



IALE 2025
European Landscape Ecology Congress
Landscape Perspectives in a Rapidly Changing World

Bratislava, Slovakia
September 2-5, 2025

Book of Abstracts



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Editors:

Juraj Lieskovský, Zuzana Baránková, Viktória Miklósová, Hubert Hilbert, Zuzana Ponecová



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PREFACE

The IALE 2025 European Landscape Ecology Congress, titled “*Landscape Perspectives in a Rapidly Changing World*,” was held from September 1–5, 2025, on the premises of the Faculty of Natural Sciences, Comenius University in Bratislava. The Congress was organized by the Institute of Landscape Ecology of the Slovak Academy of Sciences, in cooperation with the Faculty of Natural Sciences of Comenius University, IALE-Europe, Czech Society for Landscape Ecology (IALE-CZ), and Mendel University in Brno. Patronage over the Congress was granted by Mr. Juraj Droba, Chairman of the Bratislava Self-Governing Region, and Mr. Matúš Vallo, Mayor of the City of Bratislava.

The thematic framework of the Congress reflected the current rapid developments and changes in all areas of human activity, which have brought new challenges for landscape ecology—including the implementation of new technologies and the growing role of artificial intelligence in addressing landscape-ecological topics. At the same time, it emphasized opportunities for applying this knowledge in a dynamically changing world and highlighted its potential impact on the future development and sustainability of landscape-ecological research.

The IALE 2025 European Congress welcomed **428 participants from 36 countries**, including researchers and PhD students. The scientific program spanned three days of lectures held in two auditoriums and five lecture halls. The program featured **323 oral presentations, 96 poster presentations, and 3 keynote lectures** delivered by distinguished scholars: Prof. Naomi Millner, Prof. László Miklós and Prof. Marc Metzger.

Scientific sessions were divided into 39 sessions within four main themes:

1. Understanding ongoing and emergent drivers and pressures of landscape change
2. Monitoring landscape conditions and impacts of landscape change
3. Responding to changing landscapes
4. Advancing with new data, tools, and methods in landscape ecology

One congress day was devoted to excursions to Western Slovakia, Central Slovakia, and South Moravia, exploring floodplains, protected areas, cultural landscapes, agricultural regions, urban environments, and historic towns. The trips combined expert lectures with direct field experiences, offering insights into conservation, sustainable management, landscape history, and ongoing challenges such as climate change and invasive species. Each excursion also provided cultural highlights — from folklore traditions to panoramic views and historical heritage — making them both scientifically enriching and memorable experiences.

Participants enjoyed a joint gathering at the DoubleTree by Hilton Hotel in Bratislava, featuring a festive dinner accompanied by a rich cultural program, including performances of Slovak folk traditions by the Karpaty Folklore Ensemble and musical numbers by the women’s vocal group LES SIRÈNES. The performances created a unique atmosphere and actively engaged the audience.

As part of the scientific program, competitions were organized to recognize outstanding contributions. The **poster competition** was won by Anna Kowalska, Ewa Kołaczowska, Edyta Regulska, Jacek Wolski, Zofia Jabs-Sobocińska, Martyna Zarzycka, Bożena Omeliańska, Piotr Sikorski, and Andrzej Affek for their poster *“Assessing Ecosystem Condition and Service Potential under Goldenrod Invasion: Methods and Indicators for a Multifaceted Approach”*.

The **PhD presentation competition** was won by Das Agnish Kumar for his presentation entitled *“Simulating the Increasing Role of Drought as a Trigger for Bark Beetle Outbreaks and Its Potential to Transform Central European Forests under Climate Change”*.

The Congress concluded with final remarks by Ľuboš Halada, Director of the Institute of Landscape Ecology SAS, Veerle van Eetvelde, President of IALE-Europe and Werner Rolf, Communications Manager of IALE-Europe. Reflections and impressions from participants were also shared, adding a personal dimension to the closing ceremony. Following the Congress, the **IALE 2025 PhD Course** was held under the coordination of IALE-Europe in Lednice, South Moravia.

We gratefully acknowledge the support of our partner institutions that contributed to organizing the conference.

Finally, we would like to express our sincere gratitude to all partners and colleagues who have contributed — both, visibly and behind the scenes — to the organization of IALE 2025 European Congress. We extend our sincere thanks to the plenary speakers, symposium chairs, presenters, members of the Scientific Board who took important decisions in preparatory phase of the Congress, as well as to our colleagues from the Organizing Committee for their dedication and efforts in ensuring the success of the Congress.

Above all, we thank the participants for their inspiring presentations, active involvement, and valuable discussions, which made the IALE 2025 European Congress a smooth, coherent, and truly memorable experience. Thank you all for coming to Bratislava.

We look forward to meeting again at the next IALE Congress that will take place on **November 8–12, 2027**, in **Valparaíso and Viña del Mar, Chile**.

Viktória Miklósová and Ľuboš Halada

On behalf of the Organising Committee and the Scientific Committee

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Keynote presentations

The landscape ecology in Slovakia, the ILE SAS and the IALE - reminiscences and associations

László Miklós

Professor of Landscape Ecology/ Institute of Landscape Ecology of the Slovak Academy of Sciences, Slovakia

The evolution of landscape ecology in Slovakia emerged through the integration of various disciplines such as geobotany, complex physical geography, geosciences, landscape science, and landscape biology. A major milestone was the establishment of the Institute of Landscape Biology at the Slovak Academy of Sciences (SAS) in 1965. From the beginning, the Institute addressed emerging environmental issues and became a strong counterpart to existing biological and geographical institutions.

Crucial debates followed regarding the definition of “landscape,” the qualifications of a landscape ecologist, the roles of individual disciplines, and the division of competencies among scientific institutions. The field's development was significantly shaped by Soviet and German landscape-ecological schools, with less influence from Western Europe. A strong focus on applied research helped distinguish Slovak landscape ecology from other related fields.

International symposia on landscape research, organized every three years, greatly contributed to the discipline's visibility and cohesion. Prof. Milan Ružička played a pivotal role in this effort, which culminated in the founding of IALE during the 6th International Symposium in Piešťany in 1982.

Subsequent development in Slovakia was driven by several key methodological frameworks: landscape-ecological planning (LANDEP), the Territorial System of Ecological Stability (ÚSES), the concept of ecological carrying capacity, and the improvement of methods for studying individual components of the landscape. Cooperation with planning institutions ensured that landscape-ecological approaches were integrated into numerous spatial and agricultural planning projects.

In the past two decades, the discipline has been further shaped by the adoption of new technologies, including GIS, computer modeling, and remote sensing. These tools have enabled the development of landscape atlases, the study of historical landscape structures, and the automation of research methods. International cooperation and participation in large-scale projects continue to play a crucial role in the advancement of landscape ecology in Slovakia.



Professor László Miklós

László Miklós is a prominent Slovak landscape ecologist and geographer. Since 1973, he has been a scientific researcher at the Institute of Landscape Ecology of the Slovak Academy of Sciences. He also served as a professor at the Technical University in Zvolen until his retirement. Over the course of his career, László has co-authored more than 200 academic papers, with his research primarily focused on landscape as a geosystem, slope dynamics, ecological networks, landscape

planning and the theory and methodology of landscape ecology. In addition to his academic contributions, Miklós has taught at various universities in Slovakia and internationally, including Roskilde University Centre, Universität für Bodenkultur in Vienna, Technische Universität Wien, and Szent István University in Gödöllő. Miklós has also held several key governmental roles. He served as Deputy Minister of the Ministry of Environment, Minister of Environment, and as a member of the Slovak Parliament. His research has been effectively applied in shaping environmental policy, legislation, and planning processes in Slovakia. His influential work has earned him numerous prestigious awards, further underscoring his impact on landscape ecology, environmental policy, and education both in Slovakia and internationally.

Landscape Ecology, an undiscipline?

Marc Metzger

Professor of Environment and Society/ The University of Edinburgh, United Kingdom

Once the disruptive new kid on the block, landscape ecology is now an established discipline, with IALE as its worldwide organisation, dedicated journals, university courses, and professional jobs. Wonderful! But has landscape ecology lost some of its edge by becoming mainstream? Considering the urgent wicked problems facing our rapidly changing world, should landscape ecology more boldly position itself as different from traditional academic disciplines? An undiscipline perhaps? In my keynote I'll argue that landscape ecology should embrace undisciplinarity, using a diverse methods, collaborative interpersonal skills, and creativity to find solutions to the interactive and emergent landscape scale challenges we face.





Professor Marc Metzger

Marc is an interdisciplinary professor of environment and society at the University of Edinburgh. Over the last 20 years he has contributed to a wide range of interdisciplinary projects focusing on the potential impacts of global environmental change on ecosystems and the services they provide to society. Initial work focused on mapping the vulnerability ecosystem services to global change. This sparked an interest in scenario development and stakeholder engagement, and understanding normative visions of sustainable land use. His recent work

focuses on transdisciplinary collaborations with non-academic partners, aiming for useful and usable insight that can be used to support sustainable land management. Marc has co-authored over 100 academic papers, mostly focused on aspects of sustainable land use, ecosystem services and natural capital in the context of the global change challenges. He is director of the University of Edinburgh Centre for Sustainable Forests and Landscapes, chairs the UK National Committee for UNESCO's Man and the Biosphere Programme, and is president of Landscape Ecology UK, the UK region of IALE.

Pump up the volume: Integrating verticality and power relations into the analysis of conservation landscapes — in dialogue with Political Ecology

Naomi Millner

Professor of Environment and Culture/ The University of Bristol, United Kingdom

This talk embarks on a journey from drones above tropical forests to the depths of peaty soils to argue for the integration of critical awareness of “verticality” (spatial height and depth) and power relations into the analysis of conservation landscapes. Drawing on concepts and perspectives from political ecology – an interdisciplinary subfield that shares many common interests with landscape ecology – I delve into three grounded case studies from my research to show what these conceptual lenses afford, and how they can be achieved through interdisciplinary agenda-setting. The talk has three sections: (1) Eyes in the Sky: In Central American forests, drones now monitor wildlife and encroachment in protected areas. I share findings on how these unoccupied aerial vehicles come with dual potential: enabling finer-scale habitat data, more effective community management, and anti-poaching patrols, but also raising concerns of surveillance over local communities. I recount collaborative projects in which Indigenous Peoples and Local Communities (IPLC) operated drones themselves, capturing multi-layer imagery (canopy health, human activity) that improved trust and effectiveness of conservation monitoring – providing a model for incorporating new technologies without “top-down” imposition. (2) Subterranean depths: In the low Amazon and high Andes of Colombia and Perú, recent discoveries of extensive peat deposits have radically altered landscape conservation priorities. I explore how engaging with Indigenous and Environmental Knowledge of peatlands that uses other categories can enrich developing peatland governance frameworks that seek to conserve carbon deposits, raising wider questions of “whose knowledge counts” when it comes to conservation priorities. (3) Community Ecologies: Drawing from my co-authored book *All We Want is the Earth* (2023), I zoom out from these case studies to consider how and why environmental management approaches can become flattened over time, reflecting the priorities of particular groups or neo-colonial forms of spatial discipline. Bringing the three threads together I suggest eight insights from political ecology that could strengthen critical approaches to volume and power in landscape ecology approaches which aspire towards just and sustainable solutions.



Professor Naomi Millner

Prof. Naomi Millner is a professor of Environment and Culture at the University of Bristol whose work explores the social, cultural, and political dimensions of conservation, land governance, and climate mitigation. She is particularly interested in how transnational environmental policies shape landscapes and livelihoods, and how they intersect with Indigenous and local knowledge systems. Naomi has led multiple international, interdisciplinary research projects, including her current ERC-funded PEATSENSE project, which investigates how climate

policies privileging carbon imaginaries are transforming global peatland ecologies in peatlands. Her research focuses on conservation areas in Latin America, with an emphasis on (1) the ways that climate governance agendas are reshaping priorities for land use and monitoring, and (2) the ways that conservation monitoring technologies — including drones and LiDAR — reshape landscapes, often in ways that both enable and constrain the agency of Indigenous Peoples and Local Communities (IPLC). Naomi collaborates widely with biophysical and ecological scientists, policymakers, and IPLC and their organisations, integrating participatory and ethnographic methods to co-produce knowledge that supports more inclusive and just environmental governance. Alongside her academic research, Naomi is also an award-winning author, a community gardener, and an advocate for storytelling in a variety of modalities as a mode of knowledge transmission and political engagement.

Theme 1. Understanding ongoing and emergent drivers and pressures of landscape change

Change is inherent to landscapes, either gradual or sudden. Some landscapes are more characterised by continuity and persistence. Yet, what drives these changes and persistence can vary greatly over space and time. In addition to widely recognised drivers like urbanisation, political and demographic changes, climate change, and intensification of agriculture, recent times have witnessed a rise in rapid and unpredictable events that are altering society and reflecting on the landscape. Examples include the COVID-19 pandemic, armed conflicts, the energy crisis and the economic recession. All these drivers operate at various spatial scales, from local to global and from individual to community, exerting direct or indirect pressures on landscapes. Understanding the driving forces and the pressures exerted on landscapes is crucial for managing and planning for landscape changes effectively. Within landscape ecology, these issues can be addressed in several ways, including, for example, investigating emergent drivers and developing new conceptual approaches to studying drivers and pressures.

Session 1B – Trees in Agricultural landscapes – A focus on traditional orchards and coppiced woodlands

Symposium

Csaba Centeri¹, Debbie Bartlett², Alexandra Kruse³

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Keywords: agricultural landscapes, biodiversity, climate resilience rural exodus

The landscapes around us reflect centuries of agriculture practice that varies according to the context provided by geology, soil, climate, vegetation and wildlife combined with local needs. This session will focus on traditional practices of managing trees, specifically traditional orchards and coppice woodlands, to explore how examining past management practices can foster understanding of the emerging pressures on these agricultural landscapes so enabling adaptive management to maintain valued ecosystem services, specifically biodiversity and cultural heritage. Traditional orchards have provided fruits and nuts in many rural areas, contributing to regionally distinctive landscapes and resulting in local culinary specialities. Modern intensive systems increase productivity with plant breeding techniques, producing varieties that store and transport better but interest in orchard traditions continues, notably from tourism, restaurants, local consumers and for ecological reasons. Collections of old varieties provide propagation material, teach orchard restoration, and maintain the genetic resource with potential significance for future food security as well as in the context of climate change. Coppicing is a traditional method of managing woodland producing regular crops of small roundwood used for many products, including tree stakes, fruit picking ladders as well as boxes and barrels. Most hardwood trees regenerate from the base – the coppice stool – when cut. This characteristic has been exploited for centuries as, before mechanised tools, such as chain saws, regular coppicing with an axe was an efficient way to harvest firewood, still an important product, as well as material for multiple other uses. New markets for coppice are emerging; awareness of nature conservation benefits increasingly drives management with carbon accounting providing an additional financial incentive. Contributions are invited to share experience of trees as components of agricultural landscapes and, in the dynamic context of the climate emergency and biodiversity crisis, how considering traditional practices can inform adaptation, increase resilience and maintain valued ecosystem services.

Mapping Gastronomic Landscapes: Majorca's traditional tree-crop systems

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Much of the world's quality food comes from traditional agricultural production landscapes, such as virgin olive oil from Mediterranean drystone-walled terraces. This makes gastronomy an essential way for people to connect to, and care for, highly valuable landscapes, which is particularly important in the Mediterranean, where such landscapes are a hotspot for both quality food and biodiversity. This study will focus on the characteristics of landscapes that contribute to culinary development, so-called gastronomic landscapes as defined in a new framework by the Stockholm Resilience Center.

Taking Mallorca's (Balearic Islands, Spain) traditional tree-crop systems and related food products such as citrus, olives, capers, carob and Majorcan black pork as a case study, we carry out 30 freelistings-interviews each with farmers, cooks, and consumers across 4 different landscape types (360 interviews in total). This is to identify their associations with locality, quality, and diversity of landscapes and food, to specify the framework of gastronomic landscapes. With statistical software, we analyze the frequency, mean rank and salience of the items named, and compare across landscape types and stakeholder groups. We contextualize this information with Majorca's agricultural background, to get a comprehensive overview over the connection between traditional landscapes and local food systems on the island. Our study contributes to a robust framework on the gastronomy of landscapes, which is a relevant tool in the development and promotion of our valuable ecological environments that provide diverse food of high quality, ultimately helping to connect societies with these landscapes in meaningful ways.

Oral presentation

Comparing hedgerows and forest margins for their sustainable management

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Hedgerows and forest edges are two linear tree structures that are very common in rural landscapes and are recognized for their important ecological roles. Their management can be an effective lever for promoting beneficial ecosystem services, particularly for agriculture. In many European countries, hedgerows are the subject of proactive policies to protect and manage them more effectively. However, forest edges, although very long, are much less often taken into account in management. This presentation takes stock of these differences in rural landscape management policies. It proposes a framework for comparative analysis of the ecological characteristics of hedgerows and forest edges, with the aim of showing which are common, providing similar functions, and which require specific attention because they may induce different functions. It shows that forest edges receive much less attention, mainly because they are less likely to disappear than hedgerows and because they are created through afforestation. However, just as there are now precise recommendations for the sustainable management of hedgerows, we could develop sustainable management practices for forest edges, adapted to their specific characteristics. Surveys of farmers show that their management practices do not differ much between hedgerows and forest edges on their farms. The presentation concludes by calling for more detailed studies of forest edges in order to propose appropriate management recommendations.

Oral presentation

Integrating Genotyping and Species Distribution Modeling to Identify Relict Cultivars for Genetic Conservation and the Revitalization of Traditional Chestnut Orchards in NW Iberia

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Traditional chestnut orchards in the NW Iberian Peninsula are multifunctional systems that have historically provided ecosystem goods and services while sustaining rural economies. The chestnut tree (*Castanea sativa* Mill.), native to the Iberian Peninsula, was systematically cultivated during the Medieval Ages, giving rise to characteristic agro-ecosystems (soutos, castañeros, or castaños in NW Spain). These orchards, managed by local communities and private landowners, were established through a mix of grafted and coppiced trees arranged in orchards or open stands. Today, chestnut orchards face threats from abandonment, socioeconomic decline, and ecological degradation. However, they remain essential for preserving genetic, species, and ecosystem diversity while supporting ecosystem services. A key challenge is conserving genetic diversity, particularly identifying old cultivars at risk, mapping their distribution, and developing in situ conservation strategies.

This study presents actions to conserve chestnut genetic diversity in NW Spain's mountain orchards. A survey and SSR genotyping identified both well-known varieties as well as relict individuals of previously uncatalogued cultivars. Geolocation enabled species distribution modeling (SDM) using maximum entropy (MaxEnt) to predict additional locations where such unknown cultivars may exist. The integration of remote sensing and digital cartographic data, combined with fieldwork, facilitated targeted field sampling and the validation of cultivars through further SSR genotyping.

The recognition of traditional cultivars provides valuable genetic, ecological, historical, and cultural insights on chestnut orchards pattern and dynamics, with strong potential for regenerating chestnut orchards and revitalizing rural landscapes.

Oral presentation

How agroforestry is (or is not) reflected in the agri-environmental indicators

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Agroforestry, the deliberate combination of woody plants and agriculture, is one of the measures to protect the environment and the climate. The European Union uses Agro-Environmental Indicators (AEI) to assess the success of these measures and its environmental policy. If agro-ecological elements such as agroforestry are to be recognised as valuable by practitioners and policy makers, and if their development is to be monitored, they need to be visible at the level of the AEI.

We have therefore identified categories of indicators from five legal frameworks (EU 8th Environment Action Programme, Common Agricultural Policy (CAP), Carbon Removals Framework, Soil Monitoring and Resilience Directive, Nature Restoration Law) that are relevant to the assessment of the impact of agroforestry. Twelve impact indicators have been identified as most relevant for farm-scale monitoring of their impact. At present, however, each country, legal framework or sector uses its own indicators, and while some data is collected at local level, it is often only reported as aggregated data at Member State level. This prevents local decision-makers or practitioners from using the information.

As part of the DigitAF project, a HorizonEurope project on DIGital Tools to help AgroForestry, we selected a DigitAF farm as a case study and evaluated the current situation of how agroforestry is reflected (or not reflected) in the AEI. Based on the rather negative results, we outline possibilities for better representation in the AEI using existing environmental databases, but also identify bottlenecks in data availability and resolution. Finally, we make several recommendations for improving data collection and provision, e.g. at the LPIS parcel level.

The benefits of agroforestry can only be communicated if they can be 'seen' at local level and in practice. In other words, if we want to use the AEI as reporting tool, we need to provide data at field or farm level. This would allow policy makers and practitioners to use it, and thus show the best way to quantify the impact of agroforestry.

Oral presentation

Changes in the Hungarian meadow orchards

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Agricultural production usually makes intensive use of natural resources. There are only a few forms that do not seriously damage biodiversity or even enrich it. One of them is the meadow orchard (also called orchard grassland), a valuable landscape element throughout Europe. It is made up of fruit trees belonging to traditional varieties and landraces, sparsely distributed on mown (or in some places grazed) grassland. The grassland hosts butterflies and food for hymenopterans, the old trees provide food for birds, beetles, fungi, etc. My aim is to draw attention to the changes in their distribution and status in Hungary during the last 25 years.

According to the monograph of Hungarian habitat types, they have been reported from Central, Southern and South-western Transdanubia and some parts of the Northern Hills. I carried out my research in these regions after obtaining their approximate occurrences from the national habitat mapping database (MÉTA - Landscape Ecological Vegetation Database & Map of Hungary 2003–2005).

The grasslands are usually dominated by grasses characteristic of meadows (*Alopecurus pratensis*, *Anthoxanthum odoratum*, *Arrhenatherum elatius*, *Briza media*, *Cynosurus cristatus*, *Festuca pratensis*, *F. rubra*, *Lolium perenne*, *Poa pratensis*, *Trisetum flavescens*) or steppes (*Brachypodium pinnatum*, *Bromus erectus*, *Helictotrichon* spp.). They are home to protected plant species such as *Anacamptis morio*, *Anemone sylvestris*, *Centaurea triumfettii*, *Clematis integrifolia*, *Dianthus collinus*, *D. deltoides*, *Epipactis helleborine*, *Gentiana cruciata*, *Gymnadenia conopsea*, *Iris variegata*, *Listera ovata*, *Orchis purpurea*.

Meadow orchards are declining, having been marginalised over the last half-century due to low yields and lack of mechanisation. The health of the fruit trees varies. It is mainly Turkey oak and wild plum that overgrows them, and blackthorn, hawthorn and dogwood dominate the process of scrub encroachment. Even bush grass and invasive black locust can spread. However, some formerly abandoned and scrubby orchards (with closed foliage) have recently been re-opened, for example for sheep grazing. Unfortunately, the propagules of valuable grassland species have already lost their germination potential in their seed bank, so the grassland under the re-opened canopy consists of generalist or disturbance-tolerant species. In some stands, the grassland is burned in late winter to prevent scrub encroachment, but this results in species loss. There are very few examples of orchard regeneration.

Orchard meadows may have a new role to play in the conservation of the genetic heritage of old fruit varieties and in the implementation of the recently adopted European Union Nature Restoration Law, which includes the extension of protected areas.

Oral presentation

Social benefits and needs for action in fruit tree landscapes in the border area of Saxony and the Czech Republic

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Fruit alleys and orchards with traditional high-stem varieties are an important part of many protected areas and NATURA 2000 sites. If well managed and utilised, traditional fruit landscapes can provide important support for the target organisms of the European network of protected areas. In the agricultural landscape, fruit tree ecosystems are biodiversity hotspots, providing a valuable habitat for many species that would not survive in the surrounding landscape. The protection of endangered species is achieved through old varieties of fruit trees, thereby protecting the biodiversity of the agricultural landscape. Fruits were the subject of intensive trade between northern Bohemia and Saxony. The fruit varieties used in those days contain valuable genetic information. In the last decade, many new orchards have been created, but they cannot fulfil the valuable ecological function as they are not well maintained. In 30 years of work in this field, all freely available national publications have been evaluated. However, there are still gaps in our knowledge that cannot be filled from national sources. Crossborder cooperation is therefore necessary to exchange experiences. Cooperation between Saxony (Germany) and the regions of Liberec, Karlovy Vary and Ústí nad Labem (Czech Republic), which have much in common both ecologically and historically, is the most promising approach to overcoming knowledge gaps. The OKliBio project ('Fruit landscapes for climate protection and biodiversity'), funded by the Interreg program Saxony-Czech Republic, was launched in 2025 to tackle this problem. One important part of the project are German-Czech events on fruit tree pruning, planting and care, as well as orchard festivals, excursions and an exhibition. In addition, a Czech knowledge database on fruit varieties, orchards and fruit alleys will be expanded and translated into German. The project also includes the compilation of spatial data on fruit trees in the study region and the assessment of ecosystem services provided by orchards and the costs of maintaining them. Additionally, local marketing and processing opportunities for orchard and orchard fruit will be investigated. Finally, a joint strategy will be developed to improve the situation of orchards and fruit alleys in Saxony and the Czech Republic. The talk will provide an overview of the project and show first results.

Oral presentation

Trees as a Part of Plant Diversity in Agricultural Landscapes with Some Indications from Serik, Antalya

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Biodiversity is a fundamental component of agriculture dominated landscapes, enhancing their ecological resilience and supporting the sustainability of food production. Either as a product or a H6 component in agricultural landscapes, woody perennial plants of trees have been part of agrobiodiversity. In most cases trees are cultivated as crops such as Olive (*Olea europaea*), Pomegranate (*Punica granatum*), Walnut (*Juglans regia*), Fig (*Ficus carica*). Some trees such as Cypress (*Cupressus sempervirens*) provide physical shelter for crops around orchards and gardens. Some trees of native and wild found in agricultural landscape along natural corridors of drainage channels, tree lines or ditches. They are the witness of disturbed environment through farming history. And a kind of indicators of nature before the cultivation of the landscape. They greatly support agricultural systems. Regardless of their position, trees have multiple functions in agricultural landscapes as crop, shade provider, erosion controller, nitrogen fixer, habitat provision, soil restoration, etc. The aim of this study is to evaluate trees in and around agricultural systems with some cases from Serik, Antalya in the Turkish Mediterranean. First step a simplified inventory of agricultural landscape will be conducted with their main characters. Second step crop, native, non-native and wild tree species will be investigated in each type of agricultural landscapes to see the diversification or alteration.

Oral presentation

The cultural significance of traditional orchards using examples from selected European countries.

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Traditional orchards are one of the best-known examples of multifunctional agriculture. They have a long history of providing different types of fruit and combining various other agricultural activities, such as extensive animal husbandry, with a cultural significance that reflects the different regional landscapes of Europe. This study focuses on the cultural dimension of traditional orchards and the identification of common features as well as country-specific management characteristics that help to maintain these cultural landscapes up today. The present study combines an expert questionnaire survey carried out in ten EUCALAND member countries to compare and summarise the situation of traditional orchards and their cultural significance in these countries. The results show that traditional orchards are declining on a European scale but are still of great cultural importance in many regions. People are very attached to their traditional orchards, and even those who do not own them understand the value of the biodiversity and ecosystem services they provide. However, this type of farming is often dependent on public financial support, although some farmers continue to manage orchards as a hobby. This is particularly true in those regions where there has been a dramatic decline in the 20th century. The collected examples of good practice from the contributing countries reveal the close links these orchards have with local communities and often with specific traditional knowledge. The present summary of the current situation of these important components of the agricultural landscape, as well as the management characteristics of each country, has the potential to inspire other countries to conserve their traditional orchards.

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Oral presentation



Back to the future: Traditional agroforestry systems as NbS to face multiple societal challenges (TRANSForm)

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TRANSForm is a transdisciplinary, multi-actor project that will generate robust evidence on the role of traditional agroforestry systems—such as traditional orchards—as nature-based solutions (NbS) as a nature-based solution (NbS) to jointly address important social, economic, and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services, climate resilience, and biodiversity benefits. To achieve this TRANSForm will: 1) Take a system thinking approach for pulling together the multiple disciplinary, interdisciplinary, and non-disciplinary perspectives and create a holistic understanding of the social, economic and environmental components of traditional orchards at multiple scales; 2) Use a multi-scale, nested case study approach to allow deepening our understanding of both the ecological mechanisms and interactions by which traditional orchard systems exert their effect, and the need to embed system understanding at field, landscape and regional scales in a larger socio-economic context; 3) Establish multi-actor approach for co-creating knowledge with relevant stakeholders, by pulling together actors that are affected by, or can affect, traditional orchard practices across system scales and interests. TRANSForm's core ambition is to promote traditional orchard systems in the Euro-Mediterranean region as NbS that have the capabilities to make agricultural landscapes more sustainable for biodiversity, more climate resilient, and fit for the future.

Poster presentation

Dynamics and condition of traditional orchards in a Central European Landscape

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Traditional orchards are distinctive features of cultural landscapes in Central Europe, yet they are in decline despite their high ecological value. A lack comprehensive spatial data over broad extents limits trend analysis and conservation efforts. We analysed traditional orchard maps from 1952 to 1967 and alongside a 2010 map from 2010 derived from via aerial image interpretation for the state of Hesse (ca. 21,115 km²), which has Germany's second largest share of traditional orchards. We will (1) display long-term orchard dynamics, (2) compare orchard characteristics in terms of topographical, ecological, and socioeconomic factors, and (3) identify key drivers of orchard loss (Große-Stoltenberg et al., 2024). Our results reveal a significant decline in both the number and area of orchards across Hesse, with distinct local and regional patterns. Historically old orchards were generally larger, had higher shape complexity, and were located closer to settlements, highways, and other orchards. In contrast, newly established orchards were more common at higher elevations and on steeper slopes. The three historical orchard hotspots also experienced the most substantial losses, driven by different factors: expansion of artificial surfaces, residential buildings, and agricultural land (Große-Stoltenberg et al., 2024). Our findings underscore the value of multitemporal spatial data for ecological research and conservation planning. We advocate for the integration of novel geospatial technologies to enhance future analyses and monitoring efforts, e.g. regarding singletree detection and mapping shrub encroachment (Große-Stoltenberg et al., 2024).

References: Große-Stoltenberg, A., Hanzl, A., Safaei, M., & Kleinebecker, T. (2024). Once Common, Long in Decline: Dynamics of Traditional Orchards in a Central European Landscape. *Land*, 13(10), 1639. <https://doi.org/10.3390/land13101639>

Poster presentation

Farm Trees as Cultural Keystone Species: Bridging Biocultural Conservation and Sustainable Development in the Morocco High Atlas Mountains

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In many southern Mediterranean mountain areas, the livelihoods of subsistence farmers are threatened by increasing drought periods that affect agroecosystems and cause rapid socioeconomic deterioration. Current initiatives to address this through ecosystem restoration often overlook the cultural significance of different tree species that play an important role in farmers' livelihoods. This may result in the erosion of biocultural diversity and loss of local and Indigenous knowledge. We used the cultural keystone species (CKS) framework to appraise the cultural and livelihood importance of five farm tree species—almond, ash, holm oak, olive, and walnut—in Morocco's central High Atlas Mountains. Twenty-five structured interviews with knowledgeable farmers revealed that olive trees remain central to local residents' culture. This species met all CKS criteria, whereas walnut and almond trees met many criteria but have increasingly lost their cultural importance. Ash and holm oak are prevalent fodder species but do not directly bolster household cash incomes, and they are absent from cultural narratives, ceremonies, and symbolism. Our findings emphasize the importance of considering farm trees' cultural status in developing a culturally sensitive approach to conservation, stewardship of existing trees, and sustainable development in the Mediterranean mountains.

