal mountain areas	Michał Sobala
07/12/2022	04:30 PM-04:35 PM	H1_P_03. Geotourism and Mining Tourism – an important source of sustainable development of tourism (Gemera region, Slovakia)	Daniela Hutárová
07/12/2022	04:35 PM-04:45 PM	<i>Summary</i>	

### Agricultural and productive landscapes

07/12/2022	01:30 PM-04:45 PM	<b>Symposium A2. Novel perspectives on traditional agricultural features, structures and practices promoting landscape sustainability</b>	Cristina Quintas-Soriano; Maria Garcia-Martin; Mario Torralba; Tobias Plieninger
07/12/2022	01:30 PM-01:45 PM	A2_O_01. The role of biocultural values and practices in landscape conservation and local well-being	Cristina Quintas-Soriano
07/12/2022	01:45 PM-02:00 PM	A2_O_02. Promoting multi-stakeholder participatory conservation on agricultural heritage landscapes: a critical review of action research from Shexian Dryland Stone Terraced System	Tianyu Guo
07/12/2022	02:00 PM-02:15 PM	A2_O_03. Creative practice methodologies for understanding apicultural practices in delta landscapes	Maggie Roe
07/12/2022	02:15 PM-02:30 PM	A2_O_05. Influence of landscape agricultural features, field structure, and farm topography on the importance of ecological focus areas for farmland sustainability.	Viviana Alarcon Segura
07/12/2022	02:30 PM-02:45 PM	A2_O_06. Abandonment and intensification – current threats to the relic agricultural landscape features and structures in the Sudetes Mts., SW Poland	Agnieszka Latocha-Wites
07/12/2022	02:45 PM-03:00 PM	A2_O_07. Land Sharing initiative - Integrated approach and framework	Iztok Erjavec
07/12/2022	03:00 PM-03:15 PM	<i>Short Break</i>	
07/12/2022	03:15 PM-03:30 PM	A2_O_09. Assessment of heroic terraced landscapes in Aosta Valley (Italy) using a holistic approach	Enrico Pomatto
07/12/2022	03:30 PM-03:45 PM	A2_O_10. Traditional sylvopastoral systems between sustainability and multifunctionality: the sabana de morro in El Salvador and the pastures with carob trees in Italy	Antonio Santoro
07/12/2022	03:45 PM-04:45 PM	<i>Discussion session</i>	Cristina Quintas-Soriano; Maria Garcia-Martin; Mario Torralba; Tobias Plieninger

### Urban and peri-urban landscapes

07/12/2022	01:30 PM-04:45 PM	<b>Symposium U3. Tools for co-governance of nature-based solutions for sustainable cities</b>	Martina van Lierop; Rieke Hansen; Stephan Pauleit
07/12/2022	01:30 PM-01:35 PM	<i>Introduction</i>	Martina van Lierop
07/12/2022	01:35 PM-01:50 PM	U3_O_06. Green space governance between participation in top-down planning and co-creation – Examples from eleven European cities	Rieke Hansen
07/12/2022	01:50 PM-02:05 PM	U3_O_07. Integration of NBS in local governance and urbanisation trajectories in EU and CELAC cities	Beatriz Kauark-Fontes

07/12/2022	02:05 PM-02:20 PM	U3_O_09. Designing collaborative planning for nature-based solutions. Observations from Romania's Local Environmental Action Plans	Cristina-Gabriela Mitincu
07/12/2022	02:20 PM-02:35 PM	U3_O_01. From formal to informal: learning from difficulties and obstacles in co-governing and co-implementing NBS in a Latin American peri-urban neighbourhood	Nicolas Salmon
07/12/2022	02:35 PM-02:50 PM	U3_O_08. Success factors and barriers in green city co-design. A case study of the city of Łódź (Central Poland)	Renata Włodarczyk-Marciniak
07/12/2022	02:50 PM-03:05 PM	U3_O_05. Guiding NBS co-governance – an overview of principles and instruments from NBS guidance	Martina van Lierop
07/12/2022	03:05 PM-03:15 PM	<i>Short break</i>	
07/12/2022	03:15 PM-03:30 PM	U3_P_02 The role of participatory communication for sustainable cities - the case study of Turin (CONEXUS, pilot projects with schools)	Mariangela Pastorello
07/12/2022	03:30 PM-03:45 PM	U3_O_02. Unpacking self-governance initiatives of urban nature-based solutions in Chile: The case of Santiago	Alexis Vásquez
07/12/2022	03:45 PM-04:00 PM	U3_O_04. Participatory approach employing qualitative and quantitative methods for exploration of cultural ecosystem services attributed to urban green infrastructure – case study of the city of Zagreb, Croatia	Martina Kičić
07/12/2022	04:00 PM-04:15 PM	U3_O_10. Exploring 'middle-up' co-governance tools in driving the transformation of urban open spaces towards the adoption of nature-based solutions in Malta	Sarah Scheiber
07/12/2022	04:15 PM-04:20 PM	<i>Presentation of theoretical framework and how the different presentations fit within this framework</i>	Martina van Lierop
07/12/2022	04:20 PM-04:40 PM	<i>Discussion</i>	Martina van Lierop; Rieke Hansen
07/12/2022	04:40 PM-04:45 PM	<i>Closing</i>	Martina van Lierop; Rieke Hansen

### Planning future landscapes

07/12/2022	01:30 PM-04:45 PM	<b>Symposium F3. Green Infrastructure as socio-ecological systems: governance for the common good</b>	Isabel Loupa-Ramos; Werner Rolf
07/12/2022	01:30 PM-01:35 PM	<i>Introduction</i>	
07/12/2022	01:35 PM-01:53 PM	F3_O_01. Socio-ecological archetypes for managing ecological infrastructure	Sergio Wicki
07/12/2022	01:53 PM-02:11 PM	F3_O_06. Governance of Green Infrastructures across administrative boundaries in Lisbon Metropolitan Area	Isabel Loupa-Ramos
07/12/2022	02:11 PM-02:29 PM	F3_O_08. To Ally Technology, Nature and Society for integrated urban water management - ATENAS	Kinga Krauze
07/12/2022	02:29 PM-02:47 PM	F3_O_02. Instigating Green Infrastructure Planning - Advocating a 'Multi-faceted' and 'Middle-Up' Approach - The Case of Malta	Sarah Scheiber
07/12/2022	02:47 PM-03:00 PM	<i>Discussion and Outlook</i>	
07/12/2022	03:00 PM-03:15 PM	<i>Short Break</i>	
07/12/2022	03:15 PM-03:20 PM	<i>Introduction</i>	
07/12/2022	03:20 PM-03:38 PM	F3_O_03. Equitable use of urban green infrastructure. Insights for the co-design of urban parks.	Diana Onose