Poster presentation

Session 1C – Oral Sources as a way of Exploring Drivers of Historical Landscape Change: Methods towards More Sustainable Landscapes for the Future

Symposium

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Keywords: oral history interviews, historical landscape ecology, indirect drivers, sustainability transformation, ecological memory

Human activities have been shaping ecosystems since prehistoric times and are a central factor in the successive dynamics that have created our current landscapes. But the ways in which humans rely on and use the landscape tend to shift over time depending on communities' needs and values. Landscape transformations can often be traced back to events in the past, driven by socio-economic processes such as political or demographic changes. This historical interconnectedness of nature and human culture is the central concern of historical ecology research. Moreover, in order to protect and manage rapidly changing European landscapes, a proper understanding of the historical roots of these driving forces is essential. A fundamental resource within historical ecology can be found in detailed memories and knowledge of experienced past landscape transitions and management practices of local communities, e.g. in the form of oral history. While oral sources provide essential bottom-up insights into historical and social aspects of landscape change, the knowledge may be influenced by subjectivity, shifting baselines, or misconceptions about species or landscape management. Therefore, it is crucial to critically evaluate and use these sources. This session aims to explore how to integrate oral history to address different methodological challenges and more sustainable management strategies for landscape development. We call for full and flash presentations focusing on the use of oral historical sources in landscape ecology and sustainable landscape planning, on different methodological challenges and innovations that show the added value of combining quantitative and qualitative approaches, and on how triangulation with other (historical) sources is possible. We plan to facilitate the symposium with a collective brainstorm on the use, challenges and opportunities of oral sources in landscape ecology. Therefore, we encourage the contributors to participate in the entire session. This session is organised by the IALE Working Group Historical Landscape Ecology.

Time-lagged effects of indirect drivers shaping endangered habitats – a multi-site analysis in Hungary and Romania

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Traditional management is essential for maintaining the biodiversity of many semi-natural grassland habitats of high conservation value. Abandoning these practices may lead to shrub encroachment, decrease biodiversity, and habitat loss. What is often overlooked in ecological studies is that these are generally the consequences of long-lasting, slowly manifesting social-ecological processes.

Botanists collected ecological memory on 21 semi-natural grassland localities in Hungary and Romania through 60 oral history interviews with knowledgeable locals. The questions covered three time periods (before, during, and after socialist collective farming). We identified 211 mentions of indirect drivers and categorised them into five classes (demographic, economic, institutional, cultural, and technological).

Oral history helped to identify slowly manifesting drivers behind ecological processes. When asked about the causes of grassland management changes, locals identified mainly local and sub-national drivers, although they experienced the effects of national drivers. As labour shortage often led to a drastic reduction in livestock, demographic drivers were often perceived as key factors in habitat change. Economic drivers were the most often mentioned indirect drivers in both countries for alluvial and saline habitats. Demographic drivers, such as ageing, labour shortage, and rural–urban migration, were highly intertwined and most pronounced for dry semi-natural grasslands. Changing lifestyles and young people's values were often emphasised as cultural drivers.

The multi-site approach revealed that social-ecological processes affected habitat management in various, locally specific ways, but differences between the two neighbouring countries were mainly due to the two different policies of land reform after the collapse of communism and the previous dictatorial repression in Romania. We conclude that more attention should be paid to depopulating rural areas in subsidy schemes with greater consideration to local landscape and demographic specificities.

Oral presentation

Exploring causality and legacy effects in land use dynamics using oral history interviews (OHI) within a mixed methods approach: a case study from Terras de Trás-os-Montes, Portugal

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Terras de Trás-os-Montes (TTM) is a mountainous region in the northeast of Portugal, characterised by traditional agricultural systems, which contribute to its high biodiversity and cultural landscape values. In recent years, the region has been considered a hotspot of agricultural abandonment. Due to outmigration since the 1960s, its rapidly ageing population has halved to about 100,000 individuals, of whom about ¼ reside in the region's largest city. Since the start of the 21st century, agricultural abandonment processes are nevertheless slowing down in the region, while recultivation processes are gaining traction. Yet the spatial variation in this pattern cannot be fully explained by analysing common environmental and socioeconomic drivers. To better understand these land use/land cover (LULC) changes and improve future projections, we extended the temporal scale towards the start of the 20th century and integrated the place-based context of our analysis. Four parishes were selected based on statistical analysis of contemporary LULC change dynamics. We gathered historic spatial information (maps and aerial photography) for each of these parishes to map LULC changes between 1947 and 2018, complemented with census data and other (grey) literature. We then created timelines detailing events that are likely to have influenced LULC dynamics, including land (use) reform implemented during the autocratic Estado Novo regime (1933-1974), but also other (EU) policy initiatives and events. This information was used to inform an open land use questionnaire used for oral history interviews (OHI) with local elderly people in each parish. The combined results indicate that, while much of TTM has been subject to similar change dynamics, the underlying processes are often different, leading to varying spatial and temporal LULC change expressions. The OHI also confirm that many LULC changes across the 20th century have been event-driven, yet some events were more disruptive than others, and more so, were more disruptive in some places than others. The use of OHI within a mixed methods approach proved to be helpful for establishing causality and legacy in land use dynamics, especially in a location marked by profound sociopolitical and economic transitions.

Oral presentation

Memories of change in Mediterranean mountains: A comparative oral history of biocultural refugia transformation in Morocco and Spain

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Mediterranean landscapes, renowned for their multifunctionality and rich biocultural heritage, serve as exemplary biocultural refugia. However, global pressures are driving significant transformations, threatening their resilience. This study uses oral histories and narrative interviews to examine landscape change in two Mediterranean sites: Ait Blal in Morocco and Las Hurdes in Spain. By documenting lived experiences, traditional practices, and stories, these methods enable an in-depth exploration of how communities perceive and interpret changes in their landscapes. A total of 55 semi-structured interviews were conducted (32 in Ait Blal, 22 in Las Hurdes) using a combination of episodic interviews and storytelling to capture personal accounts of landscape transformation. Data analysis was performed using MAXQDA for qualitative analysis, allowing for systematic coding and thematic categorization. Through thematic analysis of these narratives, we identify shifts across emotional, functional, and institutional dimensions. Interviewees describe a deepening emotional detachment from the land due to rural exodus and shifting values. Functionally, they highlight a decline in traditional farming practices, often replaced by forestry or monocultures. Institutionally, they point to increasing misalignment between local needs and top-down conservation policies, with respondents in both regions expressing frustration over external decision-making that overlooks local knowledge. Regional differences emerged from the narratives. While in the southern Mediterranean, climate change is perceived as the primary driver of transformation, in the north, economic shifts and tourism play a larger role. Despite these challenges, narratives also emphasize biocultural stewardship, with communities expressing a desire to revive traditional practices and strengthen local governance. These findings highlight the need for adaptive policies that integrate local knowledge and lived experiences to sustain Mediterranean biocultural refugia, ensuring that conservation efforts align with community needs and support the continuity of traditional ecological practices.

Oral presentation

Local toponyms and associated knowledge to approach landscape history and change in Madagascar

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Understanding landscapes from an emic perspective is a key challenge for landscape science to think “sustainable landscapes” from the point of view of the people who live and shape these landscapes. Local place names and their associated knowledge have an untapped potential to approach this emic perspective. Indeed, we can assume that toponyms – by highlighting significant events, stories and practices, and by pointing to both past and present landscape features – are emic markers of landscape stability and change through time. In addition, toponyms often hold various meanings and are used differently by social groups and individuals within the same landscape, which can help uncover the multiple ways people relate to their human and non-human environment. Based on these assumptions, we aimed to focus on toponyms and their associated knowledge (e.g., the known origin of place names, the period when each place was named or renamed, the diverse interpretations of place names) to explore the individual and collective relationships between people and their landscapes. To do so, we carried out investigations in a village of Madagascar, in the Itasy region, where we combined 120 individual interviews and 5 collective workshops using participative mapping, and timeline methods. Data was analyzed through mixed methods at both individual and collective levels. Our results first revealed that toponyms reflected how people presently experience and live their landscape. For example, many places were named after their agricultural potential, cardinal orientation, biophysical components (topography, vegetation), and the activities that are carried out in them. Second, toponyms allowed us to grasp the collective narratives associated with the landscape such as stories, rituals, symbols, important characters, and significant events. Thus, they revealed how ancestral legacies have shaped diverse perspectives on the landscape within the same society. Thirdly, toponyms revealed landscape changes over time, including land use changes and major political or socio-economic transformations such as the ones induced by the colonization period. Our findings emphasized the potentials and limits of toponyms to approach landscapes from an emic perspective, paving the road for coproducing with local populations a shared vision of sustainable landscapes for the future.

Oral presentation

Traditional Songs as Carriers of Landscape Perception: A Case Study from Slovakia

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Folk songs as part of oral history preserve collective memories, historical events, traditions, and community values. At the same time, they capture linguistic, regional, and cultural specificities. The paper focuses on landscape perception in Slovak folk songs by analysing 4,137 traditional folk songs. A dataset was created containing landscape features and vascular plants and animals connected to specific landscape features, song genre, locality, activities and perceptions related to landscape features. Songs mentioning landscape elements appeared in 37.27% of all analysed songs. The identified landscape elements were categorised into four main groups: generally mentioned landscape, natural landscape, agricultural landscape, and waterscape. Folk songs well reflect the mainly mountainous and afforested character of Slovakia, as wooded mountains/ forests were the most frequently cited, accounting for 21% of all landscape elements. The most common activities associated with landscape features were "going through" or "passing" (e.g., "going through a forest"), mentioned in 24% of all activities, and "mowing" (e.g., "mowing a meadow") in 7%. The most frequent descriptive attributes were "green" (e.g., "green meadow," "green forest," etc.) and "wide" (e.g., "wide field"). Plants associated with a specific type of landscape were most commonly mentioned in connection with fields and gardens, thus belonging to the agricultural landscape. The most frequently cited associated plants were clover, pear, and beech. In total, 50 plant taxa were identified. In contrast, closely associated animals were mostly mentioned in connection with the natural landscape (specifically forested mountains and groves), with horses, sheep, and geese being the most frequently mentioned. In total, 32 animal taxa were identified. Traditional songs serve as musical and textual testimonies that contribute to the preservation of traditional ecological knowledge and help us better understand the past relationship of our ancestors with the land and nature.

Acknowledgement: This work was supported by the Scientific Grant Agency of the Ministry of Education of the Slovak Republic [No. 2/0135/22 Research of specific landscape elements of bio-cultural landscape in Slovakia and No. 2/0015/24 Multi-criteria approach to the sustainable multifunctional use and determination of highly vulnerable areas].

Poster presentation

The Relationship Between Architecture and Landscape on the Example of Abandoned Water Mills

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This research explores the relationship between architecture and landscape in the context of reconstructing abandoned water mills on the Bistrica River in Livno, with a focus on cultural heritage preservation and sustainability. Water mills, historically central to rural economies, provided essential grain milling services. However, industrialization led to their decline, resulting in abandonment and decay. Although this decay is tangible in the landscape former state, it is preserved in the memories of the local community. Oral history has been an invaluable source in understanding the local communities' historical relationship with these mills, capturing knowledge and stories that reveal the cultural importance and changing roles of the mills over time. These oral accounts include elements for deeper understanding of the mills' role in shaping the landscape and the local culture and economy, connecting past and present narratives. Through a discourse analysis of oral history, key challenges and opportunities in restoring these buildings were identified. The main objectives of the reconstruction include preserving architectural features, improving functionality, and integrating the mills into modern energy and ecological systems. The project also inventories and values the mills, providing guidelines for reconstruction based on socio-spatial needs. The strategy, derived from SWOT analysis, emphasizes technical, aesthetic, and sustainable practices, alongside the preservation of cultural and historical heritage. The research also considers the mills' potential to become cultural, touristic, and educational hubs, addressing the wider socio-economic context. Ecological concerns such as environmental protection, material use, and energy efficiency are key elements of the reconstruction. Guidelines for restoring the mills' foundations, walls, carpentry, and roofing show how traditional construction methods can align with modern sustainability standards. The study reveals that despite neglect, the mills are vital to Livno's identity, representing significant cultural and ecological heritage. Their restoration can help preserve this heritage while fostering economic revitalization and sustainable development in rural areas. Renovating these mills could improve ecological and economic sustainability for the local community. However, more detailed planning is needed for implementation and long-term monitoring of the effects on the ecosystem and local community. Future research should examine the social and economic impacts of the renovation and explore new sustainable uses for the restored mills.

Poster presentation

Oral history at the border of Mecklenburg and Vorpommern in Germany: “Recknitzgeschichten

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The river Recknitz displays the historical border between the former provinces of Mecklenburg and Vorpommern; today associated within the federal state of Mecklenburg-Vorpommern. But the river and valley were not only a border, more recently it became a region with various opportunities for farming, peat mining, nature conservation and tourism. Landscape development is therefore framed by different political systems, from collective farming in times of the German Democratic Republic (GDR), which was the communist style governed part of Germany (also known as East Germany) after World War II to private economics in the reunified Germany after 1990 and then influenced by European nature legislation.

In Co-operation with the nature conservation station in the Recknitz valley, five students from the Neubrandenburg University of Applied Sciences, studying nature conservation and landuse planning, got in touch with a group of ten elderly people from this region. The oldest person who was interviewed was born in 1941 while others were born in the 1950s of the past century and lived mostly their whole life in this region. The students were interested to get to know, how the people perceived landscape change due to political development in terms of reunification of both Germanys, technological progress and rewilding of the river and valley. The interviewees have background in farming, worked as teachers or mayors in the municipality.

The students met individually up to three times in face-to face communication with one of the elderly persons each, asking them about personal experience connected to the landscape in their lifetime, which dates back up to 70 years. The interviews were performed not standardized and were recorded and transcribed to document the narratives. The content was then illustrated with historical maps and photographs, which the students received from the interviewees.

As a result, a variety of tales, stories and histories appeared. For example, it is documented, how the political change in the late 90s led to change in landuse; from intensive agriculture on drained fens to natural meadows with habitats for endangered species. Today, the river Recknitz and surrounding landscape is widely part of the European Natura 2000 network. For the people living here, this means a comprehensive change in their native country, from cultivated land which feeds them, to land, where nature partly takes over. The interviews reveal emotional attachment and melancholy remembering former times, but also happiness about a long life in a very beautiful landscape – which of course is a subjective statement.

Poster presentation

Session 1D – Abandonment of Rural and Urban Landscapes: Understanding the Drivers and Implications for Ecology and People

Symposium

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Keywords: farmland abandonment, drivers, landscape change, underuse, land use change

The ‘underuse’ or complete abandonment of farmlands and settlements has become a widespread global phenomenon. Farmland and settlement abandonment significantly impact the environment, landscape resilience, and societal well-being. However, the driving mechanisms behind abandonment, the emergence of novel ecosystems, and the dynamics of landscape resilience in regions prone to abandonment remain unclear. Furthermore, theories, methods, and toolkits for measuring and interpreting farmland abandonment are insufficient. This session aims to highlight progress and address existing challenges in defining and understanding the diverse land transitions associated with abandonment, including the resulting low-intensity, underused, or fully abandoned urban and rural landscapes. Presentations are invited on the following topics: Conceptualizing land transition processes related to abandonment, such as secondary forest regrowth, evolving novel ecosystems, and implications for landscape resilience. • Coupling and decoupling processes in abandoned urban and rural landscapes. • Research methods and toolkits to measure and interpret underuse, abandonment, and post-agricultural landscape transitions. • Development of theories and evaluation of driving mechanisms of landscape change and corresponding policy responses. • Environmental and societal implications of land abandonment and related transitions. • Emerging land uses in post-abandonment contexts. • Fostering novel interdisciplinary dialogues between (critical) social sciences and natural sciences to advance understanding of land abandonment.

This research session contributes to the activities of the Global Land Programme’s initiative, “Agricultural Land Abandonment as a Global Land-Use Change Phenomenon.” https://bit.ly/l_aband and <https://www.land-abandonment.org/>

Why does the number of mountain farms in Slovakia decrease?

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Urbanisation and the abandonment of rural areas are well-known global drivers that significantly contribute to changes in the agricultural landscape in Europe. However, country- and site-specific socio-economic variables and political settings are fundamental to rural area development, particularly in mountainous regions.

In Slovakia, large farms—those spanning 100 hectares or more—manage 89% of the registered farmland, the highest share among all EU countries. In contrast, farms covering less than 30 hectares account for approximately 5% of the farmland. Currently, about 25% of Slovakia's registered farmland is located in mountain areas. However, this proportion has been declining over the last two decades. Although a decreasing trend is also observed for all registered farmland in Slovakia, the decline in the share of mountain farmland is more pronounced compared to the national average.

Given the global driving forces mentioned above, we aimed to identify the individual factors that currently shape the agricultural landscape in rural mountainous areas. To this end, we selected and analysed local farms of varying sizes, which likely exhibit differences in management practices, sustainability, and interaction with the land, as widely evidenced in the literature. Furthermore, as noted earlier, farm size plays a crucial role in Slovakia concerning the overall farming area.

Our research involved a detailed analysis of all available datasets on farm structure and farmland at national and local levels, particularly those considered for the EU's Common Agricultural Policy (CAP) payments, alongside other socio-economic variables. Additionally, farmers' perceptions, obtained through iterative in-depth questionnaires, were essential for studying the similarities and differences in farm management, continuity, landscape impact, motivations for farming, limitations, employment practices, and market aspects.

We identified several common challenges specific to each farm size group, often linked to the social background of the farm, its financial viability, and farming practices. From a top-down perspective, the impact of recent CAP conditions and unfavourable social capital in the region emerged as key constraints on the sustainability of small and medium-sized farms. These socio-economic variables, in turn, influence landscape heterogeneity, the variety of ecosystem services that support human well-being, and the preservation of local cultural identity.

Oral presentation

What are the driving forces behind the disappearance of historical agricultural landscapes and traditional vernacular architecture in rural areas? A case study from the Czech Republic

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The vernacular cultural landscape forms an integral part of the identity of a particular area. It consists of the surviving remains of the historic agricultural landscape, traditional vernacular architecture, and spatial structure of the settlements. The dramatic political and socio-economic events of the 20th century have transformed this historical heritage in Central Europe in a fundamental way. This study aims to discover what driving forces have contributed to preserving this heritage – natural and geographical conditions, historical circumstances, and the social and economic processes of the last century can be expected to influence this process.

Building monuments, conservation areas, historic cultural landscapes and places with preserved cultural values are not evenly distributed throughout the Czech Republic, which creates an opportunity to study the driving forces mentioned above.

The objectives of the study are (1) to compare the geographic distribution of traditional vernacular architecture with the distribution of preserved historic cultural landscapes, (2) to identify predictors (environmental, geographical, socio-economical and other factors) that may have influenced the preservation of both vernacular architecture and cultural landscapes, (3) to model the hypothetical occurrence of both features in regions of data scarcity (or, to identify regions with underestimated heritage record).

Oral presentation

Abandoned agricultural land: an overview and basics of its definition

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Agricultural land abandonment is considered one of the actual land use changes, and different methodological approaches are used to identify it. The analysis and evaluation of this process requires defining the concept of agricultural land, which is very dynamic due to its transformation by man over centuries. In our context, agricultural land is represented by three components – arable land, permanent crops, and permanent grasslands. Arable land is mainly associated with cultivating annual crops and occasional meadows for mowing and grazing. Permanent crops include vineyards, orchards, and fruit plantations in Central European conditions. Permanent grasslands include areas used for mowing and grazing, while these areas are not part of the field rotation system.

A literature review reveals a great diversity in defining agricultural abandoned land (AAL). We document only some substantive aspects of the definitions: land use/land cover change; cropland that was not actively managed consecutively for more than five years as fallow and converted to natural cover; contemporary forest regrowth on former agricultural lands; agricultural land completely overgrown with successional vegetation; loss of production function; identification of AAL classes taken over from agricultural census, etc.

Whereas the abandonment of agricultural land is a very dynamic process, the identification of its different stages requires the application of new progressive approaches. One of them is the application of earth observation (EO) data. Therefore, the exact AAL definitions are essential for the application of the EO data. As the literature review shows, these definitions are formed mainly through descriptive characteristics about the loss of its productive (agricultural) function.

Accordingly, the aim of this abstract is to determine the AAL definition based on the exact (as unambiguous as possible) characteristics and features of the AAL classes. Along with the spectral features of the newly developed (successional) vegetation, spatial features must be used: the size and shape of the areas overgrown by the new vegetation (represented by texture in the image record), the structure of vegetation distribution over a larger area (pattern), and vegetation height. All features used in the definition should be specified in exact form, i.e., numeric. These values are also decisive for the selection of EO data with suitable spectral and spatial resolution.

This work was supported by the Slovak Scientific Grant Agency VEGA under Grant 2/0043/23 'Detection of landscape diversity and its changes in Slovakia based on remote sensing data in the context of the European Green Deal' and the Slovak Research and Development Agency under Grant APVV-MVP-24-0386 'Advanced Assessment of Abandoned Agricultural Land in Slovakia'.

Oral presentation

Changes in livestock systems explain post-Soviet fire trends on the Eurasian steppe better than climate

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In grassland ecosystems, fire plays an important role in maintaining biodiversity and ecological functioning but also causes substantial greenhouse gas emissions. Both climate and herbivory are key determinants of fire regimes, yet the relative importance of these factors remains debated. We focused on the steppes of Kazakhstan—one of the world’s largest grasslands and a global fire hotspot—to assess the relative importance of climate and grazing patterns on fire regimes. Specifically, we made use of the natural experiment that the post-Soviet collapse of the Kazakh livestock sector provided. The subsequent pasture abandonment removed large grazers from grasslands that had evolved over millennia in concert with wild ungulates and later with domestic livestock. We used the MODIS Burned Area Product and calculated annual livestock grazing demand (required forage intake) from 2001 to 2019. We estimated a binomial mixed-effects model to extricate the impact of grazing demand and climate factors on fire occurrence. Our results show that fire regimes changed markedly on the Kazakh steppes, with exceptionally high frequencies and extent of fires in the 2000s. We found a clearly negative association between grazing demand and burned area; in other words, more heavily grazed areas burned less frequently. Moreover, annual grazing demand added more explanatory power to trends in fire occurrence than precipitation, temperature, relative humidity, or growing degree days. Given that livestock herding is declining in many grassland regions, and native grazers have been lost or greatly reduced in the past, our study highlights the increasing risk of fire associated with pasture abandonment and diminished grazing, but also the potential for grazing restoration to mitigate such risks in the world’s grassland regions.

Oral presentation

Climate-smart rewilding potential in Europe today and in the future

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Climate-smart rewilding is a promising approach to ecological restoration that integrates dynamic, process-based restoration with carbon sequestration to support climate change mitigation. However, little is known about suitable locations for climate-smart rewilding in Europe due to a lack of continental-scale spatial assessments.

We first present an interdisciplinary approach to mapping the potential for climate-smart rewilding in Europe by considering three dimensions: (1) Ecological Potential, representing optimal conditions for restoring key ecological processes; (2) Carbon Potential, describing the capacity for future carbon sequestration; and (3) Land Potential, reflecting the societal (opportunity) costs of dedicating land to rewilding. By integrating these three dimensions, we identify areas with high rewilding potential across Europe and emphasise synergies and trade-offs between them. Building on this approach, we explore how the potential for climate-smart rewilding may evolve under different future scenarios using an agent-based land-use model. This allows for a forward-looking assessment of potential shifts in rewilding patterns, synergies and trade-offs, providing a basis for exploring diverse future pathways and policy options across Europe.

We show that today's high rewilding potential is heterogeneously distributed across Europe, with hotspots primarily located in mountainous regions such as the Alps and the Scottish Highlands, as well as in parts of Scandinavia, the Iberian Peninsula, and Eastern Europe. Limited synergies between the ecological, carbon, and land potential dimensions highlight the tension between competing demands on land. Furthermore, areas of high potential are not equally distributed across European countries, adding complexity to the actual implementation of measures to reach restoration targets. Preliminary results for the scenarios show that potential areas for climate-smart rewilding, as well as synergies and trade-offs among the three dimensions, can change substantially under varying assumptions of future socio-economic and climate challenges.

Our analysis offers a perspective on where rewilding should be prioritised depending on the underlying future scenario to maximise multifunctional benefits for nature, climate mitigation, and society.

Oral presentation

Cultural Ecosystem Service Benefits in Abandoned Landscapes

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In recent decades, the decline in farming profitability and the lack of economic alternatives, particularly for younger generations, have led to land abandonment and depopulation in European mountain regions. In areas like Beskid Niski (Carpathians) in Poland, this process began earlier due to the 1945 Ukrainian and Ruthenian population transfer agreement between the Polish People's Republic and the Soviet Union, followed by forced displacement in 1947. Socio-economic changes continued to drive abandonment, resulting in landscapes that are now largely forested. However, in recent years, the region has emerged as a destination for dispersed tourism.

This study aimed to investigate the benefits associated with cultural ecosystem services provided by the area and how various landscape elements enhance these benefits. To achieve this, we conducted 15 semi-structured interviews with visitors to Beskid Niski. The findings revealed that visitors recognized a variety of benefits, with a strong emphasis on mental health, particularly relaxation and recovery, calmness, and the opportunity to escape from daily life. Interviewees highlighted the region's nature, remoteness and isolation as key contributors to these mental health benefits. The presence of abandoned villages and the low level of anthropogenic pressure combined with the vast expanse of forests, and meadows contributed to aesthetic experiences as well as feelings of freedom, relaxation, and transcendence. Furthermore, the area's complex history and culture were identified as fostering a sense of responsibility, self-development, and reflection. Visitors also noted that the absence of infrastructure and harsh conditions enhanced self-development. In conclusion, abandoned mountain regions, exemplified by Beskid Niski, offer distinct opportunities for tourists seeking mental health benefits, reflection as well as aesthetic values within a natural and historically rich area. This research highlights the significant potential for transformation in such eco-tourism destinations.

Oral presentation

Revealing pheno-spectral temporal differences in abandoned landscapes

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Farmland abandonment is one of the most prevalent land-use change processes globally and has become a focal point of heated debates regarding the future of such lands. Often, farmland abandonment is mapped as a uniform land-change transition process, for example, from cropland (Period 1) to forest (Period 2). It is generally assumed that abandoned lands will gradually converge to resemble neighboring natural areas over time. However, the way abandoned lands evolve depends on prior land uses, land-use interventions, and biophysical controlling factors. As a result, abandoned farmlands can exhibit diverse spectro-temporal characteristics and may not fully transition into natural landscapes. Using Lithuania as a case study, we analyzed farmland abandonment after 1990 by evaluating spectral-temporal characteristics with the aid of Landsat and Sentinel-2 imagery. Our results indicate that, from a satellite remote sensing perspective, of the originally 25% of abandoned farmland between 1990 and 2000, only a portion remained abandoned by 2025. By that time, abandoned lands exhibited a broad range of phenological and spectral temporal characteristics, with only a small fraction spectrally converging to resemble surrounding natural areas. We further discuss to what extent the phenological and spectral temporal characteristics of abandoned lands can provide insights into the functioning of these evolving, novel transitioning ecosystems.

Oral presentation

Land abandonment as a lever for socio-ecological transformative change

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Land abandonment is often perceived as a major social-ecological challenge affecting many European landscapes. However, it can also serve as a lever for change (i.e., nodal change), creating opportunities for social innovation and transformative change toward more just and sustainable landscapes. While literature has often explored the negative social and environmental impacts of land abandonment, there is a growing need to examine the extent, diversity, and drivers that enable it to become an opportunity for social and environmental transformation. Beyond its effects on landscapes and agriculture, land abandonment also reshapes societal configurations, influencing rural community composition and local power structures. Examples of such socio-ecological transformations include rewilding initiatives, the repurposing of abandoned areas for tourism, and the shift from conventional to extensive and organic farming. To address this gap, we conduct a literature review of European case studies to explore land abandonment as a catalyst for social-ecological transformation. Our analysis seeks to identify the diverse conditions and drivers that facilitate this process, along with the potential social and environmental benefits and trade-offs that emerge. Finally, we discuss key research gaps and the policy implications of our findings.

Oral presentation

Abandoned farmland as source and sink for invasive alien plant species in Norway

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The spread of invasive alien plant species (IAP) poses a major threat to biodiversity, ecosystems, economy, food security, and public health. In line with the Kunming-Montreal Global Biodiversity Framework adopted in 2022, Norway has implemented various strategies and action plans to mitigate IAP spread, yet many species are already established, making it unlikely to meet national targets. At the same time, the decline in active farms has increased land abandonment, particularly in rural areas with small land parcels, challenging topography and climate conditions. International studies have previously indicated that farmland, as disturbed ecosystems, are particularly prone to invasion by IAP

We performed a scoping study to identify the extent of abandoned agricultural land in Norway with high risk for invasion by IAP, examine key risk factors, and to suggest prioritization criteria for control measures. Secondary data analysis was performed based on a systematic literature review, GIS analyses, and data from two national monitoring programmes for the agricultural landscape (3Q and ASO). In the 3Q-programme, monitoring squares located on overgrown farmland, had more IAP species than squares on maintained land. Also, data from the ASO-programme confirm that semi-natural meadows that are abandoned or poorly maintained seem to have higher IAP presence than well maintained meadows. These findings indicate that abandoned agricultural land indeed is highly susceptible to IAP, which is also supported by existing literature. High diversity of native species may increase resistance to IAP through competition. Our work focused also on the role of the surrounding landscape and how it influences the spread of IAP to or from abandoned farmland. Roads, field margins, waterways, and urban areas near abandoned land serve as invasion corridors and hotspots, increasing risk

A hierarchical approach is recommended for prioritizing intervention areas, focusing on IAP occurrences, proximity to potential dispersal pathways, and risks to cultural or natural values. Highly aggressive IAP should be prioritized for control measures, along with abandoned lands near active farms for easier reintegration. Prevention is the most cost-effective strategy, including maintaining active farming, enforcing land-use policies, providing financial incentives, and managing dispersal pathways. Also, increasing public awareness and farmer support are crucial to ensure early detection and rapid-response measures to avoid uncontrolled spread of IAP at an early stage.

Poster presentation

The Many Faces of Abandoned Lands: Causes and Contemporary Transformations of Abandoned Landscapes in the Sudetes, SW Poland

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The paper aims to present the extensive land abandonment in the 1980s and 1990s in the Sudetes Mountains, SW Poland, and the subsequent transformations of the abandoned areas. These areas exhibit various trajectories of land use transitions that emerge in post-abandoned landscapes. While some areas have developed into novel, enriched ecosystems resulting from both vegetation succession and the preservation of former human-related (synanthropic and ruderal) species, other areas are currently subject to conflicting paths of reuse. This is mainly reflected in the intensification of urbanization pressure on abandoned agricultural lands, which can also be observed in areas previously designated as nature protection zones (e.g., Natura 2000, landscape parks, areas of protected landscape). In contrast, some abandoned areas have been transformed into tourist attractions, with their educational values being highlighted.

Additionally, the study addresses the driving mechanisms of landscape changes, which include both environmental and socio-economic factors. The research was based on a mixed-method approach involving field surveys, cartographic and iconographic materials from various time periods, aerial photographs, and interviews with local inhabitants.

Poster presentation

Session 1E – Islandscapes: from Biodiversity to Ecosystem Services

Symposium

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Keywords: islandscapes, ecosystem services, biodiversity, natural capital, planning

European territory is strewn with islands including Mediterranean, North Seas but also Overseas Territories. These islands are hotspots of biodiversity and evolution which is an outcome of abiotic diversity but also cultural diversity creating unique land- and seascapes. Islandscapes reflect people-environment interdependence, while natural capital on island spaces includes both terrestrial and marine elements. Planning for biodiversity management conservation on islandscapes becomes challenging since space is limited and pressures are amplified, while currently there is a paradigm shift from biodiversity conservation to ecosystem services (ES) supply. An island's limited space and isolation means that natural capital is constrained, influenced more by externalities but at the same time precious for island societies and beyond. The session will address both conceptual and methodological issues, including data challenges pertaining to natural capital assessment on islandscapes, with emphasis on small and medium size islands. It will seek to address questions such as: How do you manage natural capital and main pressures related to islandscapes of Europe? How can we account for the marine natural capital of an island? How do you plan for conservation and ES management in these spaces? Are traditional conservation approaches enough? Can we rely on new "allies", and methods already employed for landscapes and seascapes? A large part of the session will focus on work related to the COST Action SMILES (CA21158) on European islands. However, it is open to submission of any related work which deals with terrestrial marine and coastal aspects of islandscapes. We would expect 10 contributions for this session. The contributions from this session will form the core of a special issue on an international journal.

Island time – Islands as natural laboratories to study nature's contributions to human sense of time

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There is growing evidence that nature provides a wide range of contributions to people which are essential to maintain human health and well-being. While many of these contributions are increasingly being recognized, others remain to be discovered and explored. This is the case for the pivotal role that nature experiences play in shaping human time perception – our sense of time. Human time perception is complex and involves at least three key dimensions related to temporal succession, temporal duration, and temporal perspective. Yet, it is also subjective and shaped by various contextual factors, including internal cognitive, emotional and bodily characteristics as well external characteristics of the environment. Here, I draw from a growing body of evidence showing that nature experiences can influence human sense of time to propose that the role nature plays in shaping human time perception should be perceived as an ecosystem service. Furthermore, I argue that islands represent ideal natural laboratories to study the relationship between nature and time perception due to the unique combination of urban natural settings found in modern islandscapes. This can help reveal what elements of nature hold the key to reshape human time perception and provide additional clues on the unique temporalities of islands and islanders (“island time”). In a context of increasing time scarcity in modern urban societies with dire consequences for human health and well-being, a better understanding of how nature experiences shape our sense of time can generate actionable insights that can help to restore a healthier and more balanced relationship with time and nature.

Oral presentation

Other Effective area-based Conservation Measures (OECM) in European Islands

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Islands have long been studied for their unique and endemic biodiversity, and their distinctive geographical characteristics, such as remoteness, isolation, and limited area. These characteristics, along with other environmental conditions, have positively influenced human appreciation for tourism, recreational activities, and the exploitation of natural resources. At a time when European and global policies aim to halt biodiversity loss and achieve climate neutrality, islands face greater challenges in accomplishing these goals compared to continental areas, as biodiversity conservation and increasing human demand for island ecosystem services must coexist within a limited space. Other Effective Area-Based Conservation Measures (OECMs) could serve as a crucial tool for active conservation in areas in which biodiversity management is not the primary objective but benefits as a byproduct of other management activities. Through this perspective, this study aims to identify areas suitable for OECMs in European islands by employing an analytical geographical approach based on the IUCN framework. The findings indicate that most candidate OECMs are found on large and medium-sized islands. Their absence on smaller islands is largely due to the fact that the data availability at this smaller scale, or lack thereof, cannot meet the requirements of the OECMs' criteria. This suggests that in order to apply IUCN's framework for OECMs at a smaller scale, one should consider local specificities and data needs to ensure that the defined locations are in fact representative of islands. Recognizing OECMs could significantly benefit biodiversity conservation on islands, either by protecting currently unprotected species and habitats or by expanding existing protected areas to support a more holistic conservation approach. This underscores the potential of OECMs to enhance conservation efforts, fostering a more resilient, multifunctional, and multi-use landscape across European islands.

Oral presentation

Unlocking Nature's Value in Cyprus: The Contribution of Protected Areas to Ecosystem Services

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Ecosystem services (ES) are fundamentally tied to habitat and species protection, as well as biodiversity conservation. The Natura 2000 ecological network, established to safeguard Europe's biodiversity, plays a crucial role in recognizing the socio-economic benefits of protected areas. However, integrating ES into conservation strategies remains a challenge, particularly at the national level. This study presents a methodological approach and provides the first qualitative insights from an ES assessment of Natura 2000 areas in Cyprus.

Using data from Cyprus' first national ES assessment, we quantified and spatially mapped the potential ES provision across nine sites within the Natura 2000 network. A rapid assessment method, based on the matrix approach with the help of experts, was applied to quantify the potential contributions of each habitat type. By aggregating individual ES values, we generated a total ES supply map for each of the nine assessed Natura 2000 sites in Cyprus.

Our findings reveal significant variations in ES supply across different ecosystem types. Inland aquatic ecosystems exhibit the highest potential for regulating ES, while forests and shrublands offer substantial cultural ES. Agroecosystems demonstrate the highest potential for provisioning ES. We identify ES hotspots and cold spots, examine differences among N2K sites, and emphasize the importance of integrating ES hotspots into spatial planning, particularly within the context of small island states

Oral presentation

Accounting for European islands' natural capital: building a metadatabase as a tool for decision-making

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Islands often represent hotspots for biodiversity, and a wealth of endemisms, as a result of the variety of environments and the particular ecological conditions that are created. Identifying the natural capital of these territories is particularly problematic, since information is not always complete and consistent in order to allow an adequate comparison between similar environments, and because some aspects of natural capital have not been well defined. SMILES (Enhancing Small-Medium Islands resilience by securing the sustainability of Ecosystem Services) is a COST action which aims to provide an answer, among other things, to this challenge.

We built a large metadatabase, that covers about 6.000 European islands whose surface is between 1 -10,000 km², considering the entire Mediterranean basin, the seas that bathe continental Europe, and the overseas territories. We identified main natural capital components and links with the database. The database provides a tool to decision makers and stakeholders, and offers an important framework to identify conservation and management priorities, even between islands that are apparently very similar. For example, the analysis of protected landscapes (Unesco sensu) shows how important are several small islands in North Sea and Baltic Sea.

Defining and using “marine natural capital” is an important aspect covered and discussed in the SMILES framework. Combining ecological zones, geographical factors and political borders we were able to delineate a buffer area around islands that can be considered part of Marine Natural Capital belonging to the island

Examples from Sicily channel or Dalmatian archipelagos provide a way of buffers belonging to islands. FAO data set of fish resources can be the main source for information on marine natural capital

Last activity of this WG was the realization of a cartoon on Natural Capital for islands, as a dissemination tool for stakeholders and citizens.

Oral presentation

Roadkill in a highly fragmented landscape: Insights from a Mediterranean Island.

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Roads are one of the main components of the modern, human-dominated, world. While their contributions to transport, the economy, and even social aspects of life are undeniable, so are their, at times devastating effects, on the environment. While the effects of road networks on mainland areas have been investigated thoroughly, there is a lack of relevant interest concerning small-medium island ecosystems (<10,000 square Km). The effects of road networks, ranging from direct roadkill incidents to habitat fragmentation and soil sealing, can be potentially intensified in small-medium islands, where the rules of island ecology apply, and ecosystem properties interact and respond to human pressures in different ways than in mainland areas. In this research, we utilize the first systematic roadkill dataset from the island of Cyprus and attempt to quantify the extent of road networks effects on island ecosystems through roadkill incident frequency (hotspots) combined with fragmentation indices. The data collection took place in 2024 and 2025, with systematic surveys on 12 linear road systems (approximate total length ~ 47 Km) covering urban, semi-urban, industrial, agricultural and forested areas. Each of the roads was monitored four times per month following a standardized procedure, using a protocol for roadkill observation. Roadkill hotspots were calculated with the KDE+ software for each of the roads monitored. Fragmentation indices, (i.e. number of patches, mean patch size and patch density) were calculated through QGIS and the Landscape Ecology plugin at a 200 meters radius around every hotspot. Correlation of hotspots with distance from different land covers and water bodies was investigated. Descriptive and statistical analyses of the roadkill dataset and the correlation of hotspots with fragmentation and land covers were conducted through Microsoft Excel and RStudio. Preliminary results show that out of the 282 animals recorded, 198 concerned wild fauna species, with hotspot locations showcasing seasonal differences, and the most impacted species groups being birds and mammals (hedgehogs). While intense fragmentation contributed positively to roadkill frequency, land use types and distance from resources (i.e. water bodies) affected hotspot locations greatly. Highest roadkill rates were recorded in industrial and agricultural areas, further affected by distance from specific land cover types and water bodies. Proximity to certain land use types affect differently the fauna groups involved and therefore roadkill rates, for example rats in industrial areas or reptiles in forested areas. Cyprus is a Mediterranean island with high biodiversity, but also one of the densest European road networks. We envisage that this groundwork will spark academic and conservation interest both for novel research on the topic, as well as for establishing long-term monitoring in areas where such efforts are already present.

Oral presentation

Assessing Spatial Variations in CES Perceptions for Coastal Landscape Management: Urban-Rural Case Study in China

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Coastal cultural landscapes, as integral components of islandscapes, provide essential cultural, social, and ecological services, supporting dense populations and contributing to global ecosystem functions. However, spatial constraints, rapid urbanization, and environmental pressures are reshaping these landscapes, posing significant challenges for sustainable management, similar to those faced in islandscapes. This study examines the spatial distribution and supply of Cultural Ecosystem Services (CES) within the urban and rural contexts of Quanzhou's coastal cultural landscapes, highlighting implications for ES-based management strategies in constrained coastal and island environments. By employing questionnaire surveys and Participatory Geographic Information Systems (PPGIS), we analyze public perceptions of CES across different infrastructure types, including grey, blue, and green infrastructure. The findings indicate that urban areas, particularly historic districts, serve as hotspots for CES such as cultural heritage, religious values, and sense of place, whereas rural areas primarily emphasize landscape appreciation and recreation. Grey infrastructure, notably historic buildings, alongside blue-green infrastructure, including urban parks and historic villages, constitute critical elements of the natural and cultural capital shaping CES perceptions. Significant disparities in CES perceptions between urban and rural settings are influenced by socio-economic factors and diverse landscape features. This study underscores the necessity of integrating urban and rural perspectives into the planning and management of island and coastal cultural landscapes, offering strategic recommendations for balancing conservation and ecosystem service supply in spatially constrained environments.

Oral presentation

Biodiversity monitoring of island ecosystems with remote sensing

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Oceanic islands contribute disproportionately to global biodiversity, hosting many endemic species with unique evolutionary and functional adaptations. Yet, ecosystems on islands are particularly vulnerable to land-use and climate changes and introduction of invasive species. Therefore, national, transnational, and global initiatives should explicitly include islands by considering essential biodiversity variables (EBVs) that capture their ecological uniqueness and tailor protocols to the island context. In the BioMonI project [Biodiversity Monitoring of Island Ecosystems], we endeavor to build a roadmap for a long-term monitoring network adapted to the pressing needs of biodiversity conservation and monitoring on islands of the European Union and beyond. Our work package aims at scaling up ecosystem monitoring with remote sensing, focusing on EBV related to ecosystem functioning and structure. In 2024-2025, we collected terrestrial laser scans across major habitats of Tenerife, Spain and La Réunion, France. We quantified the occupation of 3D space by the vegetation by deriving structural complexity indices from the point cloud data. Our results demonstrate that these indices have potential to characterize relevant aspects of the structure of different types of habitats. We will discuss the future directions of our methodologies to develop island biodiversity monitoring protocols integrating ground-based and remote sensing measurements.

Oral presentation

Investigation into the Landscape Qualities of Dugi Otok Island

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Dugi Otok, characterized by its distinctive karst landscape, faces significant challenges related to depopulation and the pressures of tourism development—one of the primary drivers of economic growth. It is hypothesized that the landscape values of the island are not fully recognized and that the natural integrity of the landscape is at risk due to the planning and implementation of projects that fail to respect its unique characteristics. The objective of this study is to identify the most valuable areas of the island's landscape and to formulate guidelines for regional development and project planning. This is achieved through the analysis of spatial factors using spatial data and relevant literature, leading to the creation of cartographic representations in QGIS. Subsequently, landscape quality modeling is conducted using the ProVal 2000 program, wherein the analyzed spatial factors are classified into three categories: natural, cultural, and visual. The resulting composite quality model highlights the most valuable and vulnerable areas of Dugi Otok. The island's development directions and vision are further determined through an examination of strategic policy documents. The proposed development strategies for Dugi Otok focus on improving infrastructure, enhancing social activities, raising living standards, and diversifying tourism offerings. In conclusion, development guidelines are proposed that align with the island's strategic vision and the identified high-quality landscape areas. These guidelines integrate previously suggested measures while clearly defining implementation mechanisms and regulatory frameworks for managing landscape interventions effectively.

Poster presentation

An LCA perspective on landscape management in islands and mountain areas: how to account for ecosystem services to increase wildfire resilience

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Islands and mountains have long captivated naturalists, evolutionary biologists, and ecologists. Islands have been central to biogeography and speciation theories, while mountain ranges have provided insights into how populations adapt to temperature variations and how this influences species distribution globally. Both islands of varying sizes and mountains with different altitudinal ranges serve as unique "natural laboratories" for studying the effects of species loss and climate change on ecosystem service delivery. These environments share the common feature of isolation, often hosting endemic species and facing similar socioeconomic challenges, such as land abandonment. In the context of climate change, they experience increased pressure, necessitating effective landscape management to reduce wildfire risks. Recent wildfire events in Rhodes and mountainous regions of mainland Europe have heightened public awareness and concern. One emerging approach to landscape management is the valuation and payment for ecosystem services. Activities traditionally viewed negatively in environmental impact assessments can offer unrecognized benefits. For example, herding, once considered harmful, is now seen as beneficial for promoting ecosystem services like fire protection. This work explores the role a proper Life Cycle Assessment (LCA) indicator can have in evaluating and promoting multifunctional herding. By accurately accounting for the wildfire protection benefits provided by grazing, we can develop a new rationale for supporting ecosystem services policies. This approach can foster more dynamic and multifunctional economic activities in both islands and mountainous regions, especially in the context of a changing climate.

Poster presentation

Biodiversity and Ecosystem Services assessment in degraded agroecosystems, the LIFE-AgrOassis project

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The current work presents the main concepts and preliminary actions related to biodiversity and ecosystem services assessment in three degraded agricultural areas in Cyprus (namely, Tersephanou, Akaki, Peristerona) as part of the LIFE AgrOassis project (LIFE21 CCA/CY/101074744). The project aims to revert soil degradation and enhance soil quality by improving the soil structure, preventing soil erosion, enriching soil carbon, preserving soil water, enhancing soil fertility, and promoting soil biodiversity in degraded areas. The proposed interventions are expected to support ecosystem services and biodiversity conservation in farmlands prone to desertification.

Biodiversity assessment was conducted by using line transect monitoring in selected fields within the above degraded areas (10 transect lines of 50 m in each area) during spring-summer seasons of 2024 and 2025. Plant composition was determined by recording trees and shrubs in two plots (2m X 2m) per transect. Butterflies and grasshoppers were recorded by walking at a slow, constant pace along the transect using a handheld net. Soil arthropods were sampled using two pitfall traps placed at 30m and 50m along each transect. For reptiles, a time-constrained survey was conducted at each transect, searching for herpetofauna within available microhabitats (e.g. stonewalls, rock/brush piles). The characteristics of each field (e.g. monoculture vs diversified, nitrogen and fertilizer inputs, presence of hedgerows, in row vegetation, brush/rock piles, stonewalls) were analyzed to assess the impact of different agricultural practices on biodiversity.

At the same time, we employ the CICES ecosystem assessment framework to identify and classify ecosystem services provided by agroecosystems. Understanding the impacts of actual and potential changes in the state of ecosystems at individual sites is essential for promoting better planning decisions that support both biodiversity conservation and ecosystem service delivery. The methodology relies on relatively inexpensive, widely available techniques (e.g., the TESSA toolkit), allowing for comparable estimates of the most likely alternative state of the site (e.g., post-implementation of the proposed actions). This enables farmers and decision-makers to assess the net consequences of such changes and their resulting benefits. Additionally, using the Ecosystem Services Valuation Database (<https://www.esvd.info/>), we attempt to assign a monetary value to the provided ecosystem services.

Poster presentation

Session 1F – Making It Back Better: Landscape Restoration in Conflict-Affected Regions

Symposium

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Keywords: war affected regions, landscape planning, landscape architecture

This session explores how landscapes profoundly shaped by war and conflict can become sites of ecological regeneration, cultural renewal, and social healing. Drawing from case studies in Ukraine, Somalia, and beyond, the presentations examine diverse approaches to assessing war-related damage, designing therapeutic and inclusive spaces, and engaging communities in post-trauma recovery. From high-resolution remote sensing and ecological analysis to community gardens and university campus restoration, the contributions highlight both the physical and symbolic dimensions of rebuilding. The session aims to critically reflect on how landscape architecture, planning, and civic engagement can contribute to more resilient, inclusive, and hopeful futures in areas still experiencing or emerging from conflict.

Identification and Classification of War-affected Areas based on High-resolution Remote Sensing Data

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Reliable and up-to-date identification and classification of war-affected landscapes is a basic prerequisite for effective post-war landscape restoration. The use of satellite technology has a long history as a tool of warfare, but much less research has used satellite technologies to study the effects of war. Remote sensing based research holds significance, especially in areas that may be too dangerous for scientists to conduct fieldwork on-site.

To better understand how armed conflicts, affect land use/land cover, we conducted a computer-assisted photo interpretation of PlanetScope data of the Hostomel settlement in Ukraine with a total area of 66.55 km². We analysed and classified the manifestations of war-affected areas (burnt residential buildings, destroyed industrial buildings, destroyed roads, damaged green areas, etc.) using extended CORINE Land Cover classification.

Based on the analysis, 34.76 km² of the studied area was damaged by the war, representing 52.2% of the settlement's territory. The most represented land use/land cover class was Damaged arable land (1957.95 hectares, i.e. 29.4% of the total area of the settlement or 68.6% of the total area of arable land). The following land use/land cover classes were also significant: Abandoned residential areas (750.41 hectares, i.e. 11.3% of the total area of the settlement or 56.5% of the total area of residential areas), Abandoned areas of production, warehouses, and services (254.84 hectares, i.e. 3.8%), and Burnt forests (242.24 hectares, i.e. 3.6%).

This work was supported by the Slovak Scientific Grant Agency VEGA under Grant 2/0043/23 'Detection of landscape diversity and its changes in Slovakia based on remote sensing data in the context of the European Green Deal'.

Oral presentation

Therapeutic landscape and housing integration: a holistic healing model for post-war societies in forest ecosystems

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Communities, cities, and regions that have been exposed to multi-dimensional destruction due to war must address and resolve their social, economic, and physical problems through both strategic and action plans. In the creation of these action plans, elements such as meeting humanitarian needs, physical restoration and rehabilitation, political rehabilitation, economic rehabilitation, reconciliation, coping with trauma, and establishing the foundations for sustainable development are encountered. These elements cannot be evaluated independently or in isolation from one another. However, within the scope of this study, the focus has been on the element of physical restoration and rehabilitation, and the relationships with other elements have been emphasized.

In this context, the research questions include: Is it possible to create a design model that integrates therapeutic ecosystems and housing areas after addressing the immediate needs of people in war-destroyed urban areas, and how can this integration be made more effective? How do natural environment arrangements contribute to the socio-psychological recovery of communities? How can the proposed model be adapted to different socio-cultural and environmental conditions?

The model developed in the study aims to increase social welfare and urban health in post-war cities by integrating nature-based solutions and agroforestry practices with therapeutic landscapes and housing areas. It is also supported by sustainable reconstruction goals that combine urban security, social needs, and biodiversity-focused ecosystem management. The model promotes ecotherapy practices and the sustainable development of forest-based livelihoods to support post-trauma recovery processes. The integration of forest ecosystems with cities and the use of AI-assisted spatial informatics and design tools in this process aim to create adaptable and resilient urban designs. Participatory design methodologies are used to strengthen social cohesion among urban residents, ecosystem-based environmental restorations are carried out, and spaces for commemoration and memory are also included. The study adopts a multi-dimensional and interdisciplinary research methodology to deeply analyze the needs arising from post-war urban and social dynamics. In the first stage of the research, an extensive literature review is conducted, evaluating the theoretical foundations and strategic approaches of rehabilitation methods applied in different geographic regions, and case studies are carried out through various applications. These case studies focus on the long-term effects of the applications, each focusing on its unique local dynamics and the effectiveness of the method used. The collected data are examined through comparative analysis, analyzing the effectiveness of different methodologies and the conditions under which they provide optimal results. Finally, a comprehensive impact analysis is conducted to

assess the long-term effects of the projects. The results provide insights into the development of effective strategies that can be applied in the reconstruction and rehabilitation processes of post-war cities, and the role of landscape areas and architectural approaches in creating sustainable and supportive living spaces in post-war environments.

Oral presentation

“Co-creation”- Urban community gardens as social places: cases from Ukraine

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Urban community gardens play a crucial role in the welfare of urban dwellers. In times of crises (like the ongoing Russian invasion in Ukraine), socio-ecological systems become destabilized across multiple levels. This can trigger cascading effects, including economic disruptions, ecological degradation, public health crises, geopolitical tensions, and mass migration, ultimately exacerbating the polycrisis of society.

It is crucial to identify initiatives which help to deal with stress, social isolation, and other effects of these crises. Civic ecology practices often emerge in response to natural disasters and armed conflicts, particularly when formal institutions fall short in addressing urgent needs.

The aim of the study was to explore the emergence and impact of urban community gardens as grassroots greening initiatives in conflict-affected urban areas of Ukraine, focusing on the motivations, stakeholders, spaces, and practices involved in recovery at the community and individual level during wartime.

Using the snowball sampling technique, we conducted 49 semi-structured face-to-face interviews with organisers and visitors of urban community gardens initiated by civil sectors in different towns across Ukraine (Lviv, Lutsk, Kyiv, Chortkiv and Volochysk). Collected data were processed by means of content analysis using NVivo software following the main themes in the practice theory framework: competences, meanings and resources.

Our study highlights the significant role of civic ecology practices in supporting post-trauma recovery among citizens in Ukraine. The results reveal a wide range of perceived motivations for establishing UCGs, including well-being and stress recovery, post-trauma healing, recreation, social involvement, community cohesion, education, and leisure activities. Among the intangible benefits, UCGs were frequently cited as important spaces for recreation, social interaction, and the formation of new social connections. They were also perceived as vital platforms for internally displaced people to interact, recover from stress, and reconnect with gardening practices they had lost due to the war. We argue that UCGs have strong potential to be integrated into post-war landscapes as tools for fostering social cohesion and supporting stress recovery.

Oral presentation

The implications of armed conflict in Ukraine shelterbelts and steppe landscapes

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The 2022 Russian invasion of Ukraine already resulted in large-scale devastation, human deaths, economic losses and humanitarian catastrophe. However, it also has probably impacted the functioning of environmental systems and had a negative impact on landscapes. Here we evaluated the state of land use all over Ukraine before and after the 2022-armed conflict with multitemporal composites of Sentinel-2 imagery and random forest classifier. Next, we allocated approximate positions of front lines in different periods of armed conflict (until December 1st, 2022) and quantified with statistical models the spatial distribution of abandoned lands and armed-conflict-induced wildfires. Our analysis was complemented by evaluating armed-conflict-impacted landscapes by calculating landscape indices, including morphological analysis. The results showed that after 2022 some patterns of cropland abandonment and wildfires, detected with MODIS products, were close to the front lines. The landscape ecological analysis showed that combat activities took place in already fragmented landscapes, such as the South and South-East corners of Ukraine, where croplands dominate the landscapes and remnants of forests, tree lines (shelterbelts) served as “natural fortresses” and grasslands form small patches. Therefore, armed conflict in Ukraine has another strong negative pressure on the remaining seminatural vegetation, possibly reducing its resilience and adaptation to adverse climate effects projected in the South and South-East of Ukraine and causing the losses of biodiversity.

Poster presentation

Theme 2. Monitoring the landscape conditions and impact of landscape change

This theme relates to the role of landscape ecology in addressing the conditions and states that characterise landscapes. Changes in these conditions have been seen to impact landscape patterns and processes, the provision of landscape services, human well-being and the overall quality of the landscapes. Such conditions could be investigated as they have been in the past, as they are now, or as we predict they will unfold in the future. In this regard, approaches such as historical landscape research or the study of landscapes in conjunction with palaeoecological and archaeological investigations provide glimpses of the past, while landscape visions and scenarios help us address the upcoming challenges. Conditions that characterize landscapes can include and are not limited to landscape patterns, processes, and interactions, including biodiversity, habitats and species distribution, human-nature interactions, provision of landscape and ecosystem services.

Session 2A – Mapping Megatrends in Changing Agricultural Landscapes

Symposium

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Keywords: land-use planning, socio-economic factors, landscape-level agricultural management, driving forces

Agricultural landscapes are affected by megatrends (sensu Debonne et al. 2022: climate change, demographic changes, (post-)productivism shifts, environmental regulations) that operate across different spatiotemporal scales to alter landscape structure and functioning. This symposium focuses on how we can quantify and predict changes driven by megatrends to better plan and manage the response of agroecosystems, and support policy that promote sustainable practices. A key bottleneck is data availability and spatial extent: while land use data is readily available, socio-economic data to quantify megatrends are often hard to access and not tied to spatial locations. This symposium will combine invited and contributed talks that explicitly address the challenges of how to: (a) scale megatrends down to management units, (b) link megatrends to biodiversity and ecosystem service data, (c) produce maps that define landscapes as planning areas combining ecological processes and anthropogenic pressures, (d) anticipate what land-use changes are likely to happen where, and how they will affect biodiversity and ecosystem services, and (e) predict the effect of alternative management scenarios. Mapping and monitoring megatrends and their landscape impacts will enable practitioners to prioritize conservation and restoration efforts, ultimately promoting biodiversity and ecosystem services within agricultural landscapes in a global change context.

Balancing biodiversity and crop yield: evaluating the impact of agri-environment schemes on arthropod diversity and agricultural production in Europe

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In Europe, agri-environment schemes (AES) are a key instrument to combat the ongoing decline of farmland biodiversity. AES aim to support biodiversity and maintain ecosystem services, such as pollination or pest control. To what extent AES affect crop yield is still poorly understood. We performed a systematic review, including hierarchical meta-analyses, to investigate potential trade-offs and win-wins between the effectiveness of AES for arthropod diversity and agricultural yield on European croplands. Altogether, we found 26 studies with a total of 125 data points that fulfilled our study inclusion criteria. From each study, we extracted data on biodiversity (arthropod species richness and abundance) and yield for fields with AES management and control fields without AES. The majority of the studies reported significantly higher species richness and abundance of arthropods (especially wild pollinators) in fields with AES (31% increase), but yields were at the same time significantly lower on fields with AES compared to control fields (21% decrease). Our results show that landscape structure significantly moderated the effect of AES on arthropod diversity. In simple landscapes, arthropod species richness and abundance were significantly higher (29% and 35% increase) in AES than in control fields, but yield was at the same time significantly lower (36% and 33% decrease). This shows the trade-off between biodiversity win and yield loss. In contrast, in complex landscapes, yield did not significantly differ between AES and control fields, but neither did arthropod richness nor abundance. Aside from the opportunity costs, AES that promote out-of-production elements (e.g., wildflower strips) supported biodiversity (29–32% increase) without significantly compromising yield (2–5% increase). Farmers can get an even higher yield in these situations than in current conventional agricultural production systems without AES. Thus, our study is useful to identify AES demonstrating benefits for arthropod biodiversity with negligible or relatively low costs regarding yield losses. Further optimization of the design and management of AES is needed to improve their effectiveness in promoting both biodiversity and minimizing crop yield losses. For more details, please, see: <https://doi.org/10.1016/j.jenvman.2024.120277>

Oral presentation

From the analysis of global megatrends to the spatial modeling of local indicators

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Megatrends (MTs)—sweeping socio-environmental pressures—are reshaping agricultural landscapes and their biodiversity. If these MTs have global effects, their impacts vary according to local conditions, which makes the characterization of these dynamics a challenge at the territorial scale. To address this challenge, we must first identify precise indicators that capture complex phenomena and translate them spatially. The second step is the quantification of these indicators as precisely as possible in order to be usable at the landscape scale (i.e. the actionable scale). To do this, it is necessary to have data that is: (i) easily and freely accessible, (ii) reliable and regularly updated, (iii) at a sufficiently precise spatial resolution to provide an effective decision-making tool and thus enable its practical exploitation. Drawing on insights from MOTIVER—a multidisciplinary scientific consortium of 18 researchers in ecology, geography, and law—indicators were identified for each megatrend and validated through scientific literature. Here we present (i) a methodological framework to guide the choice of relevant indicators depending on the research question by linking them to specific MTs (political stringency, productivism shifts, demographic changes, and climate change) or, in the absence of a direct link, by exploring alternative approaches like spatial signature analysis; (ii) concrete examples of indicators, including data and maps, that illustrate how these measures can be calculated and spatially translated to be operational at the landscape scale. A set of 67 indicators were identified, with indicators shared by several MTs. Only one indicator, “crop diversity”, is found to be common to all megatrends. A select group of indicators was mapped and measured, showcasing their power to reveal megatrend dynamics across landscapes with striking spatial precision.

Oral presentation

The Influence of 200 Years of Agricultural Landscape Change on Present-Day Genetic Structure of Forest Herb Populations

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Landscape history is a crucial yet often overlooked factor shaping population genetic structure. In landscape genetics, what typically quantified is historical gene flow, which captures the additive functional connectivity of the landscape over an undefined period. Generally, this genetic signal represents past rather than present-day landscape composition and configurations, due to the time lag required for populations to reach equilibrium between genetic structure and functional connectivity. The length of the lag is however influenced by multiple factors like species life history and genetic structure measures applied.

In Central Europe, agricultural landscapes have been evolving for centuries, with continuous changes in landscape composition and land-use intensity. For forest-dwelling species now confined to small, isolated woodland remnants within this dynamic agricultural setting, both past and present gene flow plays a significant role in shaping their genetic structure. It is important to analyse whether and how historical landscapes have influenced these species and contributed to their long-term persistence.

To investigate this, we reconstructed historical landscapes for three regions (eastern Germany, western Germany and southern Sweden) at multiple time points using aerial imagery and historical maps. These reconstructions enabled us to examine past landscape composition and configurations and their influence on the population genetic structure of three forest herb species differing in multiple life history traits. We found that (i) historical landscape matrices could better explain genetic variation than contemporary ones, (ii) species with longer generation times exhibited a greater time lag in their genetic response compared to those with shorter generation times and (iii) although not dominant, semi-natural landscape elements still play an important role in shaping population genetics of forest herbs.

Oral presentation

Characterizing Agricultural Practice Intensities at the Landscape Scale: A Systematic Review of Satellite Remote Sensing Approaches

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The intensity of agricultural practices shapes landscapes and influences biodiversity and ecosystem services. However, quantifying these practices at a large scale remains a challenge due to the lack of spatialized data and standardized methodologies. Satellite remote sensing offers a promising solution to address this gap by providing regular and spatially explicit observations of agroecosystems. This systematic review aims to identify and compare approaches that use high-resolution satellite remote sensing (<30 m) to characterize agricultural practices. The research was conducted on Web of Science in January 2025, targeting nine major categories of agricultural practices: soil preparation, fertilization, sowing, irrigation, crop protection, harvesting, grazing, cover cropping, and intercropping. The paper selection process was assisted by ASReview, applying strict inclusion criteria, with only studies utilizing satellite imagery and producing indicators with a resolution below 30 m being retained. The results reveal strong potential for remote sensing in characterizing agricultural practices, with notable advances in detecting irrigation and soil tillage. Combining radar and optical data, along with integrating machine learning models, appears to be a promising strategy for refining the classification of agricultural practices and improving accuracy. Other practices, such as crop protection, remain less studied, likely due to their limited visible impact on soil structure or plant biochemistry, making them more challenging to detect via remote sensing. This review highlights concrete avenues to enhance the effectiveness of current approaches, including strengthening validation datasets by incorporating field measurements to improve model reliability, and assessing the transferability of methods by diversifying agroecological and pedoclimatic contexts. By structuring existing knowledge, this review provides a solid foundation to accelerate the development of operational tools, facilitating the mapping of agricultural practices and their integration into landscape models. These advancements will ultimately help better understand the links between agricultural practices, biodiversity, and agroecosystem resilience, paving the way for more sustainable and informed landscape management.

Oral presentation

Changes across socio-economic archetypes are largely shaped by climate and terrain conditions in Spanish rural landscapes

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Landscapes are shaped both by the environmental characteristics of a given territory and by the use that human societies make of the land. Understanding these interactions is highly complex, particularly when analyzed across geographic gradients and over extended time periods. In this study, we examined the current distribution, the temporal trends over the last two decades and the key drivers of the main socioeconomic archetypes linked to Spanish rural landscapes. To achieve this goal, spatial clustering techniques and generalized linear models were applied on a large database of socio-economic variables (population, economic activities and land use) aggregated at the municipality level.