07/12/2022	03:38 PM-03:56 PM	F3_O_04. Governance of densification and climate change adaptation: How to solve conflicting demands for densification and green space?	Sabrina Erlwein
07/12/2022	03:56 PM-04:14 PM	F3_O_05. Governance analysis of productive green infrastructure with multiple benefits linking urban and rural areas	Werner Rolf
07/12/2022	04:14 PM-04:30 PM	<i>Discussion and Outlook</i>	

### Learning from data

07/12/2022	03:15 PM-04:45 PM	<b>Symposium D2. Towards a dynamic assessment of habitats conservation status: from in situ data to Copernicus services</b>	Jose Manuel Álvarez-Martínez; Borja Jiménez Alfaro
07/12/2022	03:15 PM-03:30 PM	Introduction and presentation of the (hopefully) forthcoming IALE WORKING GROUP "Copernicus for landscape monitoring"	Jose Manuel Álvarez-Martínez
07/12/2022	03:30 PM-03:45 PM	D2_O_01. Modeling potential natural vegetation. Bringing to light an old concept to guide nature conservation in fragmented and degraded landscapes	Axel Bourdouxhe
07/12/2022	03:45 PM-04:00 PM	D2_O_02. Habitat classification and Connectivity-Functionality analysis along the European Green Belt using high-resolution satellite imagery	Stefan Fuchs
07/12/2022	04:00 PM-04:15 PM	D2_O_03. Challenges of using the LANDIS-II model for biodiversity protection in forest areas	Andris Ziemelis
07/12/2022	04:15 PM-04:30 PM	D2_O_05. Incorporating remotely sensed ecosystem functioning into species distribution models: limitations, advantages and future avenues	Adrian Regos
07/12/2022	04:30 PM-04:45 PM	D2_O_06. From map to management: an integrated modelling framework to assess the conservation status of habitat types at a large scale	Jose Manuel Álvarez-Martínez
07/12/2022	05:00 PM-07:00 PM	<i>General Assembly IALE-Europe</i>	

### Education in landscape ecology

07/13/2022	10:15 AM-11:45 AM	<b>Symposium E2. Teaching and learning landscape ecology and planning in times of growing uncertainties. Challenges ahead during and after the COVID-19 pandemic</b>	Veerle Van Eetvelde; Werner Rolf; Camila Gomes Sant Anna
07/13/2022	10:15 AM-10:30 AM	<i>Introduction</i>	Veerle Van Eetvelde; Werner Rolf; Camila Gomes Sant Anna
07/13/2022	10:30 AM-10:45 AM	E2_O_01. "Imagine the Landscape" – Challenges of Online Teaching and Learning of Landscape	Iwona Markuszewska
07/13/2022	10:45 AM-11:00 AM	E2_O_03. Potentials of the flipped classroom approach for landscape education – experiences beyond COVID-19	Isabel Loupa-Ramos
07/13/2022	11:00 AM-11:15 AM	E2_O_02. Transdisciplinary and Participatory Learning and Research Approach for food system resilience AESOP4Food: Sustainable Food Planning Seminar and a Food Loop Living lab in Warsaw	Roxana Maria Triboi
07/13/2022	11:15 AM-11:22 AM	E2_P_01. How can the universities' campuses support an interdisciplinary landscape ecology education? Lessons learned from the American University of Beirut	Beata Dreksler



07/13/2022	11:22 AM-11:45 AM	<i>Discussion, reflections and further experiences</i>	Veerle Van Eetvelde; Werner Rolf; Camila Gomes Sant Anna
<b>Planning future landscapes</b>			
07/13/2022	10:15 AM-01:30 PM	<b>Symposium F1. Future landscape development: forecast, visions and scenarios</b>	Michał Sobala; Urszula Myga-Piątek; Katarzyna Pukowiec-Kurda; Anna Żemła-Siesicka
07/13/2022	10:15 AM-10:25 AM	<i>Introduction</i>	
07/13/2022	10:25 AM-10:45 AM	F1_O_06. Forecast cultural landscape development. Theoretical considerations between visions and scenarios	Urszula Myga-Piątek
07/13/2022	10:45 AM-11:05 AM	F1_O_08. The geography of megatrends affecting European agriculture	Niels Debonne
07/13/2022	11:05 AM-11:25 AM	F1_O_05. Combining models with socio-ecological studies for understanding the future of agricultural landscapes in Central Europe, and options for NBS implementations.	Kinga Krauze
07/13/2022	11:25 AM-11:45 AM	F1_O_04. Impacts of climate change on extent of tree crop plantations in Southeast Asia	Jonas Appelt
07/13/2022	11:45 AM-12:00 PM	<i>Short Break</i>	
07/13/2022	12:00 PM-12:20 PM	F1_O_02. Landscape changes and its driving forces in three Lower Silesian communes – Jelenia Góra, Mysłakowice and Kąty Wrocławskie in Poland – current trends and future projections	Monika Lebiedzińska
07/13/2022	12:20 PM-12:40 PM	F1_O_01. Filling a gap in Douro protected areas network. An opportunity for the creation of the Lower Sabor Natural Regional Park	Cláudia Fernandes
07/13/2022	12:40 PM-01:00 PM	F1_O_07. Eco-revitalization - innovative and ecological aspects of revitalization projects on the example of Łódź	Rafał Michaś
07/13/2022	01:00 PM-01:20 PM	F1_O_09. Evolution of archaeological landscape in Poland – the past, present and future change	Anna Żemła-Siesicka
07/13/2022	01:20 PM-01:30 PM	<i>Discussion</i>	
<b>Urban and peri-urban landscapes</b>			
07/13/2022	10:15 AM-01:30 PM	<b>Symposium U2. Governance mixes for sustainable peri-urbanization: how can landscape ecology contribute?</b>	Marcin Spyra; Chiara Cortinovis; Silvia Ronchi
07/13/2022	10:15 AM-10:30 AM	<i>Introduction</i>	Marcin Spyra; Chiara Cortinovis; Silvia Ronchi
07/13/2022	10:30 AM-10:45 AM	U2_O_05. Governance mixes for sustainable peri-urban landscapes: an analyse of international policy approaches using a survey of practices.	Marcin Spyra
07/13/2022	10:45 AM-11:00 AM	U2_O_01. Identifying and regulating peri-urban areas by a landscape planning approach. The case study of Turin (Italy)	Enrico Gottero
07/13/2022	11:00 AM-11:15 AM	U2_O_08. Urban and peri-urban shapes for sustainable governance	Chiara Di Dato
07/13/2022	11:15 AM-11:30 AM	U2_O_07. Landscape quality and ecology of perception The improvement of the built environment and urban settlement in mountain areas	Camilla Sette