We found 14 different types of socioeconomic systems, which were distributed heterogeneously following geographical gradients across Spain. Over the past two decades, approximately 25% of the municipalities have transitioned from one typology to another. We found that municipalities located in areas with more extreme climatic conditions (for example showing higher continentality, or lower annual precipitation), or lower primary productivity, were more prone to change. Similarly, areas more suitable for intensive activities (for example, showing lower terrain variability) also exhibited higher probabilities of transformation.

These findings underscore the critical role of environmental factors, such as climate and topography, in shaping not only rural socioeconomic systems, but also their dynamics of change and transformation even at a medium term. Furthermore, they highlight the dynamic nature of human-environment interactions in the context of ongoing global environmental change, which can have diverse and region-specific impacts on different landscape types. From this perspective, it is worth noting that global and climate change may have a noticeable influence on these processes in the foreseeable future.

Oral presentation

Megatrends in European landscapes: mapping and identifying underlying structures

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Megatrends are affecting European landscapes. While these are often large scale processes with continental or global scale impacts, the way they affect landscapes is often regionally distinct. Moreover, it is the specific combination of megatrends that often creates a 'perfect storm' that may result in collapse of current landscape conditions and the transformation of these landscapes. In this presentation we will tap into two recent mappings of mega-trends for respectively European agricultural and forest landscapes. We will look at the way these trends may affect landscape conditions, but also present some analysis of underlying socio-economic structures that are a root cause of these trends. While mapping of mega-trends is critical for taking appropriate action and adaptation, the understanding of the underlying structures is critical for understanding leverage points for transformation. For agricultural landscapes we will present a study on how agri-food networks underlie some of the observed megatrends and how modelling can help to better understand the dynamics of these trends.

Oral presentation

Kyrgyzstan's Croplands: Haven or Threat to Biodiversity?

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The interplay between agricultural land use and biodiversity loss is a pressing global challenge, especially in biodiversity hotspots like the “Mountains of Central Asia.” Kyrgyzstan, located within this hotspot, has limited arable land, mostly confined to narrow valleys separated by mountain ranges with diverse ecological niches. Despite this, it supports a unique segetal flora, including many endemic species. Understanding the composition and distribution of these species is key to developing sustainable farming practices that balance yield stability with biodiversity conservation. However, vegetation studies on this topic remain scarce. To address this gap, the Sustainable Silk Road 4.0 project has carried out extensive vegetation mapping in Kyrgyzstan's croplands, providing new insights into regional influences on the biodiversity of arable lands.

Vegetation mapping was conducted in three biogeographical regions, with a 5 × 5 km cropland area selected in each. Sampling in each study area followed two 2.5 km transects: one running perpendicular to a north-facing slope and the other parallel. Rectangular plots (1 × 5 m) were placed alternately at field edges and centres along the transects. All vascular plants, including crops, were recorded, and their relative abundance was assessed using the Braun-Blanquet scale. The analysis focused on species diversity, crop type, proximity to slopes, and spatial patterns within fields, enabling both intra- and inter-regional comparisons.

The results highlight significant regional differences in species composition. Of the 223 taxa recorded, only nine were common across all regions, while many of the most frequent species in each region were absent in others. Species richness was on average 20% higher at field edges, and notably, scree-associated plants (e.g. *Lagochilus occultiflorus* Rupr.) were more prevalent near slopes.

Our findings suggest that species from adjacent slopes can establish secondary habitats in farmland, a phenomenon already documented in Tajikistan. This observation may be linked to climate change-induced range shifts, as Kyrgyzstan's mountains undergo rapid environmental transformations. The notable regional differences in the segetal flora are reflected in the distinct regional species pools. We found that the disparities between the study areas were more pronounced than those identified within, emphasising the relevance of regional factors over local variations in small patches of isolated farmland in high mountain ecosystems.

Poster presentation

Urbanization-Induced Transformations in Agricultural Landscapes and Water Resources: The Case of Antalya Düden Stream

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Today, most of the world's population lives in cities and urban areas are rapidly increasing. Growing cities create a serious pressure on natural and rural-agricultural areas, resulting in negative consequences such as degradation or destruction of these areas. Destruction of natural areas also cause serious damage to water resources and, on contrary to this, increasing population and urban uses increase water use. Agricultural areas and water resources are in a constant interaction within ecosystems. While water is the basic need for agricultural activities, they also prevent surface water runoff and support the blue infrastructure by providing water retention and absorption.

Collecting water from the Taurus Mountains and delivering it to the Mediterranean Düden Stream located is one of the important water resources that support the agriculture in the centre of Antalya city. Today, the agricultural areas fed by the Düden Stream have been degraded and even destroyed by urbanisation. Furthermore, many tributaries of Düden Stream are covered by urban areas, which creates environmental problems in terms of agricultural biodiversity loss and sustainability of water resources. Tourism led urban expansion brought further pressures not only on the framing lands but also on the water resources leading the loss of traditional land use patterns and agricultural biodiversity.

The aim of this study is analyse the relationship agriculture, inner city waters and urbanisation in the Mediterranean case of Düden stream in Antalya City. Accordingly, how agriculture has been evolved around Düden Stream will be investigated by using orthophoto images in pre-urbanisation and post-urbanisation (1956-2025) and examining changes through the stream route of Düden and pattern of agricultural landscapes and the interaction between city, agriculture and water. We hope that the result would open a different perspective on water governance in the cities and how city water can help to sustain agricultural landscapes with concern of biodiversity and climate change adaptation.

Poster presentation

The effect of land-cover classification on the ability of “ecolandscapes” to explain bee species distributions

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The new “ecolandscapes” methodology is a promising tool for multi-functional landscape management. The methodology provides an objective way of defining and delineating landscape types across a region. However, the “ecolandscapes” methodology depends on the thematic resolution of the input data (what types of land-use land-covers are mapped), which may influence the ability to link ecolandscapes with biodiversity patterns and the megatrends influencing agricultural systems (sensu Debonne et al. 2022: climate change, demographic change, productivism shifts, environmental programs). Crop diversity is a key indicator of multiple megatrends and influences species distributions. However, crop diversity may not be captured by the land-use land-cover data commonly used to delineate ecolandscape types. In this case study, we assess the degree to which the thematic resolution of the input data affects the ecological relevance of the resulting ecolandscape map in terms of its ability to predict biodiversity patterns. Specifically, we use a bee community in an agricultural region of western Canada to test whether ecolandscapes derived from a general-use land cover map, an open source crop inventory, or a bee habitat map differ in their ability to explain bee species distributions. Including crop types relevant for bees is expected to increase the ability of “ecolandscapes” to explain bee species distributions. Furthermore, the “ecolandscapes” methodology quantifies adjacencies between different cover types, which is a promising advance in bee distribution modeling because bee distributions are associated with high landscape complementarity (multiple habitat types in proximity). Quantifying the “ecolandscapes” methodology’s sensitivity to variation in the input data, especially regarding crop diversity, is key for linking “ecolandscapes” to agricultural megatrend indicators and biodiversity patterns.

Poster presentation

Assessment of the impacts of global changes in the LTSER Trnava platform

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Globalization changes significantly affect the landscape, its resources, but also changes in ecosystems, ecosystem services and subsequently a decrease in the biodiversity of the landscape. Factors causing changes and threats to the landscape and its ecosystems are diverse. They can be divided into two basic groups: natural, caused by evolutionary processes, and anthropogenic, caused by humans and their activities. However, negative human activities do not act in isolation, but often combine and influence each other, becoming uncontrollable and posing an increasing risk to the landscape and the person themselves. Intervention in one component often causes chain reactions and subsequently causes disruption and influence on other components of the landscape, disruption of phenomena and processes taking place in the landscape. From this aspect, it is necessary to develop a methodology for synergistic assessment of the impacts of globalization changes.

The country of Slovakia, including the ILTSEr site, has recently undergone significant changes, which were mainly caused by transformational changes and Slovakia's entry into the EU. The LTSEr Trnava platform was founded in 1985 and is located in the western part of Slovakia. With an area of 741 km² and a population of 132,524, it forms part of the Trnava region. Administratively, it consists of 44 rural settlements and one urban settlement, Trnava, which also serves as the regional capital. The territory represents an intensively used industrial and agricultural area with specific environmental problems such as a high level of environmental contamination, processes of agricultural land degradation, a low degree of ecological stability, etc. The aim of the poster is to present a methodology for synergetic assessment of the impacts of globalization on the landscape and its components (i) and, in the territory of the ILTSEr Trnava platform, to specify the impacts of global changes on ecosystems, natural resources, biodiversity, the environment and landscape structure (ii).

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Poster presentation

Past to Plate: Tracing Protein Crops in Agricultural Landscapes

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Agricultural systems have undergone significant transformations over time, with transitions in crop production, land use, and dietary preferences. This study examines the historical geospatial dynamics of protein crops (e.g. peas, etc.) and their role in Danish agricultural landscapes from the 19th century to the present. By analysing historical agricultural statistics and comparing them with recent data, we explore the evolution of protein crop cultivation, including changes in geographic distribution, as well as the scale and intensity of production (yields, etc.) over time.

Understanding these long-term transitions is crucial for contemporary discussions on sustainable food systems, where plant-based protein sources are increasingly emphasised as climate resilient alternatives that address biodiversity loss, and food security concerns. While modern dietary recommendations and trends promote plant-based proteins, historical data reveal patterns of specialisation, regional suitability (terroir), and long-term trajectories of protein crops. By integrating historical and contemporary perspectives, this study provides insights into the persistence and adaptability of protein crop production across time and space.

These findings contribute to the broader debate on the role of historical land use trajectories in shaping future agricultural strategies and mega trends, offering a valuable perspective on how past experiences can inform modern transitions toward more sustainable protein production systems.

Poster presentation

Selection of indicators for predicting the threat of natural hazards to historic cultural landscapes at local and regional level

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Historic cultural landscapes are an important part of the natural and cultural heritage in a national and international context. Like other landscape types, it is under threat from changing global environmental and socio-economic conditions. With increasing frequency, we are faced with threats to the landscape at local and regional level caused by risks, such as flood and extrem inundation, droughts with accompanying fires, vegetation changes, storms and tornadoes or disease and pest calamities. Correct prediction of the type and intensity of threats to historic cultural landscape units and their landmarks is a prerequisite for optimal choice of their long-term protection, planning and design of measures to strengthen the resilience of historically valuable areas. Indication of predicted risks by means of specifically selected indicators has not been tested on a larger scale on the example of individual types of historic cultural landscapes. The paper presents a partial result of the research project "Historic cultural landscape in danger and vision of its development in the context of current landscape changes". The paper will present a method of selecting indicators of drought and flood risk according to presumptive climate change scenarios in relation to the occurrence of various types and features of historic cultural landscape and their processing in the form of interactive maps. The obtained results are useful for further study of cultural landscape changes in the context of climate change and for the protection, planning and management of this specific type of heritage.

Poster presentation

Traffic growth as megatrend in agricultural landscapes: determining changes in the global ecological impact of road traffic

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Road traffic contributes significantly to various environmental and ecological issues, including habitat fragmentation, wildlife mortality and pollution from chemicals, noise and light. Despite these potentially severe environmental and ecological impacts of road traffic, there is very limited knowledge on the magnitude of these impacts on various land uses. Although few studies assess the impact of roads, none focus on traffic volume, which is the main driver of the magnitude of the impacts. This is due to a lack of large-scale road traffic datasets. Particularly outside of urban areas, where roads intersect agricultural, forested or other natural landscapes, traffic volume information is absent in many countries. In this study, we developed a global time-series of traffic volumes on all highways, primary roads, and secondary roads outside of urban areas (i.e. extra-urban roads) for the years 1975, 1990, 2000 and 2015. With this dataset we subsequently estimated the area of land impacted by road traffic (i.e. road effect zone) and identified which land uses were most strongly affected. We found that the size of the global road effect zone more than doubled between 1975 and 2015 reaching a total area of 52 million ha in 2015. From all land uses, agricultural landscapes were most strongly affected by road traffic. The significant environmental and ecological impact of road traffic in agricultural areas further exacerbates the pressures on biodiversity in these regions. Additionally, the contamination of crops and livestock with toxic substances or microplastics road from traffic poses a growing risk in agricultural areas. We conclude that road traffic is a considerable and growing ecological and environmental threat and that agricultural areas are particularly affected. Findings from this research can be used to develop urban, transport and conservation planning strategies that minimise impacts of road traffic on agricultural landscapes.

Poster presentation

Session 2B – From Landscape Science to Policy: Biodiversity Monitoring at the Landscape Scale for Future Restoration

Symposium

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Keywords: biodiversity monitoring, restoration, science to policy, landscape scale

The biodiversity crisis is taking place at national and international levels, and urgent action is needed to halt the loss of species and habitats and prevent further degradation of ecosystems and their services. Along with habitat loss, fragmentation and degradation, climate change is one of the key global drivers of the dramatic decline in biodiversity. Coordinated actions are needed to address the coupled climate- and biodiversity crises holistically, especially across whole landscapes, by linking freshwater and terrestrial realms. Existing land use conflicts between nature conservation and other land uses will intensify due to increased human demands and climate change impacts. Also, measures to mitigate climate change may create additional pressure on ecosystems, as the accelerated implementation of renewable energy infrastructure will lead to a drastic landscape change in the near future. The quality and effectiveness of protected areas in preserving biodiversity will strongly depend on their connectivity and surrounding natural or semi-natural habitats. Sufficient and high-quality monitoring data are becoming increasingly important in determining possible impacts on biodiversity due to landscape changes. Such data must be reliable, as they also provide the basis for developing effective policies and implementing targeted ecosystem restoration measures. Following research questions address these challenges: – How can novel methods and innovative approaches be optimally integrated into biodiversity monitoring at the landscape scale? – How can we address new challenges, such as the rapid expansion of renewable energy infrastructure, through monitoring? – How can resilient landscapes be maintained or established across realms to provide multifunctional benefits for nature and society? – How to combine the needs for long-term monitoring with shorter-term implementation & evaluation of various policies? To ensure a broad yet thematically focused session, we invite presentations that address various aspects of monitoring in the form of concepts, empirical data and results across realms.

Assessing habitat, plant, insect and habitat diversity in Austrian farmland – the ÖBM-K / BINATS monitoring programme

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Since 2006, the ÖBM-K/BINATS monitoring programme has been implemented in Austrian farmland in order to record status and trends in farmland biodiversity and to assess the performance of conservation measures. In 2017/18 and 2023/24, 200 representative test areas, which were defined based on a stratified sampling in the open cultural landscapes, have been surveyed. They cover main cultivation areas, grassland, semi-natural habitats and alpine pastures throughout Austria. Richness, diversity and coverage is assessed for habitats of the Austrian Red Book Species in the entire test areas of 625x625 m. Species richness, species diversity, and frequency is assessed for vascular plants, butterflies and grasshoppers in ten test circles with a radius of 20 m in each test area, for the insects groups also abundance is determined. Additionally, samples of small arthropods are taken since 2023 in each test area for Metabarcoding. ÖBM-K/BINATS sampling plots are the backbone of a national biodiversity monitoring programme and harbor further surveys of other research groups that deal with wild bees, hoverflies, earthworms, and dung beetles. We will present the structure of the monitoring concept and first analyzes comparing 2017/18 to 2023/24 data (currently not yet available), and the usefulness of the program for the evaluation of restoration success.

Oral presentation

The Forest Biodiversity Index (FOBI): monitoring the biodiversity potential of Britain's public forests over space and time

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A third of British forests are owned or managed by public forest agencies. In adherence to national and international, legally binding treaties and targets, such as the post-2020 Global Biodiversity Framework, these government bodies have a statutory duty of care to safeguard and enhance the biodiversity value of these areas. However, they often lack the information and tools needed to evidence progress towards meeting these obligations and to justify their decision-making. To help fill this information gap, we have co-developed a quantitative, transparent, and repeatable approach for assessing the biodiversity potential of the United Kingdom's (UK) publicly owned forests over space and time. The Forest Biodiversity Index (FOBI) integrates several forest biodiversity indicators or 'metrics,' which characterise management-sensitive woodland and landscape features associated with biodiversity. These are measured or modelled using spatially comprehensive forest survey data and other well-maintained spatial environmental datasets. The FOBI metric and index results are provided at annual intervals for every individual public forest and can be summarised across any reporting region of interest. Compared to existing forest biodiversity indicators that rely on sample-based data, the results better support decisions at a range of scales, from locally targeted management to national, long-term biodiversity monitoring and reporting. We set out how the FOBI approach and associated bespoke online interfaces were co-developed to meet public forest agency needs in two constituent countries of the UK (England and Scotland), while providing a conceptual framework that can be adapted and transferred to other geographic areas and forests. Opportunities and challenges for further extending and implementing the FOBI will also be presented, such as embedding the results into existing reporting and the potential to apply the approach to relatively data-poor private forests using owner-specific survey information and remote sensing data.

Oral presentation

An indicator to monitor the success of agri-environmental policies for pollinators

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The Norwegian monitoring programme for agricultural landscapes has been operational for 25 years. Through repeat mapping of one thousand 1x1 km monitoring squares it measures those aspects of landscape status and change that can be recorded from aerial photographs. In addition, field surveys of birds and plants are carried out at a subset of these areas. In 2021, pollinator monitoring was added to the programme in one region, surveying butterflies and bumblebees along 1 km transects in ten squares. Despite the limited sample, results showed a clear positive relationship between landscape heterogeneity and pollinator abundance and diversity, mirroring patterns observed in farmland birds. We are now developing a pollinator index, an indicator specifically to reflect conditions for pollinators that can be calculated for all one thousand monitoring squares. With increasing awareness of the need to restore nature in our farming landscapes, we hope that the pollinator index will enhance the predictive power of the heterogeneity index, and provide more targeted insights into the success of agri-environmental policies for pollinators.

Oral presentation

Towards an effective in-situ biodiversity assessment in European forests

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Assessing multi-taxon biodiversity is crucial to understand forests' response to environmental changes and to inform management strategies. In Europe, forest biodiversity monitoring is still scattered and heterogeneous, although a long-term monitoring network has long been advocated. Given the monitoring aims reported in various EU policies, this network should be accurately designed also through the estimation of its sampling effort, here intended as the number of sampling plots and sites.

We used a novel database of forest multi-taxon biodiversity for a pilot study to: estimate the minimum sampling effort needed to assess variation in species richness and composition; compare these estimates with the efforts invested in the pilot database; discuss estimates' differences across taxonomic groups and forest categories.

We focused on six taxonomic groups (vascular plants, birds, epiphytic lichens and bryophytes, wood-inhabiting fungi and saproxylic beetles) across six forest categories. Based on 6,165 plots at 2,084 different locations across Europe, we benchmarked the effort to achieve: a complete species richness estimate through interpolation/extrapolation curves, and a precise evaluation of species composition variation through multivariate standard error.

Our estimates differed widely, especially among taxonomic groups. For species richness, estimates range from 3 to 147 plots per site across 3 to 29 sites per forest category, with birds and epiphytic bryophytes requiring the least effort. For species composition, estimates range from 5 to over 25 plots per site across 5 to 20 sites per forest category, with saproxylic beetles, vascular plants, and fungi displaying the highest estimates.

The taxonomic groups requiring an effort comparable to existing data were the least diverse, all the others need greater efforts, either for species richness (e.g., saproxylic beetles), or species composition (e.g., vascular plants), or both (e.g., wood-inhabiting fungi). An effective monitoring network of European forests' biodiversity should thoroughly account for these benchmarks and for their taxon-dependency.

Oral presentation

Incorporating the Species Threat Abatement and Restoration (STAR) Metric into Systematic Conservation Planning at National Scale (Case Study: China)

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Increasing pressure on ecosystems and natural habitats from human activities has led to high rates of habitat degradation and loss of biodiversity. As stated by recent assessments, approximately 32.8% of the global protected area network and up to 60% of ecosystem services, have been degraded globally. In response, several legal frameworks have emerged that aim to increase the conservation of biodiversity, such as the Strategic Plan for Biodiversity 2011-2020 agreed by the Parties the Convention on Biological Diversity, which called for the conservation of at least 17% of terrestrial and inland waters and the restoration of 15% of degraded ecosystems by 2020, so as to meet the Aichi Biodiversity Targets (CBD). Hence, it is necessary to understand the relationship between threats and biodiversity, and identify areas which have the highest priority in terms of biodiversity conservation and provide insights for conservation planning. To this end, Mair et al. (2021) recently proposed a species threat abatement and restoration (STAR) metric, inspired by the structure of the 2015 Paris Agreement on Climate Change. The STAR metric utilizes red list data on species' extinction risk and the documented threats to species, and combines these with species' current Area of Habitat (AOH) data and restorable AOH to quantify the potential contribution that threat abatement and habitat restoration activities in a particular place can make to reducing global species extinction risk. The metric defines, for each species, a global STAR threat-abatement (STAR) score. The sum of STAR values across all species represents the global threat abatement effort needed, in principle, for all species to become Least Concern. This metric focusses specifically on reducing the extinction risk of threatened and near threatened species, which is one aspect of overall biodiversity conservation. Using China, and a set of threatened target species (1572 species), we aimed to integrate the STAR metric and the Marxan- a systematic conservation planning tool- to identify the priority areas for conservation in order to minimize threats and reduce the extinction risks of the target species. The result of STAR score, showed that the "agriculture and aquaculture" and "biological resource use" are among the most important threats to animal and plant species. Based on the result, the highest value of STAR metric is located in the central and southern parts of the China. Using our approach may inform the policies about the threat abatement and help to reduce the extinction risks of threatened species.

Oral presentation

Wild Bee Diversity: Can Agricultural Landscapes Stand Up to National Parks?

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Biodiversity decline is one of the biggest ecological challenges of our time. National parks serve as crucial refugia for various organisms and are expected to host higher species richness than intensively used cultural landscapes. However, direct comparisons of species diversity and community composition between national parks and comparable sites in agricultural areas remain scarce - this also applies to wild bees, the most important pollinators worldwide.

In this study the current state of Austrian's wild bee populations was surveyed during 2023 and 2024. Our goal was to evaluate the differences in wild bee diversity and community composition at sites within national park boundaries and those in cultural landscapes.

In agricultural landscapes, 200 sites (625 × 625 m) were surveyed across Austria while a total of 24 sites distributed across all six Austrian national parks were selected. Wild bees were recorded along ten cross-transects of 80 meters each per site in up to four surveys from April to August, supplemented by targeted sampling in flower-rich or nesting sites. Sites were then grouped by ecoregion and elevation for comparison.

Comparing cultural landscapes with national parks, the number of habitat-specialist was higher in the protected areas. Several species, among them endangered ones, were exclusively recorded in national parks, such as several salt-adapted species in Neusiedler See-Seewinkel National Park or sand-dwelling species in Donau-Auen National Park. Other species were quite common in the cultural landscapes but absent from national parks.

Preliminary results indicate that national park sites host a greater diversity and a higher total number of species, with less variation between sites compared to agricultural landscapes. This shows what could be possible in a minimally disturbed area within the respective ecoregion. Wild bee diversity of agricultural sites can approach that of National Parks if there is small-scale use and high flower density but can also be very low in intensively used sites. The results not only highlight the role of national parks as refuges in a landscape of agricultural intensification but also show how land-use impacts wild bee diversity and thus, influencing pollination positively or negatively.

Oral presentation

Identifying potential habitats for restoration to enhance biodiversity and ecological connectivity in the Central European Green Belt

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The Central European Green Belt (CEGB) represents a European wide, unique network of ecologically important habitats and protected areas that often host high biodiversity. However, like other valuable landscapes, it is under the increasing pressures of land use, fragmentation and climate change, which lead to a decline in biodiversity and habitat degradation. To tackle these issues, a transnational cooperation is essential. This is reflected in the presented international Interreg CE project “ReCo – Restore to Connect”, which aims to restore ecosystems to enhance their connectivity and support the biodiversity of CEGB.

One of the main tasks is to identify localities for potential restoration in six pilot regions in Poland, Germany, Czech Republic, Austria, Slovenia and Italy, which cover different types of habitats (from dry grasslands to alpine meadows, from inland wetlands to coastal wetlands) and species and their respective habitats (from the European wildcat to the European bison). Identification of these localities is based on combining present (in the form of satellite imagery and other available habitat data) and historical land cover data. The combination of present and historical data shows significant changes from natural/semi-natural habitats to degraded habitats. Degradation of habitats in terms of their intensified human use (change into arable land or sealed surfaces) was captured predominantly in two pilot regions with coastal wetlands in Slovenia, resulting mainly in drying out these habitats. Degradation by overgrowing with woody vegetation concerned all pilot regions – this process was especially unfavourable for grassland habitats in mountainous regions of Slovenia.

Based on the results of the analyses, transnational restoration and connectivity strategy for the project region will be elaborated in order to support future activities for restoring and reconnecting the ecological network of the CEGB.

Oral presentation

Systematically exploring restoration opportunities at the landscape level

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Despite (restoration) management efforts and research, biodiversity in the Southern part of the Netherlands (Heuvelland region) remains under pressure. Many habitat types and species (designated by the Habitats directive) continue to decline, with challenges such as habitat fragmentation, grassland overgrowth, slow recovery of species-rich forests, and deteriorating groundwater-dependent ecosystems due to nutrient-rich water inflows.

The Heuvelland's unique abiotic conditions, where habitats are often arranged in linear patterns, offer a distinct opportunity for targeted restoration of the entire ecosystem. Since past policies have primarily focused on restoration within Natura 2000 areas, opportunities outside these zones have gone underexplored. However, recent policy developments do emphasize integrated restoration approaches. This project, therefore, aims to identify strategic areas for restoration on the landscape level. The primary goal is to contribute to the restoration of 14 habitat types and 12 species protected under the EU Habitats Directive, many of which are regionally unique to the Heuvelland region.

The key research question is to identify in a systematic way the most promising locations to restore a 'complete system of related habitat types', in other words: at the landscape level.

In phase 1 of this project, we gathered diverse relevant spatial data (soil type, elevation maps, (historical) aerial photos and topographic information a.o.), and combined these with species distribution data of characteristic species per habitat type. We used thresholds for the amount of characteristic species per km², combined with spatial data, to identify promising areas for restoration per habitat type on a km-grid level. In phase 2, we combined all promising occurrences to identify locations that are promising for the restoration of a specific gradient or landscape.

A systematic prioritization framework will guide the selection of target areas, ensuring a science-based and scalable approach. The final output will provide spatial recommendations for ecological restoration at the landscape level, contributing to national and European conservation objectives. By addressing habitat fragmentation and reinforcing ecosystem resilience, this project aims to enhance the long-term viability of the characteristic biodiversity of the Southern part of the Netherlands.

Oral presentation

Identifying priority areas for freshwater conservation and restoration in Switzerland

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The global biodiversity crisis is particularly dramatic in freshwater ecosystems which have suffered exceptionally high species loss. High local endemism of Swiss perialpine lakes and the number of imperiled species in the surrounding rivers makes them sensitive to both climate change and habitat alterations. These pressures urgently demand conservation management to balance competing economic uses whilst supporting biodiversity, both now and into the future. Switzerland is warming at twice the global average and contains a range of habitats from natural to intensively modified, offering an excellent case study to design solutions to multifaceted conservation threats. We present an interdisciplinary project, involving scientists, governmental agencies, and NGOs identifying and implementing data-driven conservation strategies that integrate both climate change and human impacts. National observations of fishes and benthic macroinvertebrates – including cryptic fish diversity and endemic species of high conservation priority – were combined with high resolution environmental data to model changes in species' distributions. Using spatial conservation planning at the watershed scale, we identified priority areas that would benefit most from conservation and restoration measures under future climate scenarios and habitat restoration targets. This information will help local and governmental authorities as a decision support tool for freshwater conservation in a warming world.

Oral presentation

How to listen to a woodland: Building a systematic approach to monitoring woodland bats and woodland ecosystem health using AI and sound

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The echolocation calls made by bats offer vital information about the health of the ecosystems they interact with and how these ecosystems may be changing. In recognition of the importance of these woodland ecosystem indicator species, the Bat Conservation Trust (BCT) and Forest Research co-developed the National Woodland Bat Survey with funding from Defra via the Natural Capital & Ecosystem Assessment (NCEA) Programme. This innovative approach employs a combination of cutting-edge autonomous passive acoustic monitoring and AI-driven sound classification to monitor woodland soundscapes in 210 National Forest Inventory (NFI) sites across England each year. We will discuss the challenges associated with developing the technology and data pipelines required for handling the largest national database of woodland bat records ever collected by BCT. Additionally, we will highlight opportunities for assessing woodland bat population trends and underlying drivers, and present progress towards extending this approach beyond bats to the entire woodland soundscape to provide a broader assessment of ecosystem health and people pressure.

Poster presentation

Integrating Monitoring Data and Scientific Models to Prioritize European Ground Squirrel Conservation and Protect Grassland Habitats

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This study provides practical guidance on optimizing landscapes to mitigate the impacts of climate and land-use change. We demonstrate the effectiveness of integrating local monitoring data with advanced scientific models to protect grasslands and their dependent species. Our approach assesses habitat network characteristics for the European Ground Squirrel (EGS), a keystone grassland specialist, within northern Serbia's agricultural landscapes. Using the spatially explicit model LARCH, we identified 15 habitat networks based on current conditions and monitoring data, while Circuitscape helped evaluate their connectivity. This combined approach enabled us to prioritize conservation measures essential for maintaining a stable EGS metapopulation. Our analysis revealed that while two networks require no intervention, most demand habitat improvements and enhanced connectivity to sustain metapopulations. Additionally, we identified priority areas for targeted adaptation measures, including grassland restoration and ecological corridors, to improve habitat quality and microclimate conditions. In contrast, networks with poor habitat conditions and low viability may no longer need conservation efforts, allowing resources to be redirected toward more promising areas. We emphasize the importance of leveraging existing species-specific research through long-term monitoring campaigns and innovative modeling approaches to enhance conservation outcomes further. By providing a data-driven framework for balancing biodiversity conservation with agricultural land use, this study provides actionable insights for policymakers, land managers, and researchers. These results support sustainable land-use strategies aligned with EU conservation priorities, such as Natura 2000 and the European Green Deal, reinforcing the need for science-based decision-making in protecting (semi)natural grasslands.

Poster presentation

Lost in translation: from monitoring in the field to policy evaluation

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In northwestern Europe, atmospheric nitrogen deposition is one of the pressures for habitat restoration. The Dutch government introduced the Integrated Approach to Nitrogen (PAS), allowing future nitrogen reduction to justify permits. In 2019, the Council of State ruled PAS invalid, triggering the 'nitrogen crisis,' which restricted economic development unless nitrogen effects were mitigated. In response, the Netherlands launched the Nitrogen Reduction and Nature Improvement program in 2021, which includes monitoring and evaluation of the effects of nitrogen reduction and nature restoration measures. However, this evaluation turned out to not be so easy. Monitoring effects of restoration measures is quite complex as they occur on different spatial and time scales and differ depending on the type of measures taken. The Netherlands is known for its extensive monitoring data, but it is collected (opportunistically) following varying protocols, often without baseline measurements, not long-term or inconsistently over time. This information is scattered across various documents and databases, and data on the same metric—for example the area of a specific habitat type—can differ between sources. There is a risk of 'shifting baselines' as policymakers, under pressure to meet targets, may gradually redefine what is considered 'good quality' in nature restoration and ecological effects are usually visible on different time scales than policy is made. Since nature restoration involves customization in different areas, extrapolating from site-specific data to a national or EU level proves to be particularly challenging. A considerable amount of information gets 'lost in translation' between the diverse worlds of nature conservationists who focus on practical aspects and customize management to the field situation, and policy officials who require a clear and consistent overview to account for spent subsidies. This leads to the conservation status of Natura 2000 areas becoming a 'virtual reality,' essentially existing only on paper.

Poster presentation

Leveraging Citizen Science for Enhanced Monitoring of Dragonfly Biodiversity in Urban Ecosystem

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Monitoring urban biota is increasingly crucial in the context of rapid climate change. With their unique microclimates and diverse habitats, cities can serve as refuges for various species and act as early indicators of environmental shifts. Engaging the public in monitoring efforts enhances data collection and fosters community awareness and resilience, contributing to more effective conservation strategies in urban settings.