07/13/2022	11:30 AM-11:45 AM	Q&A	Chiara Cortinovis; Dr. Marcin Spyra; Silvia Ronchi
07/13/2022	11:45 AM-12:00 PM	<i>Short Break</i>	
07/13/2022	12:00 PM-12:15 PM	U2_O_02. Governance and actor mix shapes the pathway to sustainable agriculture in a Dutch peri-urban region	Nynke Schulp
07/13/2022	12:15 PM-12:30 PM	[cancelled] U2_O_10. Investigating people's agency as an essential component for sustainable development of multifunctional landscapes	
07/13/2022	12:30 PM-12:45 PM	U2_O_03. Enhancing urban resilience to flood risk through nature-based solutions in peri-urban ecosystems: the case of Mexico City	Gloria Soto-Montes-de-Oca
07/13/2022	12:45 PM-01:00 PM	U2_O_09. Re-Planning of green infrastructure and nature-based solutions for sustainable urban transition	Sigvard Bast
07/13/2022	01:00 PM-01:15 PM	Q&A	Chiara Cortinovis; Marcin Spyra; Silvia Ronchi
07/13/2022	01:15 PM-01:30 PM	<i>Wrap-up</i>	Marcin Spyra; Chiara Cortinovis; Silvia Ronchi

### Learning from data

07/13/2022	12:00 PM-01:30 PM	<b>Symposium D1. Big data science in social-ecological systems towards sustainable landscape management</b>	Martin Schultze; Evelyn Asante Yeboah; Praveen Kumar; Christine Fürst
07/13/2022	12:00 PM-12:05 PM	<i>Introduction</i>	Martin Schultze
07/13/2022	12:05 PM-12:15 PM	D1_O_01. Problems with Spatial Big Data processing on the example of physico-geographical regionalisation of the Wielkopolskie Voivodeship	Witold Piniarski
07/13/2022	12:15 PM-12:30 PM	D1_O_05. Assessing the potential of machine learning for developing landscape typologies	Adrienne Grêt-Regamey
07/13/2022	12:30 PM-12:45 PM	D1_O_03. Assessing climate change vulnerability of mapped socio-ecological systems in the Central Himalaya	Praveen Kumar
07/13/2022	12:45 PM-01:00 PM	D1_O_04. The impact of land-use/land-cover changes driven by socio-economic factors on the provision of ecosystem services in south-western Ghana using a stakeholder-based modelling approach	Evelyn Asante Yeboah
07/13/2022	01:00 PM-01:10 PM	D1_O_06. Agricultural landscape change impact on the quality of land in areas of gain and displacement	Felicia Akinyemi
07/13/2022	01:10 PM-01:25 PM	D1_O_02. Using social media review data to assess cultural ecosystem services of green infrastructure in metropolitan areas of Germany and China	Christin Busch
07/13/2022	01:25 PM-01:30 PM	<i>Conclusion</i>	Martin Schultze
07/13/2022	12:00 PM-05:45 PM	<b>Symposium D3. Earth Observation (EO) for ecosystem services monitoring</b>	Edyta Woźniak; Ioannis Manakos; Lluís Pesquer; Carmela Marangi
07/13/2022	12:00 PM-12:15 PM	D3_O_09. Spatio-temporal analysis of Ecosystem Functional Types in relation to land cover changes	Lluís Pesquer
07/13/2022	12:15 PM-12:30 PM	D3_O_08. Mapping Ecosystem Functional Types in central Africa using radar Sentinel-1 data	Małgorzata Jenerowicz-Sanikowska

07/13/2022	12:30 PM-12:45 PM	D3_O_07. Quantification of evapotranspiration and cooling function of vegetation using remote sensing	Tereza Nováková
07/13/2022	12:45 PM-01:00 PM	D3_O_14. The use of hyperspectral and LIDAR data obtained from the aerial ceiling and the UAV platform for the hydromorphological characterization of European rivers, on the scale of the watercourse section	Paweł Sudra
07/13/2022	01:00 PM-01:15 PM	D3_O_01. Correlation of the flooding regime with the presence of <i>Solidago gigantea</i> over the valley of Narew in Poland	Piotr Archiciński
07/13/2022	01:15 PM-01:30 PM	<i>Summary discussion</i>	
07/13/2022	01:30 PM-02:30 PM	<i>Lunch Break</i>	
07/13/2022	02:30 PM-02:45 PM	D3_O_10. Exploring the environmental drivers of high-latitude wildfires	Gabriele Vissio
07/13/2022	02:45 PM-03:00 PM	D3_O_06. Developing a spatially explicit, nation-wide habitat map: Challenges, data and methods	Bronwyn Price
07/13/2022	03:00 PM-03:15 PM	D3_O_13. Quality control of Copernicus High Resolution Layers for monitoring agricultural landscapes and wetlands	Wendy Fjellstad
07/13/2022	03:15 PM-03:30 PM	D3_O_11. The role of recent (1985–2014) patterns of land abandonment and environmental factors in forest establishment and growth of secondary forest the Iberian Peninsula	Joan Pino
07/13/2022	03:30 PM-03:45 PM	D3_O_15. EcoSystem Integrity – Sensor /EO-Service (ESIS) for monitoring bio- and geodiversity and social-ecological systems by spectral traits, remote sensing and data science approaches	Angela Lausch
07/13/2022	03:45 PM-04:00 PM	<i>Summary discussion</i>	
07/13/2022	04:00 PM-04:15 PM	<i>Short Break</i>	
07/13/2022	04:15 PM-04:30 PM	D3_O_03. The role of urban habitat continuity and landscape structure on informal greenspace floristical diversity	Piotr Archiciński
07/13/2022	04:30 PM-04:45 PM	D3_O_04. LIDAR, spectral and self-employed data fusion for cultural ecosystem services assessment in urban green spaces	Edyta Wozniak
07/13/2022	04:45 PM-05:00 PM	D3_O_05. Monitoring of the delivery of recreational ecosystem services based on participatory and satellite observations in the Great Masurian Lakes (Poland)	Marek Ruciński
07/13/2022	05:00 PM-05:15 PM	D3_O_02. Fast Visualization and Analytical Operations on the web to Support Ecosystem Services	Alaitz Zabala Torres
07/13/2022	05:15 PM-05:30 PM	D3_O_12. Landscape–seascape dynamics in the Arctic geography and ecology	Wiesław Ziaja
07/13/2022	05:30 PM-05:45 PM	<i>Summary discussion</i>	

### Learning from past landscapes

07/13/2022	12:00 PM-05:45 PM	<b>Symposium H3: The past as a source of knowledge, experience and a cause of change</b>	Michał Słowiński
07/13/2022	12:00 PM-12:15 PM	<i>Introduction</i>	Michał Słowiński
07/13/2022	12:15 PM-12:30 PM	H3_O_06. Forests of the Eemian Interglacial and their climate-driven changes with no human interference	Irena Pidek
07/13/2022	12:30 PM-12:45 PM	H3_O_10. Pleistocene landscape history of the Middle Dnieper River Valley (Ukraine) based on loess cover studies	Przemysław Mroczek
07/13/2022	12:45 PM-01:00 PM	H3_O_04. The use of the chosen soil characteristics in getting to know palaeoenvironment and paleolandscape	Marek Degorski

07/13/2022	01:00 PM-01:15 PM	H3_O_09. From Floodplain to Repetitive Flood Area: Landscape Change of the Floodplain in the Lower Yom River Basin in Kong sub-district, Thailand	Pakkasem Tongchai
07/13/2022	01:15 PM-01:30 PM	<i>Discussion</i>	
07/13/2022	01:30 PM-02:30 PM	<i>Lunch Break</i>	
07/13/2022	02:30 PM-02:45 PM	[cancelled] H3_O_03. Settlement relocation after flooding: how long do people remember the disaster?	
07/13/2022	02:45 PM-03:00 PM	H3_O_05. Indicators and drivers of changes in Slovak agricultural landscape	Jana Špulerová
07/13/2022	03:00 PM-03:15 PM	H3_O_07. Landscape Change Experiences in an Inner-German Border Area (Eichsfeld) using Historical Maps – between Division and Reunification and Future Tasks	Marco Neubert
07/13/2022	03:15 PM-03:30 PM	H3_O_08. Livestock grazing in temperate forests revisited – what does science know and what can be learnt from historical literature?	Kinga Öllerer
07/13/2022	03:30 PM-03:45 PM	H3_O_11. Landscape monitoring of large protected areas in Czechia	Tomáš Janík
07/13/2022	03:45 PM-04:00 PM	[cancelled] H3_O_15. Oral histories identify changing patterns of biocultural diversity and human-nature connectedness in protected areas over time	Miguel Ángel Cebrián-Piqueras
07/13/2022	04:00 PM-04:15 PM	<i>Short Break</i>	
07/13/2022	04:15 PM-04:30 PM	H3_O_12. Exploring how socioeconomic systems affect vegetation: the case of the summit forest of Gran Canaria (Spain) during the XX century	Aarón M. Santana-Cordero
07/13/2022	04:45 PM-05:00 PM	H3_O_14. Charcoal production in medieval central Europe and its environmental consequences	Michał Słowiński
07/13/2022	05:00 PM-05:15 PM	H3_O_13. Signals from the past: Preliminary evidence on the role of ancient and historical landscape changes on population genetic structure of Macedonian oak ( <i>Quercus trojana</i> Webb.) in Puglia (Italy)	Paola Mairota
07/13/2022	05:15 PM-05:30 PM	H3_O_01. Long-term, country level assessment of semi-natural and secondary forest cover change in Hungary	Marianna Biró
07/13/2022	05:30 PM-05:45 PM	<i>Summary discussion</i>	

### Agricultural and productive landscapes

07/13/2022	12:00 PM-01:30 PM	<b>Symposium A3. Defining a safe operating space for the future development of European agricultural landscapes</b>	Felix Herzog; Florian Danzinger; Peter Zander; Johannes Schuler
07/13/2022	12:00 PM-12:15 PM	A3_O_01. Participatory scenario design for ecosystem services and biodiversity modelling at landscape level	Martin Schönhart
07/13/2022	12:15 PM-12:30 PM	A3_O_02. Co-designing ecologically and economically efficient measures for conserving farmland biodiversity at landscape level	Anna Cord
07/13/2022	12:30 PM-12:45 PM	A3_O_03. Agricultural life cycle assessment for spatially explicit biodiversity modelling	Noëlle Klein
07/13/2022	12:45 PM-01:00 PM	A3_O_04. Thresholds for sustainable soil management based on ecosystem services	Bastian Steinhoff-Knopp
07/13/2022	01:00 PM-01:15 PM	A3_O_05. Navigating trade-offs in future European agricultural landscapes	Peter Verburg
07/13/2022	01:15 PM-01:30 PM	<i>Summary discussion</i>	
07/13/2022	01:30 PM-02:30 PM	<i>Lunch break</i>	

### Learning from nature

07/13/2022	02:30 PM-05:30 PM	<b>Symposium N3. 'Half Europe': where and how can biodiversity conservation be achieved in the Anthropocene?</b>	Emilio Padoa Schioppa; Claudia Canedoli; Ioannis Vogiatzakis
07/13/2022	02:30 PM-02:45 PM	<i>Introduction</i>	
07/13/2022	02:45 PM-03:00 PM	N3_O_01. Wilderness vs. Culturalness: opposing concepts or complementary schemes?	Panayotis Dimopoulos
07/13/2022	03:00 PM-03:15 PM	N3_O_03. Valuing ecosystem services and biodiversity in natural protected areas: the case study of the Gran Paradiso National (Italy)	Emilio Padoa Schioppa
07/13/2022	03:15 PM-03:30 PM	N3_O_04. Soil biodiversity conservation: evaluation of the alpine edaphic soil fauna using eDNA metabarcoding	Noemi Rota
07/13/2022	03:30 PM-03:45 PM	N3_O_05. Positive and negative ecological aspects of the current Spitsbergen landscape development	Wiesław Ziąja
07/13/2022	03:45 PM-04:00 PM	N3_O_06. Adequacy and Effectiveness of the Natura 2000 network in Cyprus	Ioannis Vogiatzakis
07/13/2022	04:00 PM-04:15 PM	<i>Short Break</i>	
07/13/2022	04:15 PM-04:30 PM	N3_O_07. The Potential of Natura 2000 and Area-based Conservation for Enhancing Functional Farmland Biodiversity	Francesca Falco
07/13/2022	04:30 PM-04:45 PM	N3_O_09. Valuation of ecosystem services at the landscape level for spatial planning	Małgorzata Stępniewska
07/13/2022	04:45 PM-05:00 PM	N3_O_12. If other animals can define the countryside, are they "nature"?	Aleksandra Ćwik-Mohanty
07/13/2022	05:00 PM-05:30 PM	<i>Discussion of the session</i>	