Urban areas, such as Bratislava, encompass diverse habitats that are vital for sustaining rich dragonfly (Odonata) populations. The city features major lowland rivers like the Danube and Morava, which, despite limited species diversity, provide essential habitats for ecologically significant species such as *Ophiogomphus cecilia* and *Stylurus flavipes*. Artificial water bodies—reservoirs, gravel pits, and ponds—serve as crucial habitats for stagnicolous species. With proper management, these man-made environments can offer more favorable conditions for dragonflies than some natural habitats left to spontaneous development. The presence of the Little Carpathians within Bratislava introduces montane and submontane streams, supporting rheophilous species like the protected *Cordulegaster heros*. Additionally, artificial and regulated water bodies, including retention reservoirs, canals, and garden ponds, often exhibit notable species richness. Terrestrial habitats, such as forest clearings and river embankments, also play a role in the life cycles of adult dragonflies, which can travel significant distances for feeding, mating, or locating new breeding sites.

In our research, we harnessed citizen science data from platforms such as Facebook, iNaturalist, and Obsmap. This approach enabled the identification of new dragonfly species in Bratislava, underscoring the significant role of public participation in scientific research.

Poster presentation

Session 2C – Tracing Back Historical Land-Use and its Legacies: Common Insights and Perspectives of Landscape Archaeology and Historical Landscape Ecology

Symposium

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Keywords: human-environment interactions, long-term processes, land-use legacies, methods of landscape archaeology

Human impacts on the environment have a long history and understanding this may bring landscape ecology and landscape archaeology closer in a view to have a robust background and a proper perspective of the ongoing environmental changes, and identifies legacies. There are many questions and challenges easier to handle by bridging the two disciplines. Landscape archaeology, together with environmental disciplines (eg. palaeobotany), could help to understand millennia-scale human-environment interactions and long-term processes with its integrative approach using a range of methods from large-scale techniques like geoinformatics and LIDAR to microscopic analyses such as the study of wood charcoal and phytolith for example. This joint session of landscape ecologists of IALE and landscape archaeologists of IALA (International Association of Landscape Archaeology) brings together researchers to learn about each other's methods and approaches and to identify common research interests and the possibilities for collaboration. The session will explore the effects of land-use and land management practices, as well as natural events over the past millennia. Topics may include the impacts of historical drainage systems and water regulations, major climatic periods and epidemics, volcanic eruptions, or the use of fire for pastoral or agricultural purposes. We are also calling for abstracts on the impact of wild and domesticated herbivores, long-distance livestock movements across European landscapes (e.g. the role of transhumance or cattle drives in landscape evolution), the agro-silvo-pastoral ecosystems across centuries, or the medieval ridge-and-furrow cultivation, and effects and legacies of other lost historical uses on the past or the present-day landscape and its habitats. As adapting to future landscape processes requires the integration of natural and social sciences, this platform will host inspiring research and debates on how the historical experiences of the two disciplines can be used to plan for a sustainable future with humans present in an improved biodiversity.

Tracing back historical changes in a Medieval rural landscape: a case study of Staffarda Abbey (Piedmont, North-West Italy)

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In order to enhance historical Italian landscapes as bio-cultural heritage, the project (Cultural heritage active innovation for sustainable society -CHANGES- PNRR, 2022-2025, Spoke 1 – Historical, Landscapes, Traditions and cultural Identities) addresses case studies at a national level. Combining landscape ecology with historical studies and archaeology is a scientific challenge: from this perspective, through the skills of historians, archaeologists, agronomists and computer scientists, an integrated interdisciplinary methodology was adopted. The aim was to track back historical landscape changes and permanences in the rural landscape around Staffarda Abbey (Piedmont, North-West Italy), a Cistercian Benedictine monastery founded in the XII Century (1356 ha) and its Grange (medieval farms). Qualitative and quantitative data were collected, processed and analysed in a digital resource: historical and archival research collection, integration and re-elaboration of iconographic and material sources concerned architectural and landscape assets. Firstly, for recognizing historical features of rural landscape and theoretical qualifying elements, historical and landscape analyses were performed. Archaeologists performed a study on medieval and post-medieval architectures. Secondly the aerial photographs acquired with the drone were analysed, reworked and georeferenced. QGIS was used to perform diachronic analyses at the landscape level. The advanced land analysis methodologies were compared with the post-medieval cartographic collected. Land uses, hedgerows, and the water system were recognized as historical permanences dating back to the Middle Ages. The project has also realized a digital resource for the storage of the digital twins of the documentation materials together with a multimodal access. Metadata support the implementation of interdisciplinary and comparative analyses on several abstraction layers. The study proved the importance of interdisciplinary method to understand the complexity of the historical landscapes. The identification of historical permanences in a rural landscape is receiving much attention from planners, researchers and farmers, who wish to achieve multiple aims, including preservation and conservation of bio-cultural values.

Oral presentation

Legacy of historical charcoal production in vegetation and soils of pine forests

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Charcoal production was carried out on a large scale in European forests from the late Middle Ages to the end of the 19th century. Wood obtained from the immediate vicinity was burned under controlled conditions in the so-called charcoal hearths – piles of wood arranged in a dome shape, with a base diameter of several meters, covered with clay, soil or turf. The burning process lasted from several days to several weeks, depending on the type of wood, and resulted in significant changes in the physical and chemical properties of soils due to the high temperatures, which could reach up to 800°C. To this day, anthropogenic soil horizons consisting of a mixture of burnt soil material, ashes, charcoal particles, and other wood pyrolysis products, are visible beneath charcoal hearth remains (CHRs).

Here, we present the results of geobotanical part of the interdisciplinary project: The environmental impacts of charcoal production in Northern Poland – a novel multiproxy approach. CHRs were identified using LiDAR imagery. Field studies on current vegetation and soils were carried out in pine forests in north-western Poland. Phytosociological relevés were collected in 10 × 10 m plots on CHRs and corresponding reference areas (controls) within 74 mature forest sites. Additionally, tree diameter at breast height (DBH) was measured, and soil and plant samples of bilberry (*Vaccinium myrtillus*) were collected from selected CHRs and their respective controls for elemental composition analysis.

Our findings confirmed the strong and long-lasting effects of in-situ charcoal production on soil morphology and certain physical and chemical properties. However, the impact on current vegetation is ambiguous, e.g., species composition and cover in CHRs and their respective controls do not differ significantly, while tree biomass in CHRs in forest stands ≥ 100 years old was found to be higher.

The study was funded by Polish National Science Centre (project no. 2018/31/B/ST10/02498).

Oral presentation

Layers upon layers. Past, present and future trends of the landscape in the World Heritage site of Las Médulas

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This paper aims to provide a comparative and long-term perspective on how a landscape has changed in the past due to historical processes, and how it is changing now because of present processes, as well as how these two phenomena interact with each other. It draws on a long history of archaeological work in the area of Las Médulas (Spain), designated World Heritage in 1997. This enormous Roman mining operation has created a stunning landscape which combines natural beauty and profound historical significance. The presentation will focus on a moving target, past and present.

For the past, landscape change as expressed in settlement, geomorphology and environment, each analyzed archaeologically using a variety of methods that help to create a dynamic picture of the situation two millennia ago. The local communities and territory were transformed by Roman imperialism when gold was discovered in the area, bringing enormous change in to how people lived, what they did, and even what they ate. First of all, the impact of an enormous mining operation, which is itself a jewel of engineering history, and which worked thanks to a combination of ancient sources, field excavation and geomorphological analyses. How people lived also changed drastically as a result. This has been revealed through on-site detailed excavation, palinology, zoology and carpology have been able to document radical changes in a short time. Once the mining activity was abandoned, a long process of isolation began, leading the area to become for centuries a rural backwater.

Coming forward to the present, the greater appreciation of heritage, and the multiplication of tourism has brought new life to this area. But this new life is also failing to meet some expectations, and poses serious challenges to the cultural landscape at hand. Tourism figures, as well as current land use, and economic and demographic data reveal that the idea of sustainable development is proving to be more elusive in this heritage success story than previously considered.

In order to understand these layers of landscape change, in the past and ongoing in the present, landscape archaeology has been vital. Las Médulas is an excellent example of cooperation between archaeology and ecology bearing fruits. Then what? That is the conundrum.

Oral presentation

Analysing long-term environmental change driven by post-medieval crofting in the uplands of north-east Scotland

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During the 18th and 19th centuries Scottish agriculture shifted from subsistence farming towards commercial production. This transformation led to a consolidation of capitalist-oriented farmland and a reduction in overall tenancies. While many displaced tenants moved to cities and overseas, others became crofters on marginal uplands, especially in the north-east. The colonization of uplands fundamentally altered the (semi-) natural environment from heaths and moorland to pockets of cultivated farmland. The settlers created arable fields, kitchen gardens and pasture, which drastically modified vegetation composition and the local ecosystem. Many of these lands are either now abandoned – having lain fallow for decades – or their land-use has shifted once again to forestry or grazing.

This project uses a variety of methods derived from historical archaeology, vegetation ecology, dendrochronology and remote sensing to investigate the lasting changes that post-medieval crofting left on the upland ecosystem. Historical maps, documentary records and standing remains are used to locate land selected by crofters. Three crofting sites have been subjected to a detailed vegetation survey, all three having lain fallow for more than 80 years. The results of the survey are being used to identify key species introduced by the settlers for culinary, medicinal or aesthetic purposes. Indicator species, such as trees and shrubs, across 47 sites at 13 different locations were identified, GPS tagged and where possible cored to assess their age. Drone photography allowed us to produce a composite orthoimage of entire landscapes shaped by human impact. The results from vegetation survey show that former crofting locations differ significantly from surrounding uplands. The sites are predominately covered by grass and herb species with a low shrub and tree cover, appearing to be 'frozen' in early stages of vegetation succession. Significantly, they also function as pockets of biodiversity on hillsides with relatively low species diversity, given they are dominated by plantation and heaths. The large-scale study shows how widespread these sites are and what they can contribute to our understanding of ecosystem change and recovery.

Oral presentation

Historical cultural landscapes in the Czech Republic

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Historical cultural landscapes are shaped and influenced by long-term human activity, which enhances both the cultural and natural values of the landscape. These activities are usually sustainable over time and do not require intensive mechanization. Some historical cultural landscapes may also be relics, meaning that the economic activities that originally shaped them have ceased, yet significant traces of these activities remain visible in the landscape. Such landscapes are harmoniously formed, characterized by a traditional small-scale structure, and preserve historical elements of land use and settlement. In the Czech Republic, historical cultural landscapes have not yet been fully mapped.

The paper presents methods and results of the historical cultural landscape mapping in the national level. The spatial framework for analyses was based on the European Environment Agency's regular 1x1 km grid (EEA reference GRID). Based on the previous research, specific set of landscape features and characteristics (e.g. small-scale landscape structure, stable land use, presence of the ponds, pilgrimage sites, old mines, spas) indicating the presence of the historical cultural landscapes was defined. Additionally, a database of these landscape features had to be made available for the entire Czech Republic in a format that allowed for processing and analysis in GIS. We combined several datasets: The Fundamental Base of Geographic Data of the Czech Republic, Consolidated Layer of Ecosystems, Natural habitat mapping data, Inventory of mine workings, Abandoned mines and Mine waste, database about the land use stability, database of historical ponds, database of the pilgrimage sites.

Based on the analysis of the above mentioned data, areas with a probable occurrence of these historical cultural landscapes were identified, including landscapes with preserved small-scale agricultural landscapes, forest landscapes, permanent grassland landscapes, vineyard landscapes, hop-growing landscapes, orchard landscapes, pond landscapes, spa landscapes, mining landscapes, and pilgrimage landscapes.

Oral presentation

Enhancing the identification of cultural heritage in relic landscapes using GeoAI and landscape characterisation approaches

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Cultural heritage is our collective memory and an important building block of our identities, which can answer questions like who we are and where do we come from. Current management practices largely focus on the protection of specific sites and monuments. However, holistic approach is needed as cultural heritage values and significance exist everywhere in landscape. These are especially prevalent in relic landscapes, which contain surviving pre-industrial landscape structure and character.

Using information from historical maps and aerial photographs, we trace changes in structure of several landscapes in Flanders, Belgium, through space and time. By combining historical information with contemporary geospatial data, we derive a set of indicators of cultural heritage values. Using GeoAI methods, we identify areas of high concentration of cultural heritage values, or cultural heritage character.

Compared to previous methods, GeoAI is expected to speed up the identification of cultural heritage in relic landscapes considerably. The results can be used to focus management efforts on areas with the highest concentration of cultural heritage values. However, further research into integration of participatory methods is needed in order to develop methodology that can be operationalized in sustainable management.

Oral presentation

“Tell me about the landscape...” – landscape management and transitions in local memories: the Sudetes case study, SW Poland

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The landscape of the Sudetes Mountains (SW Poland) has undergone significant changes over the last 100 years, closely linked to political, social, and economic conditions. The change of state borders after World War II and the resettlement of the population, followed by political and economic transformations in Central Europe after 1989 and accession to the European Union in 2004, have been reflected in the transformations of the landscape of this border region. These changes can be traced through comparative analyses of cartographic and iconographic materials from different periods. However, to gain a fuller understanding of these transformations, it is crucial to understand the perspective of the people who shaped these landscapes in different periods. The aim of the study is to present the results of research based on oral history, concerning, on the one hand, memories of past landscapes, and on the other hand, the perception of contemporary landscapes and perspectives on their further transformations. As part of the research, over 30 interviews were conducted with three groups of respondents: pre-war residents (currently living in Germany), post-war settlers, and new residents who have settled in these areas in the last 5-15 years. The results allowed for the identification of differences and similarities in the perception and evaluation of landscape changes between the different groups of respondents, as well as the identification of different ways and purposes of landscape use and management in different periods, which translates into the radical changes in land use that have occurred in the study area over the last 100 years. The major landscape transitions observed in the post-war period included: progressing delapidation of buildings, abandonment of settlements and arable lands, increasing forested areas and general overgrowing of areas with declining human impact due to depopulation. In contrast, in the last 20 years the large increase in numbers of the new buildings is observed, along with the intense development of tourist infrastructure. The encroachment of secondary succession on abandoned arable lands have been stopped or reversed and these areas have been returned to agricultural use as pastures and hay meadows. These diverse trends are evaluated by the respondents in different ways, for example elder inhabitants usually have a negative opinion on the increased „greenery” within the villages, while it is very positively perceived by the recent settlers. Similarly, the new housing and infrastructure developments receive contradictory evaluations by different groups of respondents."

Oral presentation

The landscape may not have been as species-poor in the Ice Age as previously thought – a new hypothesis for Central Europe

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The dominant paradigm about the Quaternary history of Central European landscape says that ecosystems were repeatedly impoverished by regional extinctions of species during the Ice Age glacial periods followed by massive recolonizations from southern refugia during interglacial periods and the Holocene. Recent scientific advances support our new alternative hypothesis, the Flora Continuity Hypothesis, which states that the flora could survive even the coldest periods of the Ice Age in the Carpathian Basin, and the Ice Age landscape may not have been as species-poor as previously thought.

In order to establish this hypothesis, we synthesized recent advances in paleoecological, paleoclimatological, ecological, and phylogeographic research, and the long-term history of the flora of the Carpathian Basin. We also analyzed the cold tolerance of the native flora of a test area (Hungary, the central part of the Carpathian Basin). We extracted species occurrence data from the Global Biodiversity Information Facility database (<https://www.gbif.org/>) for 18 reference areas in Europe and Northern Eurasia and the percentage overlap between these and the list of native Hungarian flora was calculated.

We found that many species have likely been continuously present locally since before the Last Glacial Maximum (LGM) period, and most of the present-day native flora (ca. 80%) can occur under climates as cold as or colder than the LGM (mean annual temperature $\leq +3.5^{\circ}\text{C}$ MAT). Our results show that habitats (especially grasslands and forests) may have been similarly species-rich under the coldest climate of LGM than today and long-term and massive flora continuity is more probable than LGM extinction followed by postglacial recolonization in the Carpathian Basin.

The long-term continuity of Central European regional flora may have fundamental consequences not only for biogeographical and ecological understanding but also for archeological or environmental reconstructions, landscape planning, and conservation strategies (e.g. increased need to protect ancient ecosystems).

Poster presentation

The Impact of Invasive Plant Species on Biodiversity and Cultural Heritage at Historical Sites (Svätý Jur)

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The presence of invasive plant species at historical and archaeological sites poses a significant threat to both biodiversity and the cultural heritage they represent. Our study in the Svätý Jur area, specifically at the Hillfort Neštich and castle sites, revealed a higher prevalence of invasive species compared to the surrounding forest. These sites, which are home to species like *Vinca minor*, possibly introduced during the medieval period, and *Viola odorata*, are particularly vulnerable to invasion due to past human activities and environmental changes.

Invasive species, such as *Ailanthus altissima*, *Ambrosia artemisiifolia*, and *Impatiens parviflora* at the hillfort site, threaten biodiversity by outcompeting native plants, altering soil composition, and disrupting historical landscapes. This is particularly concerning for historical sites, where these species not only endanger local flora but can also cause physical damage to monuments and structures. For example, *Ailanthus altissima*, a prominent invasive species in Rome's monuments, has been shown to undermine the stability of structures, indicating similar potential risks at historical sites in Slovakia.

The study underscores the importance of monitoring vegetation at these sites, as understanding plant distribution can help address the challenges posed by invasive species. Historical locations are often more susceptible to invasions due to changes in land use, tourism, and restoration activities. Effective management, including monitoring and controlling invasive species, is crucial for the preservation of both biodiversity and the historical integrity of these areas.

This work was supported by the project VEGA 2/0031/23 "Analysis and evaluations of the environmental history of selected types of Slovak landscape from the early prehistory to the present".

Poster presentation

Archaeobotanical and Archaeological Analysis of a Pit Feature from the Hradisko-Neštich Site

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The aim of the study is to evaluate the archaeobotanical and archaeological analysis of a feature in trench X from the archaeological site of Svätý Jur – Hradisko. This site is located in the cadastral area of the municipality of Svätý Jur. Systematic archaeological research has been conducting at the site since 2006. The research revealed evidence of the site's earliest settlement during the Hallstatt period, though most of the finds were dated to the Great Moravian period. The research focused on a shallow sunken feature with stone destruction in trench X, located on the acropolis of the fort. Its fill contained typical Great Moravian ceramic material, iron gear, and a glass pendant. The trench also contained a Great Moravian copper ring, and an interesting discovery was a silver denarius of Emperor Antoninus Pius. Two archaeobotanical samples were taken from the feature. The extraction was carried out using a combination of flotation and washing methods. Subsequently, seeds and charcoal were analyzed in the laboratory based on their anatomical and morphological characteristics. Several cereal species were recorded, with common millet (*Panicum miliaceum*) being the most abundant. Among the legumes, lentil (*Lens culinaris*) was identified. As for forest species representing the immediate surroundings, European hornbeam (*Carpinus betulus*) was documented. The results provide information on agricultural activities as well as the character of the surrounding environment. The combination of archaeological and archaeobotanical analyses aims to determine the character and interpretation of the find context and its significance in the interaction between humans and their environment.

This work was supported by the project VEGA 2/0031/23 “Analysis and evaluations of the environmental history of selected types of Slovak landscape from the early prehistory to the present”. Charcoal analyses was carried out at Environmental Archaeology Lab with the support of ArchLab – The National Infrastructure for Archaeological Science, Sweden. ROR id: <https://ror.org/00rky3x16>

Poster presentation

Historical oblique images for the documentation of the historical landscape around 1900

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Historical oblique images, taken both from the ground and air, are a unique source in landscape research. Being available from ~1880 onward and thus more than 50 years earlier than the earliest vertical aerial images, many regions are depicted for the first time. However, their processing poses specific challenges, as most images were acquired by amateurs with uncalibrated sensors in an unsystematic manner. As a result, images are scattered over various archives and essential metadata (e.g. approximate position, focal length) is commonly missing. Thus, not only finding and identifying potential images is challenging, but also their integration into spatial analysis.

Integration into spatial analysis requires the position and orientation of the camera to be known. Without any existing metadata, estimation of these unknown camera parameters requires the identification of (1) the approximate location and (2) corresponding points in the historical image and a georeferenced dataset (e.g. orthophoto and digital terrain model). Based on these, the pose of the camera can be calculated by spatial resection. To seamlessly document even smaller areas of interest, the image orientation of whole collections of historical oblique images needs to be repeated for each image, which is very time consuming. However, by that several potential applications within landscape research become available: i) Calculation of the visible area (viewshed) from each camera, ii) monoplottting of individual image points iii) generation of orthophotos, iv) virtual rephotography or v) reprojection of other geospatial data into the historical image.

Based on a selected collection of historical oblique images in Tyrol (Austria, Italy), we discuss the challenges faced during image orientation and potential ways to efficiently overcome those. Subsequently, we demonstrate their potential for documenting the historical landscape and change detection. We believe that by bringing historical oblique images closer to the attention of researchers and providing tools to easily integrate them into existing spatial workflows, the observation gap currently present within historical landscape ecology research can be partly closed.

Poster presentation

Creating 10% green and blue infrastructure in the Netherlands to restore biodiversity and create an attractive landscape: how heritage and design combine

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In 2022 a national Action Plan was presented in order to create 10% green and blue infrastructure (GBI, Dutch: GBDA) in the Dutch agricultural landscape. Build up areas and N2000-areas are excluded from this 10%. GBDA is aiming to connect existing nature reserves by creating corridors or 'veins' in agricultural landscapes. The plan explicitly contributes to the future perspective for agriculture and the rural area as a whole. In addition, it makes a significant contribution to meeting European obligations regarding biodiversity (Birds and Habitats Directives), climate challenge (Paris Agreements) and clean water (Water Framework Directive). A landscape with 10% GBDA, is therefore both a means and a goal to achieve higher biodiversity, reducing CO₂-emissions and improving water conditions. It can provide farmers a new and secure income for the long term and improve the quality of the cultural landscape.

In order to realise the ambitions, it will have to be made attractive for farmers to incorporate landscape elements as an extra means of income for their farm. Landscape must of should be part of the earning capacity.

There is no grand design. In each of the 12 provinces in the Netherlands several regions are distinguished, that will make their own plan/design.

Historic information is at the basis. Each landscape has its own characteristics and related landscape elements such as hedge rows, coppice trees (willows in peat areas, oak on sandy soils), ponds, botanical grass lands etc. Historic-topographical information is used during the design process in a region.

The Cultural Heritage Agency of the Netherlands is involved in the discussions about conditions for the design. Our motto is 'making sure that the right elements are put in the right place'. We contributed to background documents with historic landscape information. These contain conditions that must be met in the design. Definitions of landscape elements, sizing of elements etc etc are also available.

The plan received positive reactions, both from farmers and nature organisations and was accepted by the national and provincial governments. The funding looked certain, but with the shift of national government in 2024 a new phase has started.

In my presentation I will elaborate on the backgrounds of the ambition of the 10% GBDA, the content of the plan including the heritage/landscape-design aspects, and the conditions like finance, legal issues and planning.

Poster presentation

The trajectory of wetlands development in the upper part of the Výrovka River over the last 180 years

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The change in wetland cover and representation of different wetland categories in the upper part of the Výrovka River catchment over the last 180 years has been analyzed in this paper. Historical cadastral maps of the Stable Cadastre, the current orthophoto map, and GIS layers of classification of different land cover or land use types were used as background data. Based on the research in the available data, five types of wetlands were classified: waterlogged meadows, waterlogged meadows with woody vegetation, waterlogged orchards, waterlogged forest land, and swamps and marshes. The wetlands area has decreased dramatically from 1,133.38 ha in 1838-1841 (7.12 % of the area concerned) to 92.04 ha in current (0.58 %), which means that the area of current wetlands represents 8.12 % of the historic wetlands area. While most of the historic wetland area was waterlogged meadows (99 %), currently the largest wetland area is waterlogged meadows with woody vegetation (77.08 %). Approximately half of the extinct wetland area (51.85 %) has been occupied by arable land; therefore the observed changes can be attributed to the increase in agricultural production. The findings can be used in landscape planning concerning wetland conservation and management as well as water retention in the landscape.

Poster presentation

Can cultural heritage assets explain landscape history?

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Some cultural heritage assets (CHAs) can be linked to former activities which have been shaping landscapes through time. With this aim in mind, an available database (FEDAC) of ethnographic heritage elements of Gran Canaria has become the main source to perform this work. It provides location (points) and other attributes, among which past activities can be identified. The data encompasses XVII - XX centuries CHAs, which are so interesting to construct a timeline. This material makes it possible to discover and/or “read” the landscape past. The study area is the central summits of Gran Canaria island (Spain).

Nevertheless, CHAs not only inform about the existence of such activities, i.e. they are historical witnesses that certify the existence of certain natural resources in the past. And the integration of cultural, economic, and natural characteristics define how the society transforms the environment (determined by the socioeconomic systems), by using these CHAs. The research questions are: Which types of CHAs and natural resources are there in the study area, both in the past and in the present? Is there a subsequent use of these CHAs exploiting different natural resources than in the past, linked to socioeconomic systems? How was the relationship of the society with these resources in the past? And in the present?

CHAs types in the study area are agricultural, livestock, hydraulic, transport, industrial production, and ethnographic interest set. On the other hand, natural resources are soil, water, vegetation, among others.

The form of exploitation of these resources has changed according to socioeconomic systems and historical context. Thus, plantation, firewood extraction and grazing have been replaced by natural protection, cultural activities (interpretation centers) and sightseeing tours.

Poster presentation

Session 2D – Monitoring Farmland Habitats and Plants across Europe

Symposium

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Keywords: agriculture, monitoring, biodiversity, plants

This symposium will bring together researchers working on monitoring farmland habitats and plants at national or regional scales. Researchers will share experiences and analytical uses of current and past (potentially repeatable) monitoring approaches. We will compare methods, results, and how findings are communicated to policymakers and the public. We will also seek to identify how results from national monitoring schemes might contribute to a common farmland plant index that can be used to monitor the condition of farmland across Europe. This work will take place in the context of ever-decreasing biodiversity across European farmland and multiple measures being taken to address it, including the new Green Deal focused on a circular bioeconomy, as well as country level initiatives. It also fits within the context of climatic change and its influence on agricultural landscapes e.g. through droughts and floods. Recent work on monitoring biodiversity across the EU country level means that many countries are working on monitoring programmes which inevitably cover agricultural landscapes. By sharing our research and working together we aim to increase understanding of ecological change in Europe and underpin European agricultural policies. The objectives are: 1) to share monitoring and analytical approaches for farmland plant species across European agricultural landscapes, 2) to identify potential indicators (functional types, indicators of environmental drivers (climate, soil, management) and analytical approaches for assessing state and change, 3) identify opportunities for collaboration on indicators for measuring the condition of farmland.

Repeat recording of plants in field margins in South-east Norway

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In modern agricultural landscapes, field margins are important for the survival of many species of plants and animals. We recorded vascular plant species in three kinds of field margins: road verges, margins adjacent to pasture, and strips of vegetation with arable fields on either side (“corridors”). Field margins are not included in the current national monitoring programme, due to limited funds and difficulties standardising recording methods. In this study, we repeated a survey done 15 years earlier. For both surveys, recording effort was standardised by using the shape and size of the mapped field margin to calculate the time allocated for recording a full species list. We found that there were fewer flowering plants in the margins than previously, including a decline in many pollinator plants. However, invasive species had increased in frequency. Road verges were the most species rich, presumably because the vegetation is regularly cut for traffic safety reasons. But the Norwegian Public Roads Administration are also managing species-rich roadsides through adapted mowing. Considering international ambitions to restore nature, regular management of field boundaries could be a suitable measure in agricultural landscapes, to increase their value for biodiversity.

Oral presentation

Comparing assessment criteria for the favorable degree of conservation of Mountain Hay Meadows in the Alps: A review of classification frameworks

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Mountain Hay Meadows (MHM) are a refuge for high Biodiversity within Europe and thus their existence is crucial to counteract the ongoing biodiversity crisis. Because of this importance they are protected as an Annex I habitat under the EU habitats directive (HD) and - according to Article 11 of this directive - their conservation status needs to be assessed, monitored and reported in national (Art.17) reports. However, although the HD imposes the obligation for the monitoring and assessment, it provides no information how to implement it.

A key parameter for assessing conservation status is 'structure and functions' as it indicates the quality of a habitat type. Current practice in member states show that this parameter is mainly assessed by summing up the degree of conservation of individual assessment plots with different indicators such as floristic composition, typical habitat structure or damage of the habitat. Findings from the latest Article 17 report suggest that for MHM these assessments on the site level are very inconsistent in between member states and even partly within member states. As a consequence, the conservation status of MHM changes abruptly at administrative borders of member states. The hypothesis is that this is not always because of actual change of ecological conditions, but of different assessment approaches and indicators. This assessment inconsistency leads to incomparable data of the conservation status of MHM and thus hinders conservation efforts of this endangered habitat type.

In order to analyse this inconsistency in assessment methods and to suggest improvements, a desk review of seven assessment manuals from five countries was carried out. The manuals were collected from countries that lie along the Alps, because the habitat type has its distribution focus in the Alps alpine plots should be better comparable as alpine and continental plots. The indicators of the manuals are compared with each other in order to highlight crucial similarities and differences and connected potential risks for comparative assessments. Their universal applicability within Alpine countries is then tested by applying them to 40 vegetation plots representative of different degrees of conservation.

The results show that the current conservation status of MHM needs to be considered with caution, as methods for assessing the degree of conservation at site level differ and thus influence the overall conservation status. In addition, the identification of common and divergent indicators for assessment will help to develop comparable assessment methods within Alpine countries and by doing so support conservation efforts of MHM.

Oral presentation

Puzzle of agri-scape biodiversity indicators in Latvia

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In Latvia, farmlands constitute slightly more than 30 % of the total land area, 67 % of which is arable land. Over the last 20 years, both the arable land and the intensity of land use have increased, magnifying the stress on farmland biodiversity.

Generally, biodiversity is characterised by various indicators, such as species diversity, genetic diversity, functional diversity, habitat diversity etc. Meanwhile, a highly important but often insufficiently acknowledged component of farmland biodiversity is landscape features. The most characteristic features of Latvian agricultural landscapes are isolated trees (especially oak-trees), alleys, groups of trees (including in sites of former homesteads), field strips, wet hollows, clumps of bushes, tree lines, stone piles, etc.

Several types of biodiversity monitoring have been carried out in Latvia, however, in farmlands biodiversity monitoring is limited. In order to follow the changes in farmland biodiversity, there is a need for an assessment tool that is applicable for a country-wide and continuous evaluation. The aim of the study was to analyse the applicability of the agri-scape indicators for assessing farmland biodiversity trends.

By applying spatially explicit data on nature values, land cover, agricultural practices and implemented environmental measures, several agri-scape indicators were selected as sub-indicators. Those include protected grassland habitats, grassland areas supported by agri-environmental measures (maintenance of biodiversity in grasslands, organic farming), permanent grassland areas, as well as landscape features – field strips/buffer strips and small woody features. Based on sub-indicator evaluation and analysis of data quality, each sub-indicator was assigned with a weight expressing its potential value for biodiversity.

As a spatial expression, a net of hexagons was chosen (sized 100 ha each), covering the entire area of Latvia. Thus, the farmland biodiversity value was calculated for each hexagon. In the first step, values of each sub-indicator were calculated based on its weight and area in hexagon. Then all the calculated sub-indicator values were combined to express the overall farmland biodiversity value in each hexagon.

This approach still poses some challenges, including the overlapping of sub-indicator areas, defining precise biodiversity weights, selecting biodiversity indicators for arable land, as well as considering the possible effects of nearby forest lands which are highly common in Northern regions. Nevertheless, the resulting map represents the estimated biodiversity trends in farmlands and shows that this approach can be used as a tool for following biodiversity changes in time.