### Planning future landscapes

07/13/2022	02:30 PM-05:45 PM	<b>Symposium F2. Planning and policy approaches for future landscapes: learning from past experiences to develop novel pathways [part 1]</b>	Simona R. Grădinaru; Anna M. Hersperger; Beatriz Pierri Daunt
07/13/2022	02:30 PM-02:45 PM	<i>Introduction</i>	Simona R. Grădinaru; Anna M. Hersperger; Beatriz Pierri Daunt
07/13/2022	02:45 PM-03:00 PM	F2_O_03. Building on the past planning concepts and experiences – making the future of resilient city. Green Infrastructure implementation in Warsaw.	Gabriela Maksymiuk
07/13/2022	03:00 PM-03:15 PM	F2_O_06. Collaborative planning as a landscape approach. Experiences and insights from experimental rural landscape projects in Denmark	Jorgen Primdahl
07/13/2022	03:15 PM-03:30 PM	F2_O_07. Towards a 'glorious moment' policy approach? What we can learn from the Multiple Streams Framework for achieving sustainable landscapes	Gerd Lintz
07/13/2022	03:45 PM-04:00 PM	F2_O_09. Towards transformative landscape planning for people and nature: a critical reflection	Christian Albert
07/13/2022	04:00 PM-04:15 PM	<i>Short Break</i>	
07/13/2022	04:15 PM-04:30 PM	F2_O_11. A comparative analysis of the evolution of landscape protection system in Apulia (IT) and Wallonia (BE)	Lauriano Pepe
07/13/2022	04:30 PM-04:45 PM	F2_O_13. The role of the national urban agenda in Brazilian State capitals: a socioeconomic and land change assessment	Beatriz Pierri Daunt

07/13/2022	04:45 PM-05:00 PM	F2_O_17. Hidden incentives and impacts of land policies - the case of the Czech land value capture model	Eliška Vejchodská
07/13/2022	05:00 PM-05:15 PM	F2_O_24. Gaps in Mine Closure policies in India as per pillars of Just Transition	Amrita Slatch
07/13/2022	05:15 PM-05:30 PM	F2_O_05. Wind energy and landscapes – challenges in applying multi-criteria analysis for planning support	Deepa Manolan Kandy
07/13/2022	05:30 PM-05:45 PM	<i>Discussions</i>	

### Agricultural and productive landscapes

07/13/2022	02:30 PM-05:45 PM	<b>Symposium A1. Finding future pathways for sustainable agricultural landscapes in Europe: concepts and empirical evidence in different European contexts [part 1]</b>	Vasco Diogo; Felix Herzog; Teresa Pinto-Correia; Peter Verburg
07/13/2022	02:30 PM-02:35 PM	<i>Symposium opening</i>	Vasco Diogo
07/13/2022	02:35 PM-02:50 PM	A1_O_17. Conventional intensification, agroecological transition or marginalization? What are the dominant agricultural development trajectories in different landscapes across Europe	Julian Helfenstein
07/13/2022	02:50 PM-03:05 PM	A1_O_08. Mapping resources and good practices: cornerstones for a sustainable valorization of Inner Rural Areas	Rebekka Dossche
07/13/2022	03:05 PM-03:20 PM	A1_O_20. From global threat to local action - considering multiple dimensions of regionality for successful climate change adaptation	Michael Glemnitz
07/13/2022	03:20 PM-03:35 PM	A1_O_12. Could Europe achieve protein self-sufficiency by diversifying regional cropping systems with legumes?	Anne Elise Stratton
07/13/2022	03:35 PM-03:50 PM	A1_O_19. Modern agroforestry systems for biodiversity, ecosystem services and for sustainable intensification: What can we expect?	Felix Herzog
07/13/2022	03:50 PM-04:00 PM	<i>Plenary discussion</i>	
07/13/2022	04:00 PM-04:15 PM	<i>Short Break</i>	
07/13/2022	04:15 PM-04:20 PM	<i>Short introduction</i>	
07/13/2022	04:20 PM-04:35 PM	A1_O_06. Scale-dependent effectiveness of on-field vs off-field agri-environmental measures for wild bees	Péter Batáry
07/13/2022	04:35 PM-04:50 PM	A1_O_21. Weed communities are more diverse, but not more abundant, in bocage landscapes	Sébastien Boinot
07/13/2022	04:50 PM-05:05 PM	A1_O_14. Organic farming can conserve biodiversity more cost-effectively in landscape with low complexity	William Sidemo Holm
07/13/2022	05:05 PM-05:20 PM	A1_O_13. Disentangling the interrelated abiotic and biotic pathways linking landscape complexity and crop production	Frederik Gerits
07/13/2022	05:20 PM-05:35 PM	A1_O_07. Farmer clusters for Realising Agrobiodiversity Management across Ecosystems (FRAMEwork) – Experiences from the first year of the Czech Farmer Cluster	Iris C. Bohnet
07/13/2022	05:35 PM-05:45 PM	<i>Plenary discussion &amp; closing Part 1</i>	

### Policy making for European landscapes

07/13/2022	02:30 PM-05:45 PM	<b>Symposium M3. Policy making for European landscapes</b>	Agata Cieszewska; Werner Rolf; Isabel Loupa-Ramos; Veerle Van Eetvelde; Jarosław Balon; Jerzy Solon
07/13/2022	02:30 PM-02:45 PM	M3_O_09. The Soil Deal in Horizon Europe: Living labs at the landscape scale	Teresa Pinto-Correia
07/13/2022	02:45 PM-03:00 PM	M3_O_07. Green Deal and heritage protection: opportunities and threats of sustainable monument revitalisation	Ewa Mackiewicz
07/13/2022	03:00 PM-03:15 PM	M3_O_05. Does spatial planning in the Polish Carpathians make sense?	Agata Ćwik
07/13/2022	03:15 PM-03:30 PM	M3_O_08. Opportunities and barriers to implementation of the European Biodiversity Strategy 2030 - urban forest perspective	Renata Giedych
07/13/2022	03:30 PM-03:45 PM	M3_O_01. Implications of the European Green Deal on Landscapes – A Cross Country Analysis on Land Use Policies	Werner Rolf
07/13/2022	03:45 PM-04:00 PM	<i>Open discussion</i>	
07/13/2022	04:00 PM-04:15 PM	<i>Short Break</i>	
07/13/2022	04:15 PM-04:30 PM	M3_O_04. Implementation of the Council of Europe Landscape Convention in Finland: A Holistic Approach to Identify Nationally Valuable Landscape Areas	Nina Ahola
07/13/2022	04:30 PM-04:45 PM	M3_O_03. From geographical regions to local landscapes – abiotic-biotic hierarchy and human impact	Jerzy Solon
07/13/2022	04:45 PM-05:00 PM	M3_O_10. Commonness and diversity of landscape in Poland	Jarosław Balon
07/13/2022	05:00 PM-05:15 PM	M3_O_06. Landscape diversity in the Wielkopolskie voivodeship and the current as well as future directions of its protection	Sylwia Bródka
07/13/2022	05:15 PM-05:45 PM	<i>Open discussion</i>	