Oral presentation

Impact of Land Use Diversity and Agricultural Practices on Farmland Bird Populations: Insights from Norway's Monitoring Programme

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Over recent decades, farmland and meadow-breeding bird populations in Europe have markedly declined, attributed to factors like agricultural intensification and land abandonment. Parts of the Norwegian Monitoring Programme for Agricultural Landscapes explore the correlation between land use and bird species, aiming to understand how spatial heterogeneity and land use diversity affect the richness, abundance, and distribution of farmland birds.

Between 2000 and 2023, we saw declining populations and reduced distributions of several farmland bird species within the monitoring squares. Additionally, we found that both spatial heterogeneity of land use and high land type diversity positively influenced farmland birds. This gives important insight on how to design biodiverse agricultural landscapes.

We also examined the impact of agricultural intensity on 25 farmland bird species, using livestock density and pasture size as indicators. Larger pastures generally benefited a wide range of farmland bird species. Different bird species responded variably to livestock numbers, but high livestock density led to a decrease in overall farmland bird abundance.

Many countries subsidize sustainable farming to protect biodiversity. We studied Norwegian agri-environmental schemes' impact on farmland and meadow-breeding birds. We found that bird observations rose when these measures were in place but often declined once the support ended. Furthermore, the schemes were geographically limited and relatively few farmers participated. While short-term benefits were evident, long-term effects remain uncertain, highlighting the need for improved conservation strategies.

Emphasizing the importance of spatially heterogeneous agricultural landscapes with high land type diversity and natural areas, the study indicates the type of agricultural landscapes we should be aiming for to maintain and restore biodiversity.

Oral presentation

Characterization of Estonian Agricultural Habitats and Their Interaction with Alien Plant Species Contributing to Ecological Change

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This study investigates the distribution of alien plant species in Estonian agricultural habitats and the influence of landscape structures on their distribution.

To address these questions, the study applies a methodology derived from Bunce et al. (2011) to characterize agricultural biodiversity, providing a framework adaptable for similar studies in other regions. A statistically representative vegetation database was developed using field surveys conducted between 2015 and 2017 across 35 one-kilometer squares, documenting 453 species within 11 agricultural habitat types classified according to the Countryside Survey of Great Britain (Norton et al., 2012; Bunce et al., 2020). A detailed habitat characterization was conducted to assess the ecological structure of Estonian agricultural landscapes, with a particular focus on land abandonment, linear features, and their role in habitat connectivity and the dispersal of alien species (Pungar et al., 2021). Additionally, a landscape-scale analysis was performed to identify how landscape patterns affect the distribution of alien species.

The findings contribute to a deeper understanding of the ecological processes shaping agricultural habitats in Estonia, emphasizing the significance of management practices in biodiversity conservation and the role of alien plant species in ecosystem dynamics. This research provides valuable insights for policymakers, conservationists, and land managers aiming to develop sustainable agricultural practices that balance productivity with ecological integrity.

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Oral presentation

High-Nature-Value-Farmland and ecosystem monitoring on a representative random sample in Germany: potential for detailed analyses to enhance biodiversity conservation

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Land use and climate change are leading to significant changes in landscapes and ecosystems, both at the level of individual biotopes and at the level of the landscape as a whole. While rare and protected biotopes are generally subject to more or less intensive monitoring, changes in biodiversity in widespread habitats have so far been insufficiently observed. At least the High-Nature-Value-Farmland-Monitoring (HNV-Farmland-Monitoring), which has been established in Germany since 2009, provides data on the quality of agricultural biotopes in terms of their biodiversity on the basis of a representative random sample. Ecosystem monitoring was developed in order to close the remaining observation gaps and to obtain deeper insights into biodiversity in the landscape as a whole. It is intended to systematically record the changes in biotopes in the overall landscape in Germany. The HNV-Farmland-Monitoring will be integrated into the ecosystem monitoring. This allows much more detailed and differentiated analyses to be carried out on the status and trends of agricultural landscapes than is possible with HNV-Farmland-Monitoring. An example data set is used to show how the data on biotope structure collected in ecosystem monitoring can supplement the interpretation of the mapped HNV quality levels and in which landscape context agricultural areas with high nature value occur more frequently in the overall landscape. The analysis of such spatially aggregated monitoring data allows more sound conclusions to be drawn for measures to protect biodiversity. They also underline how indispensable continuous and long-term monitoring is in order to be able to reliably assess the status and trends of ecosystems.

Oral presentation

Agricultural landscape indicator for biodiversity based on farmland shape patterns

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Agricultural landscapes are slowly changing. Over time, changes in production methods and concentration of ruminants have altered the use of the agricultural landscape. In grass-dominated areas where agriculture land use is based on ruminants, changes are less noticeable due to low crop diversity. Milk and meat productions may be maintained independently of the grazing strategy or feed composition used. The amount of agricultural land receiving acreage support is one way to measure changes, but it doesn't tell the whole story. Larger machinery and more efficient land use can lead to new land being cultivated to improve field efficiency, while some farmland may be partially taken out of use to reduce time spent per hectare. Producing a zero net change.

High biodiversity in the agricultural landscape is to a large degree influenced by the interface between agricultural fields and the landscape surrounding the fields. The perimeter of fields per hectare (or land unit) of agricultural land, serves as a measure (i.e. indicator) of both the potential for biodiversity in relation to the amount of agricultural land and how efficient the land can be used. In many cases this measure seems to be correlated with field size, since often fields have quite similar form, but the measure also varies with the shape of the field. We demonstrate how this landscape indicator varies across Norway, and how it has changed over time. More importantly, we examine how it diverges from or complement biodiversity and landscape measures used in the monitoring program of the agricultural landscape in Norway, 3Q.

Oral presentation

European Monitoring of Biodiversity in Agricultural Landscapes (EMBAL): first results from across the EU 27

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The severe decline of biodiversity in European agricultural landscapes over the past century has led to the development of various policies and initiatives to promote more nature-friendly farming, most prominent among them the green architecture within the Common Agricultural Policy of the EU. These policies need to be informed by reliable monitoring systems tracking changes in farmland biodiversity and ecological status over time and space. While numerous biodiversity monitoring methods are used in the EU, these are either region-specific (e.g. the High Nature Value Farmland indicator in Germany) or focus on limited species groups (e.g. the Farmland Bird Index). To create an EU-wide, in-depth monitoring of agricultural landscapes that provides representative data for the Member States, the European Commission launched the EMBAL survey (European Monitoring of Biodiversity in Agricultural Landscapes). EMBAL was first piloted in 2020 and rolled out to all EU27 countries in 2022 and 2023 with 3000 25-ha sampling plots. EMBAL is a rapid in-situ survey in which surveyors collect data relating to land cover, land use intensity, pollinator forage potential (flower diversity and density), plant diversity (indicator species for species-rich vegetation), landscape heterogeneity and density of landscape elements such as hedges or grassy strips. From these data we can, for example, show changes in the coverage of landscape elements over time, or differences in grassland plant diversity between Member States. They can also be analysed at other spatial levels: preliminary results demonstrate, for example, hotspots of arable plant diversity and landscape heterogeneity in the Mediterranean biogeographic region, as well as increases in pollinator resources at higher elevations. As well as analysing the parameters individually, we have also developed a composite nature value indicator for agricultural landscapes that can be tracked over time or between regions. This presentation outlines the EMBAL methodology and discusses results from the analysis of the data collected in 2022 and 2023 and their relevance for European policy goals.

Oral presentation

The Bunce legacy: A framework for landscape monitoring in the UK

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In the UK, the late Professor Bob Bunce developed an approach to landscape monitoring involving a stratified sampling strategy in the late 1960s and early 1970s. The strategy facilitated large-scale landscape estimates and assessments of land use information, including farmland habitats and plant species, from a statistical sample of survey sites. The success of the approach at smaller scales led to a series of ongoing national monitoring programmes, managed by the UK Centre for Ecology & Hydrology, which are currently the longest running and most comprehensive ecological surveys in the UK. Data collected during these surveys is critical to the understanding of the extent of farmed land in the UK and its relevance for the provision of a wide range of ecosystem services (as well as production).

Notably, the Countryside Survey of Great Britain has been running since 1978 and has been repeated at approximately decadal intervals, until 2019 when it became an annual rolling programme. The programme is flexible, and has been used to evaluate agricultural impacts on habitats and plant species including agri-environment schemes and nitrogen deposition. For example, it recently enabled an assessment of hedgerows in England to be carried out in 2023. The linked Countryside Survey in Northern Ireland has been running since 1986 and has just undergone a repeat survey in the last 2 years. In Wales, the Bunce methods have been adapted to develop the Environmental Monitoring and Monitoring Programme (ERAMMP) field survey – a comprehensive integrated assessment of the Welsh landscape.

An overview of the stratified sampling approach will be described including a description of the approaches to calculating state and change in agricultural landscapes, in particular, changes in farmland plants and habitats. Background to the latest monitoring programmes will be given and some key findings from the Countryside Surveys and ERAMMP will be presented, with an emphasis on potential farmland indicators.

Oral presentation

Session 2E – Landscape Ecology for Drought Mitigation in the Context of Climate Change

Symposium

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Keywords: climate change adaptation, nature-based solutions, sponge-scape, drought resilience, hydrological management, water retention strategies, concepts and methods

The increasing frequency and severity of droughts due to climate change pose significant challenges to ecosystems, agriculture and water resources. Landscape ecology, focusing on spatial patterns and ecological processes at different scales, provides insights to manage drought impacts and enhance landscape resilience. This symposium will explore how landscape-scale approaches can mitigate droughts – meteorological, hydrological, agricultural and ecological – and improve the management of natural and human-modified systems in drought-prone regions. The symposium will bring people together to share research findings, case studies, and strategies that demonstrate the relevance of landscape ecology to drought mitigation. Topics may include the role of spatial heterogeneity in water retention, improving hydrological and ecological systems, and innovative land use practices for sustainable water management. In addition, the symposium will explore how landscape ecology and leverage into policy making and planning to reduce the drought vulnerability of land use systems. We invite researchers and practitioners from all disciplines to contribute. Papers highlighting integrated approaches to drought monitoring, spatial analysis, land use planning, and ecosystem restoration are particularly welcome. Submissions should focus on how strategies on the landscape scale can contribute to sustainable drought management and improve resilience under changing climatic conditions. Depending on the interest of participants we will consider a joint publication of the outcome of the session.

Transboundary Mountain Water Resources and Irrigation Demand: Assessing Climate Impacts and Sustainable Management in Mountain Regions of Kazakhstan

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Mountain snowpack is a vital component in regulating water availability for irrigation, ecosystems, and human consumption in Kazakhstan's high-altitude regions. This study investigates mountain snow dynamics, land cover changes, and irrigation water demand across five key regions—Zhambyl, Almaty, Zhetysu, Abay, and East Kazakhstan—which are heavily reliant on transboundary mountain water resources. Significant variations in snow cover duration, driven by rising temperatures and shifting precipitation patterns, are likely to disrupt the timing and volume of snowmelt, potentially leading to water shortages for irrigation. Additionally, dependence on transboundary water flows introduces complexities that could exacerbate water security challenges. Proactive measures are essential to ensure the resilience of water resources and agriculture water use demand, as well as ecosystems that depend on transboundary mountain water. By integrating historical climate data, satellite-based remote sensing techniques, and hydrological modeling, we analyze long-term trends in snow cover extent, seasonal melt patterns, and their impacts on downstream water availability. Land cover classification using remote sensing imagery provides insights into changes in vegetation, urban expansion, and agricultural land use, highlighting shifts in water demand. Additionally, irrigation water consumption is estimated using actual evapotranspiration (ETa) analysis to evaluate the sustainability of current water management practices. This research offers critical insights for policymakers and stakeholders, providing a foundation for developing resilience-focused water resource management plans in Kazakhstan's mountain regions. By addressing the interplay between climate change, land use, and water demand, this study aims to support informed decision-making for long-term water security and sustainable development. The Kazakh Ministry of Science grant # BR27197639 "Development of Innovative Hydrogeological Methods for Water Resource Management in the Zhambyl, Almaty, Zhetysu, Abay, and East Kazakhstan Regions" supports this project. The current status of the project activities will be presented.

Oral presentation

The Role of Contour-Strip Agroforestry in Water Retention and Soil Conservation

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Water scarcity and soil degradation are major challenges in arid and semi-arid regions like Kazakhstan, where over 75% of agricultural land is affected by degradation. Conventional farming practices accelerate these issues by increasing soil erosion and water runoff, leading to reduced agricultural productivity. Contour-strip agroforestry presents a sustainable alternative by strategically planting trees along contour lines to enhance water retention and soil conservation.

This study evaluates the effectiveness of contour-strip agroforestry in reducing soil erosion, decreasing water runoff, and improving soil moisture retention. Using meteorological data and agronomic models, our findings demonstrate that contour-parallel ridges and ditches significantly reduce surface erosion and soil loss. In comparison to conventional slope-aligned planting (which recorded an average soil loss of 24.6 m³/ha), contour-strip systems limited soil loss to just 0.83 m³/ha. Additionally, shelterbelts and protective forest plantations increased snow accumulation, leading to higher moisture reserves in soil. For instance, shelterbelts retained 174% of moisture compared to open fields.

Furthermore, our research highlights the role of protective forest plantations in redistributing snow cover, thereby enhancing soil moisture availability for crop growth. Windbreaks and shelterbelts were found to increase snow depth and moisture reserves by up to 133 mm, contributing to improved soil water availability in the growing season. The results suggest that integrating agroforestry techniques with contour farming can serve as a practical and scalable approach to mitigating land degradation, improving water conservation, and enhancing agricultural resilience in water-limited environments.

Oral presentation

Flood Risks and Water Quality Management in Mountainous River Basins: A Case Study of the Usek River

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The Mountainous Usek River plays a critical role in water supply in southeastern Kazakhstan. Seasonal precipitation and runoff dynamics influence its hydrological stability, requiring integrated management strategies to mitigate flood risks and maintain water quality. Climate change has intensified precipitation variability, increasing flood hazards and affecting water quality in the Usek River Basin. We analyze historical hydrological records and remote sensing data to assess changes in river discharge and seasonal flood trends. Satellite-based monitoring, including soil moisture and land surface temperature (LST) analysis, helps track watershed conditions and their impact on extreme weather events. While short-term runoff may increase due to heavy rainfall, long-term flood control remains a challenge. Effective flood mitigation measures are essential to prevent damage to infrastructure and agriculture. Engineering solutions, such as levees and retention basins, regulate peak flows, while nature-based approaches, including wetland restoration and afforestation, enhance water absorption capacity. Implementing adaptive flood management strategies will be crucial for the region's resilience. Heavy rains also degrade drinking water quality by increasing turbidity and pollutant loads. Advanced treatment techniques, including sedimentation, filtration, and ultraviolet disinfection, help remove contaminants. Additionally, conservation practices like riparian buffer zones and erosion control reduce sediment inflow into the river. To enhance flood resilience and water quality, a combination of engineering and ecosystem-based solutions is required. Climate adaptation strategies, such as floodplain restoration and improved land-use planning, offer sustainable approaches. Slovakia's "water for climate healing" initiative provides insights into flood risk mitigation and watershed protection. Sustainable flood control and water management depend on policy frameworks, economic incentives, and international cooperation. EU environmental programs, such as the Common Agricultural Policy (CAP) and Green Deal (GD), offer valuable strategies for integrating flood resilience with sustainable land use. By adopting these approaches, the Usek River Basin can enhance its long-term water security and environmental stability. The Kazakh Ministry of Science grant # BR27197639 "Development of Innovative Hydrogeological Methods for Water Resource Management in the Zhambyl, Almaty, Zhetysay, Abay, and East Kazakhstan Regions" supports this project and the current stage of our work will be presented.

Oral presentation

Climate Change Adaptation through Carbon farming incentives

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Climate change presents a growing challenge for agricultural sustainability worldwide. Carbon farming, a climate adaptation strategy, offers an innovative approach to mitigating the negative effects of climate change while enhancing soil health and agricultural productivity. Slovakia's initiatives in "water for climate healing - the new water paradigm and public policy" <https://www.youtube.com/watch?v=NPx-tiTrqNQ> with contour-strip land organization under investigation by our Kazakh-Kyrgyz group of researchers for the Central Asia (CA) adaptation. Carbon farming as a tool for climate adaptation, focusing on policy frameworks, economic incentives, and their impact on agricultural practices are new for the CA region, which we need to learn from the European Union (EU) experts. EU Slovakia's environmental programs, such as the Common Agricultural Policy (CAP) and Green Deal (GD) initiatives, which support farmers in adopting carbon sequestration practices, including no-till farming, cover cropping, agroforestry, and biochar application are targeted efforts to adapt for CA region. Improvement of financial mechanisms, including subsidies, tax benefits, and carbon credit trading, in encouraging sustainable land use are required for CA. Furthermore, the exchange dual study programs to learn the Slovak agricultural regions in the environmental and economic benefits of carbon farming incentives applications are our target. The EU Slovak experience in "water for climate healing - the new water paradigm" provides valuable insights for CA countries. The implementation of the similar programs in contour-strip land organization with connection to the carbon farming strategies as part of their climate adaptation and sustainability policies are in the adaptation process. These efforts align with the goals set by President Tokayev for 2025 as the "Year of Skilled Professions" and develop Kazakhstan as a carbon neutral country by 2050 with expansion of the carbon farming programs. The Kazakh Ministry of Science grant # BR27197639 "Development of Innovative Hydrogeological Methods for Water Resource Management in the Zhambyl, Almaty, Zhetysu, Abay, and East Kazakhstan Regions" supports this project. The current status of the project activities will be presented.

Oral presentation

Forecast of Groundwater Resource Potential and Quality of the Shelek Groundwater Deposit in Almaty Region

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The Shelek groundwater deposit is a vital water supply source in the Almaty region. This study provides a comprehensive assessment of the resource potential and groundwater quality of the deposit using modern hydrogeological and geostatistical analysis methods. The research includes an analysis of hydrogeological conditions, modeling of resource dynamics, and a forecast of changes in the chemical composition of water under natural and anthropogenic influences.

To predict groundwater reserves, hydrodynamic modeling methods were applied, taking into account key parameters of aquifers, recharge, and discharge conditions. Water quality analysis was carried out using hydrochemical studies and an assessment of anthropogenic impact, including agricultural and industrial water use.

The study results reveal potential scenarios for changes in groundwater reserves and quality in the medium and long term. Possible risks related to aquifer depletion and water quality deterioration due to anthropogenic factors were identified. Based on the findings, recommendations are provided for the rational use of water resources, groundwater monitoring, and preventive measures to mitigate contamination.

The presented conclusions can be used for developing regional water management strategies and planning sustainable groundwater management measures for the Shelek deposit.

Oral presentation

Identification of optimal water storage zones in the arid areas of Kazakhstan using GIS-based AHP

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The arid regions of Kazakhstan indicate significant changes in water availability, which leads to the need for rational water supply plans. This article discusses the definition of ideal water accumulation zones using multi-criteria analysis (MCA) and geographic information technology (GIS). These changes in water resources are increasingly influenced by climate change, urbanization, and agricultural activities, which emphasize the importance of effective management strategies. The study focuses on determining the most suitable locations for water accumulation and various factors influencing the water storage and replenishment capability. It utilizes geographical data on relief, soil cover, hydrography, climate conditions, and land use. These datasets are analyzed to evaluate the spatial distribution of suitable zones for water accumulation. Priority regions are identified in the study applying the Weighted Overlay and Analytical Hierarchy Process (AHP) techniques. These methods allow for the integration of various criteria, ensuring a balanced and objective assessment of the potential sites for artificial water recharge. The AHP method, in particular, aids in quantifying the contribution of each factor, allowing the identification of areas with the highest potential for water retention and replenishment. The acquired results can be applied to model artificial groundwater recharge systems, reservoirs, and sustainable water consumption during drought periods. These solutions will not only help mitigate the effects of water scarcity but also contribute to the long-term sustainability of water resources in Kazakhstan's arid regions. Furthermore, MCA and GIS application in this context presents a novel approach to water resource management, providing a solid foundation for future research and decision-making in the face of ongoing environmental changes. This method can be adapted for use in other regions with similar climatic conditions and water resource challenges, thus promoting a broader understanding of effective water management strategies in arid environments.

Oral presentation

Landscape-level analysis of ungulate responses to plant productivity may improve ecosystem resilience to the increasing frequency and intensity of droughts and floods caused by global warming in Europe's Atlantic region

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The increasing frequency and severity of droughts due to climate change pose significant challenges to pastoral systems in the Mediterranean region. These systems are often embedded in High Natural Value ecosystems where livestock coexists with wild ungulates (red, fallow and/or roe deer, wild boar) where they may represent key conservation elements but they can also trigger short- and long-term degradation. Landscape-level analyses of the interaction between the foraging and movement ecology of large ungulates, and the composition and productivity of vegetation may provide critical insights to improve the management of drought impacts and enhance ecosystem resilience. In this presentation, we explore how landscape heterogeneity in an iconic Mediterranean area, the Doñana National Park, modulates the effect of inter-annual variation in rainfall (including droughts and floods) on the interplay between plant production, ungulate landscape use and wild-ungulate population dynamics. We also evaluate the implications for ecosystem resilience against global warming, and propose how to improve current management practices. Additional cases from highland and lowland areas of Europe's Atlantic Region (Serra de Xistral, NW Spain; Lauwersmeer National Park, The Netherlands; Cairngorms National park, Scotland) will be used to discuss how these processes operate in different bioclimatic conditions, and how this variation may be incorporated into the proposed management practices.

Oral presentation

Drought and Disconnect: Climate blindspot under contemporary conservation planning strategies in Zimbabwe (Africa)

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Climate-related extreme weather events have drastically negative impacts on socio-ecological systems. These events are causing significant losses in terms of human casualties, negative socio-economic developments and ecological degradation. Although these long-term developments are of major social and economic relevance, conservation planning frameworks, typically ignore these extreme events. Climate-smart conservation planning in protected areas fosters a proactive role in mitigation and adaptation to climate change impacts by (i) providing strategies to protect wildlife and (ii) restoring and facilitating ecosystems resilience to climate change. However, even climate-smart conservation planning often exclude the likelihood of the surrounding communities. This paper aims to address this gap by examining how climate-smart conservation planning can adopted to mitigate the negative impacts of climate change while incorporating risk-reduction strategies that enhance community resilience. Our study focuses on two large-scale national parks in Zimbabwe (Gonarezhou and Hwange). Both parks have been significantly affected by large-scale drought events intensified by the current El Nino phenomena threatening the current state of biodiversity. The drought impact in these national parks have largely resulted in enormous rates of wildlife mortality and socio-economic losses in surrounding communities. To address these issues, we applied a mixed-method approach to integrate both quantitative and qualitative social science research methods and to triangulate the research objectives from different perspectives. Two community workshops involving 42 participants were conducted and five semi-structured interviews with key actors in the parks were administered. Participatory GIS mapping and Q-method research were subsequently conducted. Q-sort data was collected from 74 participants from communities adjacent to the two national parks, followed by post-sorting interviews to enhance validity. The first results show a strong increase of human-nature conflicts in both national parks over the past years. Our findings also reveal increase of illegal use of the protected areas in terms of subsistence poaching and park encroachment through illegal grazing of cattle following these extensive drought events. This in turn has resulted in an increased risk of illegal invasion by the surrounding communities. Nevertheless, in response to drought impacts, both national parks strive to engage with communities to mitigate the potential losses by providing food or allowing illegal grazing activities. This study contributes to the broader debates of conservation planning by providing empirical results of key areas of concern in conservation planning frameworks, particularly in the global South. It reveals the in-depth socio-economic concerns in the context of climate impacts that should be addressed in policy by both the park and the government to mitigate these impacts.

Oral presentation

Assessing the Livelihood Vulnerability Index (LVI) evaluation with acceptance to improve the flood-drought issues locally

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Kazakhstan faces water resource problems every year, with increasing extreme floods-droughts, and desertification expansion. Currently, the Kazakh government's strategy to address flood-drought challenges relies on costly engineering solutions, such as the construction of large dams, which attempt to control natural water cycles. This approach often leads to inefficient allocation of budgetary resources, benefiting a small group of construction and disaster mitigation agencies, while excluding local farmers from active participation in emergency preparedness. A more rational approach would involve strengthening local expertise and empowering farmers to address flood-drought issues through capacity building and financial sup. Kazakhstan spends the budget expenditures mainly on the surface water use programs, with a poorly integrated chain of surface-groundwater movement restoration programs. The flood water retention and reuse programs, accumulation of flood drainage waters in underground aquifers, as managed aquifer recharge (MAR), Flood-MAR programs, are missing in Kazakhstan. At the same time, such technologies have been used for thousands of years in Central Asia before, as underground storage with underground water movement in the Kariz (Qanat or Aqueduct) network system. Flood-drought problems could be more rationally to be solved by strengthening the local expertise in the regions, involving the local people, farmers in the villages with intensive capacity Technical and Vocational Education and Training (TVET) programs in integrated Flood-MAR, accumulation of flood drainage water underground, and use in summer during droughts. Expanding the programs for improving the skills of solving flood-drought problems by local residents of Kazakhstan themselves using Flood-MAR could be more rational for the Kazakh budget, tax money, instead of using the flood-drought emergency events money just by a very small group of people from Ministries. Expanding the use of Flood-MAR programs will allow Kazakhstan to be more rational with budget tax expenditures, effectively accumulate flood drainage water with lower costs with the involvement of local residents of Kazakhstan themselves, who will use this accumulated water during the drought season in summer. Combined the Flood-MAR <https://www.teresa.inowas.com/>, <https://www.inowas.com/> efforts with Slovakia's initiatives in "water for climate healing - the new water paradigm and public policy," <https://www.youtube.com/watch?v=NPx-tiTrqNQ>, including the contour-strip land organization, could be the rational flood-droughts mitigation strategy. In this context, this study aims to assess the acceptance of Flood-MAR programs for climate change adaptation in Kazakhstan, using the Livelihood Vulnerability Index (LVI). A survey is being developed to collect data from farmers, encompassing fourteen main components and fifty-six sub-

components. The study will be conducted in Kazakhstan's five oblasts, including Zhambyl, Almaty, Zhetysu, Abay, and East Kazakhstan regions, employing combined composite index methods and various vulnerability indicators. Natural disasters, manifested through drought, temperature fluctuations, and precipitation changes, significantly contribute to farmers' vulnerability. Key areas of vulnerability include natural resources, flood-drought events, food security, and social networks. By identifying the levels of vulnerability and understanding farmers' adaptation strategies, this study seeks to provide new pathways for reducing the vulnerability of agricultural livelihoods. Expanding programs that enhance residents' skills to manage flood-drought challenges, using a model similar to Slovakia's "Water for Climate Healing" approach, would be a more cost-effective solution. Adapting this Slovak expertise could optimize Kazakhstan's budget expenditures, while fostering local community involvement. The success of such programs will depend on the acceptance and interest of local populations in implementing these strategies. This survey is part of the ongoing research supported by the Kazakh Ministry of Science project # BR27197639 "Development of Innovative Hydrogeological Methods for Water Resource Management in the Zhambyl, Almaty, Zhetysu, Abay, and East Kazakhstan Regions". The current status of the project activities will be presented.

Oral presentation

Multi-criteria analysis applied to locate water accumulation zones in arid Kazakhstan

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Kazakhstan is one of the countries most impacted by climate change, experiencing extreme events such as floods, including those in the spring of 2024, and droughts, like the one in 2023, with more predicted for summer 2024. These alternating floods and droughts lead to significant soil erosion. To combat this, shelter belts and protective plantings have been widely used. However, deep plowing in the 1950s, driven by industrial wheat production, caused soil degradation in many areas. Forest shelter belts were introduced to mitigate soil droughts, preserve snowmelt, and enhance soil moisture retention. The forest shelter belts also contributed to agrarian landscapes, microclimates, and biodiversity. Unfortunately, support for forest shelter belts has dwindled over the past three decades, leading to their degradation and destruction, with many trees being cut down for firewood. In light of these challenges, significant changes in water availability in Kazakhstan's arid regions highlight the need for rational water supply plans. Slovakia's initiatives in "water for climate healing - the new water paradigm and public policy" with contour-strip land organization under investigation for adaptation, <https://www.youtube.com/watch?v=NPx-tiTrqNQ>. We are targeted to combine these efforts with managed aquifer recharge (MAR) technologies, the TERESA project expansion in cooperation with INOWAS group. We are utilizing multi-criteria analysis (MCA) and geographic information systems (GIS) to identify priority areas for water management, using data on relief, soil cover, hydrography, climate, and land use. Techniques like Weighted Overlay and Analytical Hierarchy Process (AHP) help pinpoint areas suitable for groundwater recharge systems, reservoirs, and sustainable water use during droughts. These findings are crucial for designing effective water management strategies in Kazakhstan's arid regions. These efforts are supported by the Kazakh Ministry of Science project AP19679749 "Mapping of shelterbelts, their impact on productivity and water resources, expansion prospects, using geospatial technologies in the Akmola region".

Poster presentation

Sustainable Water Management in the Talgar River Basin: Adapting Innovative Approaches for Climate Resilience and Resource Optimization

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The Talgar River, located in the Almaty region of Kazakhstan, is a vital source of water supply for local communities and agriculture. We are working on an investigation of the Talgar river basin, to set up more sustainable water programs for the basin. By integrating historical climate data, satellite-based remote sensing techniques, and hydrological modeling, we are analysing the long-term trends in water availability, seasonal variations, and the impacts of climate change on the river's hydrological cycle. This comprehensive approach should allow us to identify patterns of water scarcity, predict future challenges, and develop adaptive strategies for sustainable water management. At the same time, currently, Talgar river is facing significant ecological and infrastructural challenges that negatively impact water quality and resource availability. Water from the river is used for both drinking and irrigation purposes, but its quality often falls short of desired standards. During flood periods and snowmelt, the water becomes turbid due to high levels of sand, clay, and other impurities, rendering it unsuitable for consumption without additional treatment. Local residents have repeatedly complained about dirty, foul-smelling water entering their homes through the water supply systems. This raises serious concerns about public health, especially given the lack of alternative water sources. One of the key issues is the absence of an effective water resource management system. During the summer months, when water levels in the river drop, residents, without having any other water sources, use potable water for their backyard gardening irrigation, which creates problems for other water consumers, leading to the depletion of water networking supply. The proper incentives to divide technical irrigation purpose water and potable drinkable water usage are missing. The local people lack a water efficient use culture of water separation on technical and drinking categories, which exacerbates the water availability problem. As a result, even during dry periods when water is particularly valuable, it is used inefficiently for the basic irrigation needs, instead of use of the technical water in advance, as snow, rain and flood water retention. To address these issues, the implementation of water usage culture with efficient water collection and reuse technologies is proposed, such as snow flood water collection during the winter spring seasons in the retention storage ponds, connected to the managed aquifer recharge (MAR), for the reuse during the summer drought season. Slovakia's initiatives in "water for climate healing - the new water paradigm and public policy," including the application of contour-strip land organization, <https://www.youtube.com/watch?v=NPx-tiTrqNQ> are very applicable to mitigate Kazakhstan's flood-drought issues with water consumption culture improvement. We hope to adapt the experience of Slovak villages, where methods for managing meltwater and

sediment accumulation have been successfully applied. Adaption of Slovakian expertise could contribute to the development of agriculture, improve the quality of life for the population, and reduce the strain on natural resources. We are working on adaptation of the Slovakian expertise for the Talgar River basin in Kazakhstan. The Kazakh Ministry of Science grant # BR27197639 "Development of Innovative Hydrogeological Methods for Water Resource Management in the Zhambyl, Almaty, Zhetysu, Abay, and East Kazakhstan Regions" supports this project. The current status of the project activities will be presented.

Poster presentation

Impact of precipitation on soil moisture variability at sites with presence of historical agrarian landforms (case study Liptovská Teplička)

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The study provides a comprehensive examination of how historical agrarian landforms influence soil water content (SWC) variability in the study area of Liptovská Teplička. The study emphasizes the significance of these man-made features in altering hydrological processes on cultivated hillslopes, which is crucial for understanding local water dynamics. The authors conducted continuous soil moisture measurements across five distinct monitoring sites, each characterized by unique combinations of agrarian landforms and environmental factors, to assess the stability of SWC across these different landforms. By comparing pairs of sites located adjacent to one another—one on productive plots and the other on balks—the study captures a representative sample of the agrarian landforms within varying natural conditions, thereby providing insights into how these landforms affect SWC variability. In order to examine the complex effect of landforms during various precipitation events on SWC variability, four scenarios reflecting the various rainfall totals, intensities and initial SWC values were prepared. The results revealed, that agricultural landscape features significantly affect soil moisture variability, with each site showing unique moisture regimes due to factors like biomass accumulation and micotopography. Sites with terraces along contours exhibited higher moisture levels at lower rim positions within agrarian landforms in comparison with balks oriented downslope. Additionally, the initial soil moisture was found to be more influential on soil moisture changes during rainfall events, than the intensity or total amount of rainfall.

By linking historical land use to current hydrological outcomes, the study provides a valuable framework for understanding the interplay between human activity and environmental processes in the West Carpathian region and beyond.

Poster presentation

Droughts mitigation by improving the surface-groundwater interactions and sustainable use of the Shelek groundwater deposit in Almaty Region

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The increasing frequency and severity of droughts due to climate change pose significant challenges to groundwater resources, requiring sustainable management strategies. The Shelek groundwater deposit is a vital water supply source in the Almaty region, where water scarcity risks are intensifying. Comprehensive assessment of the resource potential and groundwater quality of the Shelek Groundwater deposit is required. We are working on these tasks by historical data evaluation, modeling and prediction analysis. The hydrogeological conditions, modeling of resource dynamics, and a forecast of changes in the chemical composition, distracted by the natural and anthropogenic influences, are under our investigations. To predict groundwater reserves, hydrodynamic modeling methods were applied, taking into account key parameters of aquifers, recharge, and discharge conditions. Water quality analysis was carried out using hydrochemical studies and an assessment of anthropogenic impact, including agricultural and industrial water use. We are aiming to adapt Slovakia's initiatives in "water for climate healing - the new water paradigm and public policy" <https://www.youtube.com/watch?v=NPx-tiTrqNQ> on restoring the small water cycle, emphasizing how integrating hydrological processes into state policies and public initiatives can enhance groundwater recharge and quality. These principles are particularly relevant for the Shelek groundwater deposit, where changes in land use and climate affect water balance and resource sustainability. Slovakian landscape-scale approaches in mitigating drought impacts, aligning with sustainable groundwater management strategies will be beneficial for Kazakhstan. The study results reveal potential scenarios for changes in groundwater reserves and quality in the medium and long term. Possible risks related to aquifer depletion and water quality deterioration due to anthropogenic factors were identified. Based on the findings, recommendations would be provided for the rational use of water resources, groundwater monitoring, and preventive measures to mitigate contamination. The long-term drought resilience by improving hydrological and ecological systems are under preparation and Slovakian expertise is required. Our efforts are aligned with landscape-scale drought mitigation strategies and can be used for developing regional water management strategies, integrating hydrogeological processes into land use planning, and enhancing policy frameworks for sustainable groundwater management in Kazakhstan, Central Asian region. The Kazakh Ministry of Science grant # BR27197639 "Development of Innovative Hydrogeological Methods for Water Resource Management in the Zhambyl, Almaty, Zhetysay, Abay, and East Kazakhstan Regions" supports this project. The current status of the project activities will be presented.

Poster presentation

Can fertilization with phosphorus mitigate the negative impact of drought on the photosynthesis of common beech and sessile oak?

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Common beech and sessile oak represent two species of forest trees that form mixed forest stands throughout Europe, with very high biodiversity and economic, ecological and social value. However, these stands have recently been increasingly exposed to negative impacts of long-lasting drought and severe drought stress. Such events have negative effects on CO₂ assimilation, biomass production, vitality and the natural regeneration of common beech and sessile oak. However, negative impact of drought on photosynthesis may be mitigated by the higher availability of mineral nutrients. The aim of this study was to investigate whether the fertilization with P can mitigate the negative impact of drought on the photosynthesis of common beech and sessile oak saplings, by investigating the effect of fertilization with P on their photosynthesis during the drought and post-drought period. The research was conducted on saplings originating from two mature mixed stands dominated by these species. In the common garden experiment, saplings were exposed to four different treatments; control treatment (regular watering without P fertilization, W/-P), P fertilization treatment (regular watering with P fertilization, W/+P), drought treatment (water deprivation without P fertilization, D/-P) and combined drought and P fertilization treatment (water deprivation with P fertilization, D/+P). In the period from 15th May to 1st September saplings in drought and combined treatment were exposed to drought, which on 1st September interrupted by re-watering. Every 10 days during the growing season, rate of net-photosynthesis (Anet) and photosynthetic performance index (Plabs) were measured in saplings of both species. Accordingly to our results, photosynthetic response to four different treatments was the same for common beech and sessile oak saplings. It means, during the drought period, the highest values of Anet and Plabs were recorded in control treatment and the lowest in combined drought and P fertilized treatment. After drought release, in the post-drought period Anet and Plabs were still higher in control treatment, compared to P fertilized, drought and combined drought and P fertilized treatments. Moreover, in the post drought period Plabs was higher in the drought, compared to combined drought and P fertilized treatment. Based on our results, we concluded that P fertilization in drought period does not mitigate the negative impact of drought on the photosynthesis of common beech and sessile oak, nor does it promote better recovery of their photosynthesis after the drought release in the post-drought period.

Poster presentation

Management of peatlands affected by drainage for agriculture and by climate change

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The peatlands interact with climate through the uptake and release of greenhouse gases. They represent stores of carbon, since peatlands store large amounts of organic matter in their soils. Many studies to date highlight those feedbacks of peatland ecosystems make them somewhat resilient to climate change.

Anthropogenic use of peatlands change rate of greenhouse gases exchange. Drainage for agriculture and changed hydrological conditions leads to drier conditions in the soil and these speeds of the rate of decay. Drained peatlands are also more susceptible to wildfire, with the potential for other greenhouse gases emissions. Therefore, suitable peatland management can represent an important climate change mitigation strategy.

We followed the Klin peatland in the north of Slovakia. Based on climate indicators from a local weather station and groundwater level records from a drill, as well as on the identification of agricultural drainage built in the second half of the 20th century, we investigated the impacts on the ecological quality of this peatland.

Poster presentation

Session 2F – Enhancing Landscape Assessments through Ecosystem Services Science

Symposium

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Keywords: landscape assessments, ecosystem services, methods, indicators

In the XXI century, there is no landscape not facing strong change pressures. Traditional landscape assessments must deal with the increasing complexities of landscape change crossed by the intricate interplay between ecological patterns and processes, cultural values, and socioeconomic and technological factors while at the same time facing increasing ecological deterioration, biodiversity loss, environmental inequality and urbanisation. Ecosystem services science can provide ready-to-be-used scientific knowledge to enhance landscape assessments to better cope with these new challenges, improving landscape responses to ongoing challenges, and facilitating better landscape protection that ensures that the benefits people receive from well-functioning ecosystems are maintained and enhanced. This session explores the integration of ecosystem services science within landscape assessments, focusing on contributions showing the current international state of the art in developing, testing and implementing multi-dimensional (ecological, economic, social) landscape assessments using ecosystem services science. Conceptual, methodological as well as operational contributions and case studies are welcome. The following topics are encouraged: -landscape restoration, biodiversity monitoring and ecosystem services – Landscape assessment conceptualisations, methods and indicators – Interactions between stakeholders, planners and policymakers – spatiotemporal relationship between urbanisation and ecosystem services – Healthy landscapes through ecosystem services – landscape indicators characterizing spatial processes related to ecosystem services – landscape strategies for better use of ecosystem services science

A New Approach to Urban Climate Vulnerability: Regulatory Ecosystem Services in Mińsk Mazowiecki, Poland

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The objectives of the EU Adaptation Strategy in the context of urban areas are established to enhance urban resilience, integrate climate adaptation to improve infrastructure and urban planning, and promote nature-based solutions. These policies are primarily implemented in large cities. However, as the European Commission highlights, the risks associated with climate change also affect small and medium-sized cities, especially those undergoing intensive development, where the problem becomes increasingly urgent. This is the case in the city of Mińsk Mazowiecki (Poland), where recent rapid development coupled with a high proportion of impervious surfaces, has increased the city's vulnerability

The aim of this study was to identify regulatory Ecosystem Services in a medium-sized city. Many methods for assessing spatially explicit ES are mostly based on interpreting the land cover and/or land use. In our analysis, we expanded the range of environmental conditions considered by incorporating factors such as relief, soil and substrate type, climatic parameters, and water aspects.

The research has been conducted in three steps. In the first step, the most vulnerable places to climate change impacts were identified. Next, these places were grouped into vulnerable zones. In the third step, for each zone, ES were identified and analysed with different problem intensities in terms of their ability to serve regulatory services. This process led to the development a new index: the Index of Urban Area Vulnerability. The index facilitates the identification of areas where nature-based solutions (NBS) can be introduced to improve the function of regulatory ecosystem services at a local scale.

Due to the historical spatial structure of Mińsk Mazowiecki, there is still an opportunity to adopt policies that could effectively mitigate the impacts of climate change. The Index of Urban Area Vulnerability helps to prioritize problematic areas and plan nature-based investments.

Oral presentation

Where and Why? Linking Expert-Driven Spatial Diagnostics of Land Degradation Sensitivity, Ecosystem Services, and Socio-Ecological Drivers to Optimize Nature-Based Solutions

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Land degradation, coupled with the decline and loss of forests, natural habitats, and their associated ecosystem services (ES), continues to be one of the most pressing global environmental challenges. This growing concern underscores the increasing application of Nature-based Solutions (NBS) such as agroforestry, among other forest landscape restoration interventions, across regions worldwide. Despite the rising use of NBS, spatially-explicit frameworks for identifying priority hotspot locations for NBS implementation remain fragmented. Existing research and approaches often treat land degradation and ES as separate domains, leading to suboptimal site analyses of critical areas that require NBS.

The presented study addresses this research gap by integrating local expert knowledge to map (i) land degradation sensitivity (LDS), (=areas susceptible to land degradation during 2000–2023), and (ii) ES supply potentials to identify priority hotspots for NBS interventions, using the Philippines as a case study. The primary objective is to harmonize LDS trends and ES supply potential to spatially map and identify priority areas for NBS interventions while considering their socio-ecological and management dynamics. Key research questions include: (1) How have biophysical, land management, and demographic factors influenced LDS over time? (2) Which areas represent priority zones for NBS interventions based on LDS trends and ES supply potential? (3) What are the socio-ecological and management characteristics of these priority hotspot areas?

The study employs multi-criteria analysis (MCA) to assess LDS over time using local expert-weighted indicators leveraging Analytical Hierarchy Process (AHP) and remote sensing time-series analysis. Concurrently, ES supply potential is mapped using a Tier 1 ES mapping approach, informed by Philippine local-expert scoring. Geostatistical analysis and a developed matrix are then applied to identify NBS priority hotspots and highlight their socio-ecological and management connections.

The study presents a novel geospatial framework that integrates local expert and stakeholder knowledge for identifying NBS prioritization areas, leveraging remote sensing and other geospatial data. By integrating LDS trends with ES supply potential, this approach offers an innovative methodology that bridges the gap between scientific analysis and local perceptions and needs. The study provides a replicable blueprint for sustainable forest and land-use management, with results that can support decision-making by local stakeholders in the Philippines and other tropical regions.

Oral presentation

Mapping cultural ecosystem services of river landscapes in the Iberian Peninsula using an artificial intelligence-based social media approach

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Cultural Ecosystem Services (CES) are essential for human well-being, particularly those provided by river landscapes. However, CES remains understudied and often overlooked in river conservation strategies due to its intangible nature and the challenges associated with their assessment. Social media data is a useful resource for assessing the cultural value of landscapes through geo-located posts. This study employs Artificial Intelligence (AI) to identify and classify Flickr images related to river landscape CES into six categories, assessing their applicability for large-scale CES mapping in the Iberian Peninsula. To achieve this, a ResNet-152 convolutional neural network was pre-trained on the ImageNet dataset and fine-tuned with 10,000 geotagged Flickr images from diverse freshwater regions to minimize spatial autocorrelation. We trained and evaluated the model using 5-fold cross-validation, achieving an accuracy of 97%. Further validation on unseen images from the Ter Basin (Spain) and Sorraia Basin (Portugal) resulted in 91% accuracy, effectively distinguishing CES-related images from non-CES content. The model successfully identified images depicting landscape aesthetics, recreational activities, cultural landscapes, and wildlife observation. To assess its large-scale applicability, we used the model to classify and map all Flickr images (2022–2024) within a 1 km² buffer zone along river networks across the Iberian Peninsula, covering 312,398 km² of freshwater landscapes. Almost one million posts were evaluated, with aesthetic values and recreational values being the most frequently represented categories, while flora appreciation was the least common. Our findings demonstrate the effectiveness of AI in mapping freshwater CES, offering high accuracy, scalability, and spatiotemporal applicability. This approach facilitates the integration of CES into river management and conservation planning by providing spatial insights into human-nature interactions and identifying valued river landscapes. Additionally, it is adaptable to other regions and expandable to incorporate additional CES categories, making it applicable for global ecosystem assessments.

Oral presentation

Approaches to linking economic reporting with biodiversity and ecosystem services indicators

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The consumption of natural assets in our economy manifests itself in the way we produce and consume and thus define our prosperity. A socio-ecological transformation requires a more holistic approach and reporting that includes the values of nature for society as a whole. Such an understanding of welfare, which is innovative for Germany, links economic growth with the services provided by nature and thus works towards biodiversity-friendly economic growth. Good examples include the further expansion of ecosystem accounting, which is part of environmental economic accounting, and the integration of natural capital into economic decision-making mechanisms. International compatibility is ensured via the indicators of the Global Biodiversity Framework and the standards of the UN SEEA-EA.

The contribution outlines the existing approaches/indicators and conditions of an understanding of welfare that views biodiversity as a valuable resource that needs to be protected and preserved. This is illustrated on the basis of results from an R&D project. It also shows how a more integrated view of welfare aspects can make a valuable contribution to the informational foundations of a socio-ecological transformation.

Oral presentation

Comparing pgis and the invest model for cultural ecosystem services mapping

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Landscape ecology has recognized the pivotal role of the human-nature relationship as a driver of transformation, leading to the proliferation of methods for assessing socio-ecological interactions. The Cultural Ecosystem Services (CES) have gained relevance due to their ability to operationalize this relationship. CES frameworks provide valuable insights into ecosystem values -aesthetics, recreation, identity, or sense of place-, making them functional for policymaking processes.

The growing interest in people's preferences and interactions with natural environments has led to the development of various methods for mapping CES. , research methods utilizing Participatory Geographic Information Systems (PGIS) and modeling techniques have highlighted their respective strengths and limitations. Factors such as data accuracy, sample size, time consumption, socio-demographic information, and required expertise are crucial considerations when selecting the most suitable method for CES mapping.

This study focuses uses a comparative approach to a questionnaire in Maptionnaire for PGIS and the Visitation, Recreation, and Tourism (VRT) model from the Integrated Valuation of Ecosystem Services and Trade-offs (InVEST). By applying both methods in the same geographic area—the municipality of Mafra, Portugal—we compare the results.

These show alignment between PGIS and the InVEST model in identifying CES locations, while also revealing key differences that showing their complementarity potential. Combining both methods helped mitigate certain limitations, such as integrating sociodemographic data from PGIS into the broader dataset of the InVEST model. Additionally, applying a linear regression model with PGIS-derived predictors enhanced the understanding of underrepresented CES categories.

Integrating these methods approaches offers valuable insights by combining datasets to refine outputs participatory methods and models. Ultimately, recognizing the strengths and differences between global (InVEST) and local (PGIS) methods fosters synergies, advancing CES assessment and mapping.

Oral presentation

Assessing the effects of climate protection measures on pollination services and landscape heterogeneity: A case study of rewetting and paludiculture implementation in the Upper Rhinluch, Brandenburg, Germany

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Peatlands in Brandenburg, Germany, are significant sources of greenhouse gas (GHG) emissions due to extensive drainage for agriculture. Rewetting degraded peatlands, combined with sustainable land management strategies such as paludiculture, is increasingly recognized for its potential to mitigate climate change, enhance biodiversity, and ensure economic value creation. However, the effects of these landscape transformations on other ecosystem services, such as pollination services and landscape heterogeneity, remain largely underexplored.

This study investigates how different land-use scenarios in the Upper Rhinluch landscape influence pollination services by affecting the availability and spatial arrangement of floral resources and nesting sites for various pollinator groups. We developed and analyzed multiple landscape scenarios with varying degrees of rewetting and paludiculture implementation, considering both compositional and configurational heterogeneity. By modifying the spatially explicit InVEST crop pollination model, we assessed potential changes in pollinator abundance and pollination supply across these scenarios.

By comparing different configurations of rewetted and cultivated areas, the study examines potential trade-offs between large-scale landscape transformations aligned with GHG reduction targets and more diversified land-use patterns. Additionally, we analyzed hotspots and coldspots of pollination supply to better understand spatial variations in pollination potential across the landscape. The findings underscore the importance of landscape-scale planning in peatland restoration projects. Integrating pollination services into landscape assessments can support decision-making that balances climate mitigation, biodiversity conservation, and agricultural productivity.

Oral presentation

Engaging Rural Communities in Ecosystem Service Valuation: A Case Study of Participatory Approaches in Armenia

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This presentation is divided into two parts: the first is a systematic literature review that examines participatory approaches used in aquatic ecosystem valuation. Several approaches are discussed in relation to the categories of ecosystem services. The second part presents a practical case from Armenia, where various participatory activities, including stakeholder workshops, teacher seminars, and a summer school, were implemented in case study regions to explore and assess local ecosystem services. Additionally, the photovoice method will be explored as an effective approach for revealing ecosystem service valuation in rural regions of Armenia.

The results will emphasize the importance of local knowledge in understanding ecosystem services and the potential of participatory methods to bridge the gap between academic research and community perspectives. Findings underscore the value of ecosystem services in rural Armenia and their role in enhancing local well-being. The study also identifies challenges in implementing participatory approaches, such as logistical constraints and varying levels of participant engagement.

Although the study focuses on the specific context of Armenia, it contributes to broader discussions on the role of participatory methods in ecosystem service valuation, particularly in regions undergoing transitions in both academic and societal structures. It highlights the potential of participatory approaches to improve ecosystem management by incorporating local knowledge, addressing cultural ecosystem services, and fostering inclusive decision-making.

Oral presentation

Willingness to pay for landscape benefits - case study from Lower Silesia, Poland

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Like ecosystems, landscapes provide significant benefits that influence human well-being. However, these benefits are often taken for granted and not accounted for in economic terms. This study examines how local communities in Lower Silesia, Poland, use different landscape types and assesses their willingness to pay (WTP) for improved landscape services. The research combines participatory mapping and a discrete choice experiment (DCE) to evaluate preferences for six key landscape services: accessibility to essential services, outdoor recreation, physical and mental health benefits, social integration, educational opportunities, and aesthetic experiences.

The study was conducted in six municipalities representing diverse landscape types, including urban, suburban, rural, and forest-dominated areas. A total of 617 residents participated in structured face-to-face interviews using the Computer-Assisted Personal Interviewing (CAPI) method. Respondents were asked to mark locations where they engage in various outdoor activities on pre-prepared maps. This spatial data was then analyzed to identify patterns of landscape use. The discrete choice experiment (DCE) assessed WTP for improvements in landscape services, with attributes such as reduced travel time to basic services, expanded recreational infrastructure, increased public forest areas, new social integration spaces, educational trails, and scenic viewpoints.

The results indicate that residents are most active in landscapes near their homes, with forest landscapes being the most valued and perceived as multifunctional. Urban, suburban, and rural respondents demonstrated significant differences in their landscape preferences, particularly regarding accessibility and social interaction spaces. The highest WTP was recorded for increasing public forest areas (+4%: €34 per year per household) and reducing travel time to essential services (-20%: €24 per year).

These findings highlight the importance of incorporating residents' preferences into spatial planning and landscape management. The study provides valuable insights for policymakers, supporting the development of landscape policies that balance economic, social, and environmental factors. The methodology applied in this research—integrating participatory mapping with DCE—offers a robust framework for assessing landscape values and guiding sustainable land-use planning.

Oral presentation

Developing Ecosystem Service Assessment as a Pragmatic yet Meaningful Complement to River Basin Management Plans

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The 2023 United Nations World Water Development Report highlights freshwater systems (rivers, floodplains, wetlands) as some of the most vulnerable landscapes due to human pressure and climate change. Already, 85% of wetlands have been lost, primarily in the U.S. and Europe.

This decline is driven by human activity, both indirectly—through climate change and the neglect of cause-and-effect relationships, such as biodiversity loss affecting the water cycle—and directly, through unsustainable resource use (space, water, species). These factors cause recurring droughts, increased groundwater extraction, and water transfers between surface bodies, while also making riverbanks more flood-prone.

Despite their vulnerability, floodplains and wetlands remain highly multifunctional landscapes. Increasingly converted into farmland or forestry due to droughts, they also serve as habitats for wildlife, natural corridors, sources of food, materials, and fuel for humans. They attract tourism and, in urban areas, offer valuable real estate with cultural and aesthetic benefits.

Ecosystem services within these areas interact in both supportive and competitive ways, shaping the long-term impact of human activities on nature's ability to provide them. Identifying key areas for water security and other ecosystem services—provisioning (e.g., food, fuel), regulatory (e.g., climate control, pollination), and cultural (e.g., recreation, education)—is crucial for sustainable management.

This paper presents the results of the EEA-funded ECOSERV_PL project (“The Services Delivered by Main Ecosystem Types in Poland – An Applied Approach”), which developed an ecosystem service-based assessment to complement monitoring carried under Water Framework Directive. Unlike traditional approaches focused on geomorphology or species diversity, it evaluates the functional value of riverscapes. We discuss data gaps, methodological challenges, and the process of scaling indices up and down.

Our approach, tested through the LIFE Pilica Integrated Project, aims to integrate ecosystem services into decision-making using accessible data—local statistics, maps, and socio-economic information. The project supports capacity-building for remedial measures in line with the Vistula River Basin Management Plan, applied to the Pilica River catchment.

Oral presentation

Landscape assessment changes in rapidly urbanising Northern Patagonia: Applying Ecosystem Services valuation for a spatial econometric testing

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The monetary valuation of ecosystem services (ES) can enhance fairness in land rent distribution in ecologically and socially sensitive landscapes. Property tax regimes often overlook ecological elements due to their limited understanding of how different ecosystem services (ES) impact property prices during urbanisation. This study aims to bridge this knowledge gap in Northern Patagonia, Chile, an ecologically sensitive area experiencing urban-to-rural migration, low-density residential growth, and rising land values.

The research follows several steps: first, it identifies and maps ES using land-use and satellite-assisted cover maps to establish urban structural types (USTs). ES are assessed through Burkhard's matrix and feedback from a panel of 12 local experts. A GIS-based geodatabase analyses property factors like price and size, utilising around 400,000 observations from 2000 to 2023. Accessibility to ES is measured using various criteria, aiming to demonstrate how access to specific ESs influences property values differently. The hedonic pricing analysis estimates the marginal willingness to pay for proximity to each ecosystem service (ES) across different urban service territories (USTs), potentially transforming property tax appraisal systems in the region and beyond based on enhanced knowledge of ecosystem services.

Oral presentation

Ecosystem services assessment at a landscape scale for sustainable human-wildlife interactions in the mountains: a case study of Central Balkan, Bulgaria

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Human-wildlife coexistence, where humans and wildlife share space, has become an important paradigm of European biodiversity protection and conservation management (König et al., 2020). However, the coexistence of humans and permanent or recovering wildlife species remains a societal challenge in all landscapes, which often manifests in trade-offs and conflicts, such as illegal wildlife killing, crop and livestock damages, and ensuing social conflicts (Smith et al., 2017), thus threatening long-term conservation goals. The ecosystems in the mountain areas are often the last places where they can find suitable habitats to save their population. However, the human pressure in these areas also increases as a result of expanding tourism and livestock practices. Therefore, sustainable concepts of sharing space are required that take into account the needs of wildlife species, differences in affectedness and values of stakeholders, regional landscape, and land use conditions, while also learning from successful and unsuccessful stories, to enable long-term sustainable human-wildlife interactions. In this paper, we are trying to identify spatial and temporal patterns of human-wildlife interactions in the case study of the Central Balkan biosphere reserve. The main research question is how these interactions are influenced by landscape and socioeconomic factors, and can we use this information for risk assessment and prediction. We apply the InVEST (Integrated Valuation of Ecosystem Services and Trade-Offs) and more specifically its habitat quality module to identify the areas of good habitat quality and the areas of potential risk for human-wildlife interactions. Thus, we reveal spatial mismatches such as benefits concentrated in one area, conflicts concentrated in another area, and hotspots of disservices such as spatial damage concentration from multiple species.

Oral presentation

Twenty years of ecosystem services research in Bulgaria: lessons learned and future directions from a geographical perspective

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The ecosystem services (ES) concept has established itself in recent years as the predominant paradigm for framing environmental research and policy-making. The EU Biodiversity Strategy to 2020 with its task for member countries to map and assess the state of ecosystems and their services has contributed vastly to the development of the ES studies in the European countries. Bulgaria was among the countries that made substantial progress in its implementation and the contribution of the geographers was of vital importance. This paper aims to provide an overview and analysis of the ES research in Bulgaria focusing on the contributions of the geographers and the spatial aspects of the studies. The information on the ES research was performed through a literature review by collecting all available published works that address the main objectives of the study. To systematize and characterize the content of the reviewed papers, a special database with a standard nomenclature was constructed. The findings from the review allowed us to identify both achievements and research gaps in the ES studies conducted by Bulgarian geographers. This enabled us to define the main research priorities of the coming years which can trace the future directions of ES research in the country. They include the development of the spatial aspects in the methodological frameworks for mapping and assessment of ES, better use of GIS-based tools for mapping ES alongside models' integration, and improvement of the publication's quality and increase of the papers published in highly rated indexed journals.

Oral presentation

Assessing the Contribution of Communal Lands to Ecosystem Services: a Case Study from Portugal

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In Portugal, baldio refers to communal land, a remnant of an ancient governance model where local communities, or communes, collectively managed common lands. Today, communal lands cover almost 550,000 hectares, primarily forests, and are governed by rights obtained over centuries through customary use, formalized in law in 1976 following Portugal's democratic transition. Concentrated in the remote northern and central highlands, communal lands are historically linked to extensive agro-pastoral systems. In these regions, sustainable, traditional land use practices have been preserved that have a positive impact on landscape and environmental protection.

In contemporary society, communal lands are often undervalued, considered obsolete or viewed as a challenge to manage within a capitalist framework. Yet these lands hold substantial value—not only for their cultural heritage and governance model, but also as well-preserved reservoirs of forests and natural resources that support traditional agro-pastoral systems and rural livelihoods. Additionally, the spatial scale they represent (typically large continuous areas) enhances the importance of these territories, where the micro-scale predominates, bringing along all the associated challenges.

The sustainable management of communal land in Portugal faces significant challenges, primarily due to the decline of traditional agricultural and pastoral activities, the low economic returns for landowners and the increasing risk of large-scale fires. Communities struggle with insufficient financial resources for investment, and constraints associated with their location in protected natural areas. Ecosystem services present a promising opportunity to increase the value and sustainability of communal lands by integrating new economic incentives.

The aim of this study is to assess the contribution of Portuguese communal lands to ecosystem services and investigate the potential for carbon sequestration. We selected communal lands from a specific region as a case study and identified the main ecosystem services provided by these lands through surveys with local stakeholders. We also quantified carbon sequestration, an ecosystem service with established market value. To this end, we explored the capacity of using MODIS satellite imagery to explore effective and scalable approaches for future monitoring.

Oral presentation

Revealing habitat maintenance and cultural aspects of the fishpond production landscapes

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Freshwater fishpond systems are an integral part of the agricultural landscape of Central and Eastern Europe. They play an important role in EU aquaculture production, contributing not only to local food production and food security but also providing wider environmental and cultural benefits. These systems, together with their surrounding landscapes, function as complex ecological units, integrating social, economic, and environmental elements and providing a wide range of ecosystem services (ES).

Cultural and habitat maintenance services, which mainly result from the complex dynamic relationships between ecosystems and humans in landscapes over time, are difficult to quantify in biophysical assessments and are generally controversial. Especially for fishpond ecosystems, these assessment indicators for these categories of ES may be lacking. Therefore, this study aimed to comprehensively assess the habitat maintenance, aesthetic and recreational values of fishpond landscapes using remote sensing and GIS-based indicators. To assess habitat maintenance services, indexes such as the fractal dimension index were used to assess the shape complexity of the ponds, vegetation cover quantified plant presence, and shoreline density measured the irregularity, along with edge density calculations. Assessment of cultural ES including aesthetic and recreational values, were assessed using a combination of indicators. These included potential for water-related activities, tourist attraction capacity, site accessibility, travel time, as well as landscape structural diversity and perceived naturalness of fishpond landscapes. The relationship between ES at the fishpond landscape level and local socio-ecological indicators was also understood. Understanding the relationship between human activities, socio-economic factors, and landscape changes is crucial for effective ES management. Exploring these linkages can aid pond management, inform policy decisions, and prevent conflicts while improving landscape planning and socio-economic outcomes.

Our findings from this study aim to contribute to the existing knowledge gap and deeper understanding of reusable indicators for mapping fishpond ES, and also support sustainable development strategies to explore the multifunctionality of aquaculture food production systems.

Oral presentation

Comparing two spatial models' performance for urban flood regulation supply

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The occurrence of pluvial-induced events in urban ecosystems has been increasing in recent years, and flood regulation supply assessment should be a key priority for urban areas. The presented study compares the performance of two models for flood regulation supply (FRS) assessment using different input data. The assessment of the ecosystem services of urban FRS was performed by using the Urban Flood Risk Mitigation (UFRM) by Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) and IMECOGIP Waterflow Regulation (Retention Model) (WRRM). We have applied several aspects for data improvement, including updating the national ecosystem-type assessment for the case study area of Sofia, Bulgaria, by connecting it with the Urban Atlas typology and proposing an approach for soil data refinement. The two models' outputs show significant differences in FRS values for each land-use/land-cover class. The UFRM assesses different impervious urban classes with different values, while the WRRM assesses the FRS in densely sealed areas with one fixed value for low supply (where nearly all rainfall is transformed into runoff). By applying the proposed approach, we testify that the improvement of input data can increase the precision of modelling results and thus ensure comprehensive data for designing measures for urban flood risk reduction. This approach is an objective balance between data accuracy, dataset accessibility, and relevant adaptation to the case study's characteristics.

Oral presentation

Enhance Ecosystem Services Science in Hydrological Hydrogeological Restoration for Sustainable Water Resource Management

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Climate change and anthropogenic activities accelerate water ecosystem degradation, threatening ecological stability and economic resilience. The integrated model for water resource management, combining economic valuation of ecosystem services (ES) with hydrological restoration was developed. The approach applies cost-benefit analysis and nature-based solutions to optimize policy decisions. Using the Ecosystem Service Value Database (ESVD) and meta-regression analysis, ES values were quantified across provisioning, regulating, and cultural services. Hydrological restoration employed Potapenko's method to enhance groundwater infiltration and reduce erosion, identical to the managed aquifer recharge (MAR) approach, <https://www.teresa.inowas.com/>. A mixed-methods sociocultural analysis, including petition data (3,140 signatures) and stakeholder surveys, assessed public priorities. Results demonstrate the economic and ecological benefits of ecosystem preservation. Maintaining Lake Maly Taldykol's natural hydrological regime provides a 20-fold cost advantage over artificial alternatives, saving \$2.5 million annually. Cultural and regulatory services, including flood mitigation and tourism, contribute an estimated \$111.7 million per year. Public engagement data show 78% of surveyed residents prioritize ecosystem conservation over infrastructure expansion. This study bridges economic valuation and ecological restoration by aligning ESVD metrics with hydrological engineering, providing a scalable framework applicable to Berlin (Spree River) and Dresden (Elbe Basin). It fosters Kazakhstan-Germany collaboration in technology transfer, GIS-based ES mapping, and policy integration, supporting The Economics of Ecosystems and Biodiversity (TEEB) principles. The interdisciplinary approach addresses DFG sustainability research priorities, ensuring civic engagement in water governance activities. Slovakia's initiatives in "water for climate healing - the new water paradigm and public policy" <https://www.youtube.com/watch?v=NPx-tiTrqNQ> with contour-strip land organization under our investigation for the practical expansion of these efforts. The Kazakh Ministry of Science grant # BR27197639 "Development of Innovative Hydrogeological Methods for Water Resource Management in the Zhambyl, Almaty, Zhetysay, Abay, and East Kazakhstan Regions" supports this project. The current status of the project activities will be presented.