### Poster session II

### Agricultural and productive landscapes

07/14/2022	11:00 AM-11:45 AM	A1_P_01. Traditional Agricultural Landscapes - an opportunity for biodiversity conservation	Anca Georgiana Vasilescu
07/14/2022	11:00 AM-11:45 AM	A1_P_02. German biosphere reserves as pioneers for a sustainable agricultural land use - successful support for insect promoting measures	Gyde Petersen
07/14/2022	11:00 AM-11:45 AM	A1_P_03. Transformative learning about agrobiodiversity in a two-year participatory trajectory	Frederik Gerits
07/14/2022	11:00 AM-11:45 AM	A4_P_01. Agriculture under pressure: spatial and temporal trade-off dynamics of nature's contributions to people in peri-urban agrarian landscapes	Matteo Riva
07/14/2022	11:00 AM-11:45 AM	A4_P_02. Provisioning Services of Historic Gardens in the Iranian Urban and Peri-urban Contexts	Majid Amani-Beni

### Education in landscape ecology

07/14/2022	11:00 AM-11:45 AM	E2_P_01. How can the universities' campuses support an interdisciplinary landscape ecology education? Lessons learned from the American University of Beirut	Beata Dreksler
07/14/2022	11:00 AM-11:45 AM	E2_P_02. Small urban water bodies and the factors influencing their diversity. A case of lakes and ponds of Warsaw, Poland	Maria Zachwatowicz

### Learning from past landscapes

07/14/2022	11:00 AM-11:45 AM	H1_P_01. Water in the landscape as an indicator of changes in the Elbe River lowlands	Pavel Richter
07/14/2022	11:00 AM-11:45 AM	H1_P_02. Anthropogenic landforms as indicators of past land use in marginal mountain areas	Michał Sobala
07/14/2022	11:00 AM-11:45 AM	H1_P_03. Geotourism and Mining Tourism – an important source of sustainable development of tourism (Gemera region, Slovakia)	Daniela Hutárová
07/14/2022	11:00 AM-11:45 AM	H3_P_03. Reconstruction of the hydrographic network in Jelenia Góra Basin (SW Poland) as a tool of geohazards prediction and proper spatial planning	Iwo Wieczorek
07/14/2022	11:00 AM-11:45 AM	H3_P_04. Identification of driving forces behind landscape changes - case study of Sobótka commune in Poland	Piotr Krajewski
07/14/2022	11:00 AM-11:45 AM	H3_P_05. Landscapes of the Middle Dniester River Valley during the Gravettian and Epigravettian occupation – findings from the Doroshivtsi III camp (Ukraine)	Przemysław Mroczek
07/14/2022	11:00 AM-11:45 AM	H3_P_06. Human and climate drivers of changes in the use of peatlands throughout the 20th century in north western Poland (the Tuchola Pinewoods)	Sebastian Czapiewski
07/14/2022	11:00 AM-11:45 AM	H3_P_07. Semi-natural grasslands in the landscape of Karkonosze National Park (Poland) over 130 years, differences between modern and ancient grasslands	Hubert Kasprzak
07/14/2022	11:00 AM-11:45 AM	H3_P_08. Diversity of historical landscape structures and ways of their identification	Marketa Santruckova
07/14/2022	11:00 AM-11:45 AM	H3_P_10. A Policy Analysis on Securing Tenurial Rights over Ancestral Domain: Case of Agta-Dumagat Tribe of Polillo Islands	Leajim Villanueva
07/14/2022	11:00 AM-11:45 AM	H3_P_11. Identification of touristic routes and creation of heritage maps for the enhancement of the historical landscape. The historical landscape of the Leonardo da Vinci's Gioconda	Francesco Piras
07/14/2022	11:00 AM-11:45 AM	H3_P_12. Soil changes within the modern forest-steppe zone of Ukraine as a reflection of the evolution of landscapes in the Pleistocene and Holocene	Zhanna Matviishyna

### Policy making for European landscapes

07/14/2022	11:00 AM-11:45 AM	M3_P_01. Social awareness of food waste and evaluation of activities carried out by retail outlets on this matter, based on the example of the city of Poznań.	Milena Zięba
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### Regions in the spotlight

07/14/2022	11:00 AM-11:45 AM	R3_P_01. The Constructed Wetlands Knowledge Platform for sustainable development (CWetlandsData)	Tomasz Bergier
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### Urban and peri-urban landscapes

07/14/2022	11:00 AM-11:45 AM	<b>U1_P_01. Assessing the level of landscape change in Poland – quantitative study for districts and provinces</b>	Iga Kołodziejka
07/14/2022	11:00 AM-11:45 AM	U1_P_03. Main directions of landscape transformations in post-industrial urban areas	Katarzyna Pukowiec-Kurda
07/14/2022	11:00 AM-11:45 AM	U1_P_04. Mapping changes to functional urban green space globally	Elizabeth Schrammeijer
07/14/2022	11:00 AM-11:45 AM	U3_P_01. Visualisations as a tool in participatory processes – lessons learned from practitioners	Martina van Lierop
07/14/2022	11:00 AM-11:45 AM	U4_P_01. Pollinators of the Oriental Park of the city of Porto. Designing ecological maintenance toward biodiversity	Cláudia Oliveira Fernandes
07/14/2022	11:00 AM-11:45 AM	U4_P_04. The accessibility of public urban green areas in selected towns of the Gdańsk-Gdynia-Sopot Metropolitan Area	Barbara Korwel-Lejkowska
07/14/2022	11:45 AM-12:00 PM	<i>Short break</i>	

### Learning from nature

07/14/2022	12:00 PM-03:30 PM	<b>Symposium N8. Forest expansion, landscape dynamics and ecosystem services in Europe</b>	João Azevedo; Pinar Pamukcu Albers
07/14/2022	12:00 PM-12:15 PM	<i>Introduction</i>	João Azevedo
07/14/2022	12:15 PM-12:30 PM	N8_O_01. Forest habitat availability in Spain: recent changes and retrospective resilience assessment	Sergio González-Ávila
07/14/2022	12:30 PM-12:45 PM	N8_O_02. Forest landscape changes after deep land use and human population changes: A case study in La Rioja region (Spain)	César López-Leiva
07/14/2022	12:45 PM-01:00 PM	N8_O_03. Comparing the effect of fire management strategies on fire regulation capacity in a Mediterranean mountainous landscape undergoing farmland abandonment and climate change	Angelo Sil
07/14/2022	01:00 PM-01:15 PM	N8_O_04. Coping with fire in a Mediterranean Biosphere reserve: a multiobjective plan under uncertain future global change	Miguel Cánibe Iglesias
07/14/2022	01:15 PM-01:30 PM	N8_O_05. Review of landscape indices to assess condition and functioning of disturbed forest landscapes – the example of Tuchola Forest, northern Poland	Sanjana Dutt
07/14/2022	01:30 PM-02:30 PM	<i>Lunch Break</i>	
07/14/2022	02:30 PM-02:45 PM	N8_O_06. Towards a non-monetary valuation of forest ecosystem services at the local scale – A case study in Southern Germany	Markus Meyer
07/14/2022	02:45 PM-03:00 PM	N8_O_07. Contemporary local scale transformation on post-agricultural landscapes in Central Poland	Agnieszka Sosnowska
07/14/2022	03:00 PM-03:30 PM	<i>Debate</i>	João Azevedo



### Learning from people

07/14/2022	12:00 PM-04:00 PM	<b>Symposium P2. Approaches integrating ecosystem services and disservices in social-ecological landscapes to foster sustainability</b>	Julien Blanco
07/14/2022	12:00 PM-12:15 PM	<i>Introduction</i>	Julien Blanco
07/14/2022	12:15 PM-12:30 PM	P2_O_04. What, where, and why do residents experience in the urban riverscape? Insights from the PPGIS survey	Tomasz Grzyb
07/14/2022	12:30 PM-12:45 PM	P2_O_03. Benefits and disbenefits related to cultural ecosystem services of green spaces	Agnieszka Nowak-Olejnik
07/14/2022	12:45 PM-01:00 PM	P2_O_01. Beekeep calm and think in common: a game for the governance of floral resources use among beekeepers.	Léo Mouillard-Lample
07/14/2022	01:00 PM-01:15 PM	P2_O_02. Seeking for a sustainable fire resilient landscape at a living lab in Northern Portugal	Inês Duarte
07/14/2022	01:15 PM-01:30 PM	<i>Summary discussion</i>	
07/14/2022	01:30 PM-02:30 PM	<i>Lunch Break</i>	
07/14/2022	02:30 PM-02:45 PM	P2_O_06 Methods and indicators for evaluating ecosystem services: a need for standardization	Claudia Canedoli
07/14/2022	02:45 PM-03:00 PM	P2_O_07. Urban Waterfront: potential of landscape. Case study in Bacoli	Dora Francese
07/14/2022	03:00 PM-03:15 PM	P2_O_05. A novel cascade model for ecosystem services and disservices applied in a Brazilian working landscape	Julien Blanco
07/14/2022	03:15 PM-04:00 PM	<i>Roundtable: summary discussion &amp; perspectives</i>	

### Learning from nature

07/14/2022	12:00 PM-04:00 PM	<b>Symposium N5. Road ecology in times of rapid road construction: Recent advances and growing challenges</b>	Jochen Jaeger; Wenche Dramstad
07/14/2022	12:00 PM-12:10 PM	<i>Welcome and overview of the session</i>	Jochen Jaeger; Wenche Dramstad
07/14/2022	12:10 PM-12:30 PM	N5_O_03. No place to go: wildlife and road network in an island environment	Savvas Zotos
07/14/2022	12:30 PM-12:50 PM	N5_O_07. Incorporating the Landscape Ecological Risk Index in Assessing the Impacts of Road Networks (Case Study: Chaharmahal & Bakhtiari Province, Iran)	Shekoufeh Nematollahi
07/14/2022	12:50 PM-01:10 PM	N5_O_04. Orthopteran assemblages in a roadside habitat: adverse effects of traffic noise and vegetation height	Fran Rebrina
07/14/2022	01:10 PM-01:30 PM	N5_O_08. Effects of road lighting on insects: assessing the role of landscape and vegetation structure along roads in Norway	Ulrike Bayr
07/14/2022	01:30 PM-02:30 PM	<i>Lunch Break</i>	
07/14/2022	02:30 PM-02:50 PM	N5_O_01. Ungulates and Trains – Factors Influencing Flight Responses and Detectability	Manisha Bhardwaj
07/14/2022	02:50 PM-03:10 PM	N5_O_02. Can Acoustic Stimuli be Used to Reduce Ungulate-Train Collisions? Results of a Behavioural Experiment	Manisha Bhardwaj
07/14/2022	03:10 PM-03:30 PM	N5_O_05. Are olfactory repellents reasonable alternatives to fencing along secondary roads in prevention of ungulate-vehicle collisions?	Michal Bíl

07/14/2022	03:30 PM-03:50 PM	N5_O_06. Addressing the FLOMS trade-off: How long do wildlife fences along roads have to be to mitigate the fence-end effect?	Jochen Jaeger
07/14/2022	03:50 PM-03:55 PM	N5_P_01 Spatio-temporal distribution of wildlife–vehicle collisions in the Polish Carpathians between 2015 and 2021	Wojciech Haska
07/14/2022	03:55 PM-04:00 PM	<i>Overall discussion and conclusion</i>	

### Planning future landscapes

07/14/2022	12:00 PM-04:00 PM	<b>Symposium F2. Planning and policy approaches for future landscapes: learning from past experiences to develop novel pathways [part 2]</b>	Simona R. Grădinaru; Anna M. Hersperger; Beatriz Pierri Daunt
07/14/2022	12:00 PM-12:07 PM	F2_O_21. Is 3D urban morphology evolution associated with socio-spatial patterns? Evidence from Spanish urban areas for the past decades	Dario Domingo
07/14/2022	12:07 PM-12:22 PM	F2_O_02. An integrated assessment of ecological integrity and ecosystem services in agro-forestry landscapes	Cristian Echeverria
07/14/2022	12:22 PM-12:29 PM	F2_O_23. Mapping and classifying pervious surfaces and canopy cover through NDVI to shift towards sustainable urban planning	Anna Codemo
07/14/2022	12:29 PM-12:44 PM	F2_O_01. Rural fire prevention: an integrated landscape planning solution	Manuela Magalhães
07/14/2022	12:44 PM-12:51 PM	F2_O_20. A landscape assessment in a rural – natural region of Natura 2000 protected areas in Peloponnisos (Greece)	Ioannis P. Kokkoris
07/14/2022	12:51 PM-12:58 PM	F2_O_18. Integrating Human-Ecological dimensions into Urban Green Infrastructure Planning	Catarina Teixeira
07/14/2022	12:58 PM-01:13 PM	F2_O_12. Framing how a mountain landscape changes in the long term by focusing on layered social processes and deeper causes.	Margherita Pasquali
07/14/2022	01:13 PM-01:30 PM	F2_O_04. Actors' involvement for ecosystem-based coastal protection: a digital approach to social network analysis	Evke Schulte-Güstenberg
07/14/2022	01:30 PM-02:30 PM	<i>Lunch Break</i>	
07/14/2022	02:30 PM-02:45 PM	F2_O_16. Values of Large-versus-Small Urban Greenspaces and Their Arrangement	Richard Forman
07/14/2022	02:45 PM-02:55 PM	F2_O_19. Landscape management planning in protected areas of Lithuania: present challenges and learning from the past	Zenonas Gulbinas
07/14/2022	02:55 PM-03:10 PM	F2_O_15. Green City of the Future - Integrating Climate-Oriented Measures into Planning Processes	Simone Linke
07/14/2022	03:10 PM-03:25 PM	F2_O_10. Identification of different pathways based on flood-related challenges at different watershed scales in Germany	Pinar Pamukcu Albers
07/14/2022	03:25 PM-03:35 PM	F2_O_22. Making connections – green space accessibility as an indicator of wealth distribution	Tereza Aubrechtová
07/14/2022	03:35 PM-03:50 PM	F2_O_08. Multiple ecosystem services modelling and mapping for Friuli Venezia Giulia Region (NE-Italy) planning	Valentina Olmo
07/14/2022	03:50 PM-04:00 PM	<i>Final discussions</i>	

### Agricultural and productive landscapes

07/14/2022	12:00 PM-04:00 PM	<b>Symposium A1. Finding future pathways for sustainable agricultural landscapes in Europe: concepts and empirical evidence in different European contexts [part 2]</b>	Vasco Diogo; Felix Herzog; Teresa Pinto-Correia; Peter Verburg
07/14/2022	12:00 PM-12:05 PM	<i>Introduction Part 2</i>	
07/14/2022	12:05 PM-12:20 PM	A1_O_01. Assessing European farmers' willingness to implement biodiversity-friendly farming measures – Combining evidence from a systematic literature review and farmer interviews across Europe	Fabian Klebl
07/14/2022	12:20 PM-12:35 PM	A1_O_02. Farmer decision-making on agri-environmental schemes: An agent-based modelling approach to evaluate different policy designs	Meike Will
07/14/2022	12:35 PM-12:50 PM	A1_O_09. Cooperative versus non-cooperative behaviour: Using agent-based modelling to identify spatial supply-demand mismatches of ecosystem services and to coordinate conflicting actors' demands	Mostafa Shaaban
07/14/2022	12:50 PM-01:05 PM	A1_O_03. A typology of agricultural land systems to facilitate targeted action for farmland biodiversity enhancement in Germany	Martin Pingel
07/14/2022	01:05 PM-01:20 PM	A1_O_10. Farming System Archetypes for modelling impacts of agricultural policies	Tomas Vaclavik
07/14/2022	01:20 PM-01:30 PM	<i>Plenary discussion</i>	
07/14/2022	01:30 PM-02:30 PM	<i>Lunch break</i>	
07/14/2022	02:30 PM-02:35 PM	<i>Short introduction</i>	
07/14/2022	02:35 PM-02:50 PM	A1_O_18. Understanding' of the agriculturally shaped environment as an important factor for sustainable development in rural areas	Judith-Maria Maruschke
07/14/2022	02:50 PM-03:05 PM	A1_O_15. Building a shared vision for the future of multifunctional agricultural landscapes. Lessons from a Long Term Socio-Ecological Research site in South Western France	Annie Quin
07/14/2022	03:05 PM-03:20 PM	A1_O_04. Collaborative landscape planning in a changing world. Managing conflicts and making places in a Danish River Valley	Lotte Ruegaard Petersen
07/14/2022	03:20 PM-03:35 PM	A1_O_05. Landscape labs approach for co-designing insect-friendly agricultural landscapes	Maria Busse
07/14/2022	03:35 PM-03:50 PM	A1_O_11. The Art of Blue-Green Alliances. Co-creating sustainable agricultural landscapes	Sylvie Fosselle
07/14/2022	03:50 PM-04:00 PM	<i>Plenary discussion &amp; closing symposium</i>	

### Urban and peri-urban landscapes

07/14/2022	12:00 PM-04:00 PM	<b>Symposium U4. Multiple perspectives on Green infrastructure and Nature-Based Solutions</b>	Werner Rolf; Isabel Loupa-Ramos
07/14/2022	12:00 PM-12:05 PM	<i>Introduction</i>	Werner Rolf; Isabel Loupa-Ramos
07/14/2022	12:05 PM-12:25 PM	U4_O_01. What is the effect of cultural greenway project in high-density urban municipalities? Assessing the public living desire near the cultural greenway in central Beijing	Haiyun Xu
07/14/2022	12:25 PM-12:45 PM	U4_O_04. Warsaw vernacular front gardens as a missing suburban public space	Beata Gawryszewska
07/14/2022	12:45 PM-01:05 PM	U4_O_09. Social aspects of pro-environmental technologies in Polish suburbs	Jadwiga Biegańska

07/14/2022	01:05 PM-01:25 PM	[cancelled] U4_O_10. Investigating the long-term spatio-temporal relationships between urban heat island and landcover: a case study of Kyiv, Ukraine	Daria Svidzinska
07/14/2022	01:25 PM-01:30 PM	<i>Sum Up and Outlook</i>	
07/14/2022	01:30 PM-02:30 PM	<i>Lunch Break</i>	
07/14/2022	02:30 PM-02:35 PM	<i>Introduction</i>	Werner Rolf; Isabel Loupa-Ramos
07/14/2022	02:35 PM-02:55 PM	U4_O_07. Enhancing green infrastructure networks through nature-based solutions: an assessment of challenges and opportunities in a high-density urban area	Mario Balzan
07/14/2022	02:55 PM-03:15 PM	U4_O_03. Fostering the Resiliency of Urban Landscape through the Sustainable Spatial Planning of Green Spaces	Donatella Valente
07/14/2022	03:15 PM-03:35 PM	U4_O_08. Keyline planning and its potential adoption in water sensitive urban design and planning	Kaan Ozgun
07/14/2022	03:35 PM-03:55 PM	U4_O_05. Targeting planners. A toolbox for the assessment of Ecosystem Services within the planning of green infrastructure	Harald Zepp
07/14/2022	03:55 PM-04:00 PM	<i>Sum Up and Outlook</i>	

### Plenary session

07/14/2022	04:15 PM-04:45 PM	<b>KEYNOTE:</b> Designing Symbiosis	Richard Weller
07/14/2022	04:45 PM-05:15 PM	<i>Closing of the Congress</i>	Veerle Van Eetvelde; Andrzej Affek

### Short course/ workshop

07/15/2022	10:30 AM-02:30 PM	Towards a dynamic assessment of biodiversity patterns: from in situ data to Copernicus services	
07/15/2022	03:00 PM-06:00 PM	Developing a farmland biodiversity indicator for Europe ...and beyond?	