Oral presentation

Integrating Vegetation and Ecosystem Structures into Water-Related Ecosystem Services Assessments for Sustainable Watershed Management

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The distribution of water resources at the landscape scale is essential for ecosystems and society, yet it is increasingly contested. Water demand is rising, driven by irrigation, drinking water needs, and hydropower. At the same time climate change alters supply, resulting in more frequent and intense floods and droughts, which threatens both ecosystems and human well-being.

A key approach to addressing these challenges is to integrate water-related ecosystem services (WRES) into watershed management and landscape planning. Assessing WRES helps balancing societal water needs with water supplied by ecosystems, making its evaluation increasingly important in research. Effective WRES assessment must consider watershed planning at landscape scales, where vegetation and ecosystem structure influence underlying hydrological processes such as surface runoff, infiltration, groundwater recharge, and evapotranspiration. Plant traits and thus vegetation is crucial in these hydrological processes.

We hypothesise that plant-water interactions are insufficiently considered in currently published WRES assessments. To investigate this, we systematically reviewed the literature on WRES assessment at the landscape level, analyzing whether and how vegetation and ecosystem structure are considered. In our initial scoping, we searched Google Scholar and Web of Science using a set of predefined queries. After screening titles and abstracts of 693 articles, we selected 26 papers for further analysis. These were evaluated based on study scale and spatial context, evaluated ecosystem services, WRES assessment approaches and landscape classification systems.

Our analysis revealed that most studies linked WRES to land use or land cover (LULC) data based on remote sensing. Only four papers considered more detailed vegetation characteristics, and another four focused on specific ecosystems. The ecosystem services that were most frequently analyzed, were regulatory WRES, followed by provisioning and cultural services. Specifically, the hydrological WRES affected by vegetation included water supply, water retention, groundwater supply, flood regulation, run-off control and water quality. Geographically, most case studies were conducted in Asia and Europe. Our findings highlight a mismatch between the spatial scale of WRES assessments and the scale where measures to enhance these services are implemented. This underscores the need for a framework that integrates vegetation and ecosystem structures into WRES assessment to effectively support biodiversity conservation and sustainable watershed management.

Oral presentation

Mapping Stakeholders' Perceptions of CES for Maritime Silk Road Coastal Management via Social Media in China

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The coastal cultural landscape embodies the dynamic interaction between human activities and the natural environment, offering a diverse range of Cultural Ecosystem Services (CES). However, the perspectives of multiple stakeholders on CES are often overlooked in coastal cultural landscape management, particularly in developing countries, thereby hindering effective conflict resolution and sustainable governance. This study examines the spatial distribution of CES valued by residents and tourists in a coastal cultural landscape along the Maritime Silk Road in Quanzhou, China, by employing geotagged social media photos and image content analysis. The results identify cultural heritage, recreation, artistic appreciation, and sense of place as the primary CES benefits recognized by both groups. Tourists predominantly concentrate on central urban sites, whereas residents exhibit a more dispersed perception of CES across the landscape. Furthermore, random forest analysis reveals significant differences in the contributions of natural and human-made features to CES intensity between residents and tourists. These findings deepen the understanding of human interactions with coastal cultural landscapes and provide insights to inform sustainable local development policies.

Oral presentation

Understanding the spatial drivers of cultural ecosystem services in freshwater landscapes: a systematic review

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Freshwater landscapes are important for supporting biodiversity, sustaining livelihoods, preserving traditions, and offering significant Cultural Ecosystem Services (CES). However, these landscapes face increasing pressures from anthropogenic activities, endangering not only their ecological integrity but also their contributions to human well-being. This systematic review examines the literature on CES in natural freshwater landscapes from 2010 to 2024, with a focus on biophysical drivers. Thus, a systematic search was conducted in the ISI Web of Knowledge database with the following keywords: "cultural ecosystem services" or "cultural services" or "hydrolog*" or "water*" or "freshwater*" or "aquatic*" or "river*" or "lake*" or "basin*" or "stream*" or "reservoir" or "wetland*" or "floodplain*" or "lagoon*" or "pond*". The search yielded 1,232 papers, from which 156 studies were selected for further analysis. The publications were categorized based on their geographical location, freshwater ecosystem type, methodologies, CES categories, and biophysical drivers. Europe (66 studies) and Asia (48 studies) accounted for 76% of the total, with China (21 studies) being the most frequently studied country. Rivers were the most studied ecosystems, whereas ponds received the least attention. Among CES categories, recreation and aesthetic values were the most studied, while knowledge systems and health and well-being were the least studied. Principal Component Analysis revealed distinct geographical patterns linking continents to specific CES categories. Asia was primarily associated with cultural heritage values and spiritual values, Africa and Oceania were linked to knowledge systems and spiritual values, and Europe was associated with sense of place, inspiration, and social relations. Correlation analysis revealed strong associations between CES and biophysical drivers, notably between ecological quality and connection to nature, recreational values and land use, and water quality and aesthetic appreciation. This review synthesizes CES evaluations and their geographical relevance, emphasizing key biophysical drivers shaping their distribution. By identifying these relationships, this study underscores the need for integrating ecological and social dimensions into freshwater landscape management to promote sustainable conservation strategies that contribute to human well-being.

Poster presentation

Assessing ecosystem condition and service potential under goldenrod invasion: methods and indicators for a multifaceted approach

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North American goldenrod species (e.g. Canadian goldenrod and giant goldenrod) were introduced to Poland in the second half of the 19th century as ornamental plants and nectar sources for honey production. However, it was only in recent decades - as a result of land use changes and agricultural land abandonment - they have begun to spread on a large scale. Nowadays, they are considered highly invasive and pose a serious threat to the native fauna and flora, as they are rapidly expanding and outcompeting local species. One of the objectives of the SolidES project (Countrywide mapping of goldenrod invasion and assessing its impact on ecosystems and human well-being) is to assess and compare the potential of invaded and non-invaded ecosystems to provide 11 ecosystem services (ES). Here, we present methods for a multifaceted assessment of ecosystem condition (including soil properties, biomass production and biodiversity of plants and selected animal groups) and how we plan to translate its results into ES potentials. For this, we will utilize several ecosystem-condition-related indicators, which are simple or complex, direct or indirect. For example, honey production potential will be measured as estimated nectar yield of plants weighted by its cover in kg/ha, while global climate regulation will be assessed via soil organic carbon stock in Mg/ha. Less specific services, such as maintaining nursery habitats, will be estimated by a set of complementary indicators taking into account different groups of organisms (insects, earthworms, native plants). Since cultural ES are intangible, highly subjective and require a direct interaction between humans and nature, recognition of users' opinions and behavior is of key importance for their evaluation. Therefore, we have elaborated a questionnaire to gather information on the potential of three cultural ES (recreation, wildlife observation, aesthetic experiences) from direct users of ecosystems invaded by goldenrod species: landowners, neighbors, passers-by and recreational visitors.

This contribution is funded by Poland's Ministry of Science and Higher Education (grant no. NdS-II/SP/0216/2024/01)

Poster presentation

Exploring the Geoecosystem Approach to Ecosystem Services: Case Studies on Water Issues

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The concept of ecosystem services (ES) is a central topic in environmental discourse, engaging the scientific community and policymakers. A substantial body of literature has explored this issue, revealing varying interpretations of key terms such as ecosystem, geosystem, landscape, utility values, and services.

This paper clarifies these fundamental terms, emphasising the ecosystem as a unified system of biota and abiotic surroundings. However, many ES studies overlook this holistic perspective, focusing primarily on biotic components and reducing ecosystems to simplistic representations like vegetation formations or land cover. Recent critiques argue for a more integrated approach considering the interactions between biotic and abiotic elements in ES assessments.

In response, we adopt the term "geoecosystem", which incorporates both abiotic and biotic components. This paper presents three case studies that assess water-related ES, applying an integrated landscape-ecological and geoecosystem approach that gives equal consideration to both components.

The key message of these case studies is the importance of an integrated approach in ES assessment. By applying this approach, we can achieve more accurate, quantitative evaluations of ES while reducing the reliance on extensive field investigations.

Poster presentation

Elements of green infrastructure of agricultural landscape and their ecosystem services

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The aim of this contribution is to provide review of role of green infrastructure in agricultural landscape and benefits that provide for society.

Agricultural landscapes play a crucial role in sustaining global food production and rural livelihoods, yet they face growing challenges due to biodiversity loss, soil degradation, water pollution, and the impacts of climate change. As agricultural intensification often compromises ecological balance, integrating green infrastructure (GI) into these landscapes offers a sustainable path forward. Green infrastructure encompasses a network of natural and semi-natural elements, such as hedgerows, riparian buffers, wetlands, agroforestry systems, and pollinator strips, that contribute to landscape resilience and enhance multiple ecosystem services. These elements provide provisioning services, including crop pollination, soil fertility improvement, and habitat provision for beneficial organisms. They also deliver vital regulating services, such as carbon sequestration, water filtration, microclimate regulation, and natural pest control, which help mitigate environmental impacts and support long-term agricultural viability. Supporting services, like nutrient cycling, habitat connectivity, and soil formation, reinforce ecosystem stability, while cultural services, such as enhanced landscape aesthetics, recreational opportunities, and contributions to local heritage, enrich human well-being. By strategically incorporating GI elements, agricultural landscapes can become more adaptable to changing environmental conditions, promoting biodiversity conservation while sustaining productivity. The interconnected functions of green infrastructure not only strengthen ecological networks but also aid in achieving broader sustainability goals, including climate change mitigation and landscape-scale restoration. This integrated approach empowers policymakers, land managers, and farmers to balance food security with environmental stewardship, fostering agricultural systems that are more resilient, productive, and ecologically harmonious in the face of global environmental change.

This works presents the collection of research finding and best practices of biodiversity-friendly farming in relation to green infrastructure, which was supported within the project FarmBioNet – funding from the European Union's Horizon Europe Framework Programme under project No. 101082102. Grant agreement ID: 101182942.

Poster presentation

The Role of Common Lands in the Provision of Ecosystem Services: A Case Study from Triglav National Park, Slovenia

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Common lands, including forests and mountain pastures managed by agrarian communities, play a crucial role in the provision of ecosystem services. This study investigates their role in carbon sequestration in the Triglav National Park (Slovenia). We used MODIS net primary production (NPP) as a proxy for carbon sequestration, downscaled to a spatial resolution of 10 m per pixel, matching that of the EU Copernicus High Resolution Layers. The results show that although common lands has moderate carbon sequestration overall, their forests make a significant contribution due to their large spatial extent. As the sequestration capacity of Slovenian forests has declined since 2014, the sustainable management of forests by private owners, including agrarian communities, supported by national and EU funding, will be essential for maintaining and enhancing this important ecosystem service.

Poster presentation

Assessing Spatial Variations in CES Perceptions for Coastal Landscape Management: Urban-Rural Case Study in China

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Coastal cultural landscapes serve as vital ecosystems that provide essential cultural, social, and ecological services, supporting dense populations and contributing to global ecosystem functions. However, rapid urbanization and environmental degradation are reshaping these landscapes, presenting significant challenges for sustainable management. This study investigates the spatial distribution of Cultural Ecosystem Services (CES) within the urban and rural contexts of Quanzhou's coastal cultural landscapes. By employing questionnaire surveys and Participatory Geographic Information Systems (PPGIS), we analyze public perceptions of CES across different infrastructure types, including grey, blue, and green infrastructure. The findings indicate that urban areas, particularly historic districts, serve as hotspots for CES such as cultural heritage, religious values, and sense of place, whereas rural areas primarily emphasize landscape appreciation and recreation. Grey infrastructure, notably historic buildings, alongside blue-green infrastructure, including urban parks and historic villages, emerge as key contributors to CES perceptions. Significant disparities in CES perceptions between urban and rural settings are influenced by socio-economic factors and diverse landscape features. This study underscores the necessity of integrating urban and rural perspectives into the sustainable management of coastal cultural landscapes and provides strategic recommendations for enhancing the protection and utilization of cultural and natural heritage to promote socio-ecological sustainability in coastal regions.

Poster presentation

Session 2G – Forest Landscapes for Multiple Benefits and Local Ecological Knowledge in Various Contexts

Symposium – flash presentations

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Keywords: functional landscapes, forests, non-wood forest products

The multifunctionality of forest landscapes is crucial for supporting biodiversity, building resilience, and increasing the productivity of forest ecosystems while simultaneously supporting community wellbeing. These multifunctional landscapes provide a wide range of ecological, economic, and social benefits at local, national, and global levels, ensuring sustainability for present and future generations. This session aims to highlight the crucial role of ecosystem services provided by forested landscapes in Europe by discussing case studies of the reciprocal contributions between people and forest landscapes across various temporal and spatial contexts. Moreover, we encourage a discussion around the relevance of local ecological knowledge (and its transmission) for achieving Sustainable Development Goals (SDG). We will focus on the bijective relationship between the forest landscapes and their inhabitants, with emphasis on the changes in such relationships in time and space. We will discuss the current trends in increasing and diversifying recreational, economic, ecological, and social-cultural demands on forest resources. Particularly, how people use forest resources other than wood (i.e. non-wood forest products (NWFPs) for food, medicine, fibre, and employment to sustain their livelihoods as well as various cultural and spiritual values for well-being. The session will discuss the changes in NWFP use and demand patterns and the associated drivers of change (e.g. lifestyle changes, urbanization, lesser contact with nature). Maintaining the overall health of the ecosystem in a “durable” and balanced way to achieve long-term resilience of the forest ecosystem, is crucial for human health. We will discuss how Indigenous and local communities have maintained (and enriched) forest systems (i.e. agroforests and agroforestry) over time through stewardship practices informed by their local ecological knowledge. Local ecological knowledge is crucial in maintaining a functional landscape for sustaining livelihoods while suggesting practices for forest management that help to achieve SDG.

Climate smart rewilding: co-benefitting future for social-ecological systems

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Nature based solutions (NBS) represent a paradigm shift from conventional, technology-driven interventions to approaches that harmonized human development with natural processes. Embedding NBS into European governance frameworks ensures not only cost-effective and sustainable strategy that addresses the interlinked challenges of climate change and biodiversity loss but also fosters resilient socio-ecological systems capable of adapting to future uncertainties.

And thus, rewilding, as an essential nature-based climate solution, makes ecological restoration financially feasible, promotes social-environmental co-benefits, safeguards cultural, socio-economic values, while enhancing rewilding's climate benefits. Rewilding paves the way for innovative governance models that integrate local stakeholder participation with adaptive management strategies, thereby aligning conservation objectives with rural development and sustainable land-use practices. The approach not only enriches natural capital but also unlocks new avenues for tourism, research, and community engagement, making it a pivotal strategy for advancing a more sustainable and resilient future.

However, rewilding also faces several institutional challenges. One key hurdle is the integration of rewilding principles into existing legal frameworks, which are often tailored to traditional conservation, forestry or agricultural practices. Issues such as land tenure, property rights, and potential conflicts with established land uses necessitate stakeholder engagement and adaptive governance structures. The long-term nature of rewilding projects also demands sustained financial commitments and cross-sector collaboration, making it imperative for policies to be both flexible and innovative to accommodate ecological uncertainties and evolving socio-political dynamics.

Our research resulting from Horizon Europe project wildE (focusing on rewilding implementation opportunities and challenges) introduces firstly institutional analysis of the rewilding policy framework to understand existing policy support/constraints, legal frameworks as well as economic tools for rewilding implementation at European level. Secondly, we introduce empirical experience of cross-border rewilding case study Tatra Mountains positioned on the Slovak-Polish border. Despite being a significant conservation area of NATURA 2000 framework and belong to the Tatra Biosphere Reserve, Tatra mountains are facing the challenge how to ensure the ecological integrity of this territory due to several nature extreme events and human activities, and how to ensure the balanced coexistence between conservation efforts and community well-being. We apply a co-creation participatory approach which involves a diverse array of stakeholders and enables to create collaboratively a comprehensive strategy for Tatra Mountains.

Oral presentation

Evaluating wild boar effects in forests

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Wild boar is an invasive and prolific species, one of the 100 worst invasive species, causing conflicts with humans and other players in the ecosystems. Still, as an ecosystem engineer, it plays an inevitable role in its native forest habitat (contribute to the balance of populations, regulate plant species, disperse seeds, participate in soil formation, etc.). This emphasizes the importance of its management and monitoring to maintain the carrying capacity of forest ecosystems. The purpose of the presentation is to show the results of the wild boar research of our team. Several significant relations were found between wild boar rooting and soil properties, including positive effects on soil erosion mitigation as one of the ecosystem services. There are several, almost philosophical questions that we wish to answer, regarding wild boar's impact in a forested environment. What is the natural and what is the damaging effects of the wild boar? When do we need to intervene to its activities? Are wild boar's activities considered as effect or damage? What is the role of wild boar in nature conservation areas?

Oral presentation

Multifunctional Forest Landscapes: A Local-Scale Approach to Mapping and Valuing Ecosystem Services

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Forested landscapes provide a wide range of ecological, economic, and socio-cultural benefits, shaping human well-being while maintaining biodiversity and resilience. Understanding the multifunctionality of these landscapes is crucial for sustainable forest management and achieving the Sustainable Development Goals (SDGs). This study applies a non-monetary valuation approach to assess and map ecosystem services (ES) in urban and rural municipal forests in Augsburg, Germany, considering how forests contribute to livelihoods, biodiversity conservation, and long-term resilience.

We analyzed 15 ES—including water protection, timber production, recreation, and non-wood forest products (NWFPs)—to evaluate their spatial distribution and interactions. To assess ES value, we applied four complementary valuation approaches: (1) stakeholder preferences, (2) spatial immediacy of ES use, (3) number of beneficiaries, and (4) a ranking based on the Millennium Ecosystem Assessment well-being framework. Our results highlight significant differences between urban and rural forests, with water protection and recreation ranking highest in urban areas due to their local benefits and high number of users, while timber production dominated in rural forests. The valuation approaches produced distinct rankings, with stakeholder-based assessments emphasizing cultural and regulating services, while number-of-beneficiaries weighting prioritized widely used services such as drinking water.

Our spatial analysis identified over 240 different ES bundle combinations, illustrating the complexity of multifunctionality and the trade-offs in forest management. The Simpson Diversity Index was used to assess ES multifunctionality, revealing high agreement between unweighted and Millennium Ecosystem Assessment-based rankings but notable deviations when incorporating stakeholder perspectives. Recreation, environmental education, and aesthetic values were strongly emphasized in urban forests, while timber and fuelwood provision gained prominence in rural areas. The stakeholder-based valuation also highlighted divergences between forestry, conservation, and urban planning interests, reinforcing the need for inclusive decision-making.

This contribution will explore how non-monetary ES valuation can guide forest governance, balancing ecological integrity with societal needs. We will discuss how stakeholder perspectives, local ecological knowledge, and multifunctional forest planning can contribute to more adaptive and resilient landscapes. Integrating non-monetary valuation into conservation strategies provides an opportunity to align forest management with broader sustainability goals while acknowledging the diverse benefits that forests provide to communities.

Oral presentation

The Role of Trees Outside Forests in the Cultural Landscape of the Prosecco Hills UNESCO Site

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The multifunctional role of Trees Outside Forests (TOF) is largely recognized in scientific literature, but they are still rarely considered in forest inventories and planning, with consequent underestimation of their role and amount. In addition, their cultural role has rarely been considered both at scientific and management level as well as in UNESCO sites. TOF characterize many European cultural landscapes, including the one of the Colline del Prosecco, inscribed in 2019 in the UNESCO World Heritage List. One of the reasons of the inclusion, in fact, is the landscape mosaic made of vineyards interspersed with small woodlands and tree rows. This paper focuses on two types of TOF, Small Woods and Linear Tree Formations (TOF NON A/U). Their detailed mapping and the performing of different spatial analysis allowed to assess their role and to provide data for future monitoring and for local forest planning. Results confirmed that TOF NON A/U are one of the main features of the UNESCO site landscape: despite the limited overall surface (1.95% of the area), 931 different patches have been identified. Spatial analysis highlighted the key landscape and ecological roles, acting as stepping stones connecting large forest patches. In addition, they also have an important role for hydrological protection, as they can be found even in slopes above 80% of inclination. The study provided a detailed mapping and database of one of the main features of the Colline del Prosecco UNESCO site cultural landscape, verifying the multifunctional role of TOF and the necessity to include them into local forest planning, but also suggesting their inclusion in national forest inventories.

Oral presentation

Session 2H – Ontology of Landscape Open Spaces in Urban-to-Peri-Urban Gradients

Workshop

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Keywords: landscape, open spaces, ontology, planning, governance

To plan for resilient futures of transforming landscapes we require a sound and systematic understanding and typification, or thus ontology of landscape open spaces (LOS), which are one of the most important natural resources providing crucial services for human and non-human actors. The ontology will be based on a set of interrelated ideas assigned to specific categories contributing to an improved and shared conceptualization of LOS. This session will focus on LOS along urban-to-peri-urban gradients, as the most rapidly transformed types of open spaces. The broad understanding of LOS is that they are publicly and privately-owned terrestrial areas, their land cover/uses not being related to different types of urban fabric, commercial and transportation areas. Nevertheless, we are interested to further develop this understanding into a comprehensive ontology of LOS. The scope and the purpose of this ontology will be to increase understanding of what are LOS, to understand what role they play in securing physical and social resilience of cities. Moreover, we envision that the ontology may support landscape governance by making linkages between specific aspects of LOS with corresponding planning/management schemes/institutions/actors. This session aims to start building the ontology of LOS in a participatory way. The participants will be invited into an interactive workshop which will provide a basis for a semi-formal semantic description of LOS, which will subsequently be translated into a LOS ontology prototype. The prototype will be visualized during the workshop in the form of mind maps expressing semantic networks, i.e. graphs containing named nodes (that represent spatial, governance and functional traits of LOS and their attributes) and edges showing connections and relationships between the nodes. Session participants will work on a valuation of graph nodes to explore each node's role in the ontology, to devise a taxonomy of nodes, and to model relationships between nodes.

Session 2I – Cities as Social-Ecological-Technological Systems: From Urban Research to Interventions in Planning Application

Symposium

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Keywords: nature-based solutions, urban green infrastructure, urban landscapes, systems-thinking approach

With an estimated two billion people living in urban areas by 2050, urbanisation poses unprecedented challenges. Urbanisation leads to the depletion and degradation of natural resources, biodiversity, and ecosystem services. The inclusion of Urban Green Infrastructure (UGI) as nature-based solutions is an effective tool to counteract those urban challenges and to make cities more climate resilient. UGI is planned and managed to deliver many provisioning, regulating, and cultural ecosystem services that provide multiple benefits to humans and integrate biodiversity in urban areas, e.g., climate regulation, water runoff mitigation, space for recreation and food production. Further, UGI can substitute for non-renewable resources (e.g., fossil fuels for air conditioning) and can be used for smarter design and management of cities through integration into technical infrastructures. However, the integration of multifunctional UGI in densely populated urban environments is meeting significant barriers such as limited and intensively used above and belowground spaces, siloed administrations and regulations. Overcoming these and further obstacles call for integrated urban research between social, ecological, and technical sciences. Approaching urban areas as social-ecological-technological systems (SETS) will facilitate a deeper understanding of the interrelationships and dependencies between the three domains concerning UGI as an application solution. Collaborative knowledge development and sharing among researchers, practitioners and other stakeholders are needed to develop this systemic understanding, and to achieve a transformation towards urban sustainability and resilience. This symposium invites presentations on novel approaches to create and manage biodiverse urban green infrastructures that provide multiple ecological and social benefits. Inter- and transdisciplinary approaches to better integrate urban research into urban planning with a focus on urban green infrastructure are particularly welcome. The session should include case studies, conceptual ideas as well as new methodologies from researchers and practitioners working at the intersection of social, ecological, and technological domains.

Using landscape metrics for assessing the efficiency of residential planning in urban areas

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Urban landscapes are composed of a diverse mix of features, each representing a function that enables cities to operate and thrive. Among these, residential landscapes are the most prevalent. The overall structure and organization of residential neighbourhoods can suggest a certain level of quality of life for a specific urban fabric and can also portrait the efficiency of the local planning approaches.

Building on this premise, we have conducted analysis on 12 Romanian cities, including small towns to major cities, covering all historical regions of the country, to cluster residential neighbourhoods in different typologies. To do so we used a set of variables, including built-up areas and road networks, for the artificial features, and average slope, altitudes, NDVI and land use and land cover for natural features. We have processed these variables using a set of landscape metrics (e.g., patch number, patch density, shape etc.) to determine whether different typologies of residential neighborhoods exist based on the size and geographical location of the cities.

Our findings revealed how the landscape metrics indicate residential neighbourhoods clustering differently based on the age of the neighbourhoods. The analysis also showed homogenous residential neighbourhood patterns for the urban fabrics established during the socialist regime, while the urban fabrics developed in the past 30 years show heterogenous patterns.

Such analysis and their results can provide an important foundation for further assessments regarding the suitability of adopting different planning approaches at city level, such as the 15-minute city approach, compact city approach or other approaches aimed at increasing the sustainability and resilience of urban areas. Future inquiries will focus on whether socio-demographic data for the established neighbourhood typologies correlate.

Oral presentation

Integrating human and ecological values for urban green infrastructure connectivity

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Planning and decision making for a just green transition requires acknowledging both human and ecological aspects of values for nature. This means that solutions should be balanced across not only humans and the diverse communities they belong to, but also across multiple species and elements of biodiversity. While the topic of multispecies justice (MSJ) is gaining traction, it remains unclear how to integrate these aspects in the planning of urban nature areas, including how to create a network of green infrastructure and ensuring the availability of different habitats that support multiple species. Here, we present preliminary findings on identifying and comparing methods of green infrastructure landscape analysis that integrate ecological connectivity and place-based social values in Turku, Finland. Ecological values were derived for species archetypes based on trait data to model connectivity needs of different types of species, and human values were derived from a PPGIS survey that elicited residents' place-based values on nature following the IPBES nature values typology. Using these data, we test different approaches and aim to 1) evaluate spatial hotspots between human and ecological values, 2) examine how human values influence resistance to ecological connectivity, and 3) analyze the overlap between connectivity networks for multiple species, including humans. We assess the characteristics of the different connectivity analysis methods and how they support MSJ in terms of representation, distribution, and agency as well as their benefits, trade-offs, and conflicts.

Oral presentation

Planning Green Infrastructure on basis of mobile climate data measurements in urban areas – a case study from Neubrandenburg, Germany

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Planning Green Infrastructure on basis of mobile climate data measurements in urban areas – a case study from Neubrandenburg, Germany. The city of Neubrandenburg is located in the North-Eastern part of Germany, which is assigned as a very dry region due to longterm precipitation measurements and different climate scenarios. To protect citizens from extreme heat in the city, especially in quarters with social facilities (e.g. schools), nature based solution like green infrastructure shall be implemented.

To localize optimal sites for green infrastructure structures in Neubrandenburg, we conducted mobile measurements, using Meteo Tracker on a bike. Measuring activities took place in summer 2024 and include 48 bike rides on sixteen days, each day in the morning, afternoon and evening. As a result, a high amount of meteorological data like temperature, humidity, pressure or global radiation could be captured.

Data were then classified, analyzed and displayed using GIS systems, which let to identification of several “hot spots” within the investigation area. By combining these hot spots with further information about existing green structure (e.g. lawns), town constructions (e.g. buildings) and social facilities (e.g. schools), we identified locations, with a high need of introducing elements of green infrastructure.

For most relevant sites, detailed suggestions were made, to prepare the implementation of measurements. These information and proposals deliver good, well sounded information for responsible institutions like the city planning authority or housing companies to realize green infrastructure.

Oral presentation

Earth Observation Data Analytics Toolbox as a Technological System for Supporting Social-Ecological Systems in Sponge City Interventions in the Danube Region

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The Danube Region (DR) faces increasing climate change-induced threats, with approximately 75% of its population residing in urban areas vulnerable to heat waves, droughts, wildfires, and flash floods. The varying micro-climatic, infrastructural, financial, legal, and social contexts across DR settlements necessitate transnational cooperation to enhance climate adaptation measures. To address these challenges, the SpongeCity - Interreg Danube project promotes the Sponge City concept, which improves urban resilience by integrating nature-based solutions, Green Infrastructure, reducing impermeable surfaces, and implementing water retention measures. Within this social-ecological-technological systems (SETS) framework, we developed the Earth Observation (EO) Data Analytics Toolbox as the technological component to support decision-makers in planning and implementing Sponge City interventions. The development process began with comprehensive surveys and comparative studies of 12 pilot settlements in the DR to understand their diverse characteristics, risks, and requirements, which directly informed the toolbox's design and functionality. Key innovations include: (1) a Semantic Earth Observation Data Cube System that enriches Sentinel-2 satellite imagery using the Satellite Image Automatic Mapper (SIAM) algorithm; (2) an interactive, user-friendly web interface designed for stakeholders with varying technical backgrounds; and (3) integration of multiple data sources including ECOSTRESS Land Surface Temperature, Copernicus DEM, and high-resolution local data. The toolbox enables monitoring and analysis of critical ecological processes such as green space changes, land use patterns, urban heat islands, and water dynamics. Following testing and refinement in pilot settlements, this technological system will be integrated into participatory planning approaches and action plans for SpongeCity interventions across more than 160 settlements in the Danube Region, demonstrating how technological innovations can bridge social and ecological domains in urban sustainability efforts.

Oral presentation

Assessment of the urban heat island effect and quantification of the cooling effect of urban green spaces

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In addition to a gradual increase in global average temperature, climate change is bringing local heat waves and sudden extreme precipitation events. These are most pronounced in cities due to the high proportion of artificial surfaces and limited natural ecosystems. Cities are home to more than half of Slovakia's population (more than 75% globally) and therefore represent priority areas for adaptation to climate change. The high proportion of mineral surfaces in cities alters the microclimatic conditions of the environment, which in turn manifests itself in the form of an urban heat island, negatively affecting human well-being and the health of its inhabitants. The urban heat island can be detected and quantified in several ways using direct and indirect methods. In our work, we combined its detection based on land surface temperature calculated from satellite images with ground-based temperature measurements. We made direct temperature measurements using stationary stations and a mobile station on transects through the city. Statistical analysis showed significant temperature differences (up to 6°C) between the open landscape and temperatures measured in areas with different proportions of artificial surfaces. We also analysed the cooling effect of urban green spaces as a function of their area and vegetation structure. The most significant cooling effect is provided by large green spaces (over 1 ha), where the cooling intensity (difference in the land surface temperature compared to an urban area without vegetation) was almost 4.5 °C on average and the cooling distance was significant up to 90 m. Identifying the areas with the highest temperature allows us to prioritise the areas that require active thermal comfort solutions for the occupants. In turn, quantifying the cooling potential of vegetation provides practical options for revitalising existing or creating new cooling green spaces.

Oral presentation

Investigate the role of private green spaces in urban flood mitigation to support spatial planning

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Private green spaces can account for up to 30% of the urban core, including residential yards, private parks, areas associated with commercial and industrial properties, and domestic gardens. Land cover and vegetation changes in private green spaces impact climate-related urban ecosystem services, such as flood mitigation. Urban flooding is a hydrologic-hydraulic phenomenon occurring when runoff from impervious surfaces exceeds sewer capacity. For example, a case study in Venice showed that private areas can generate over twice the runoff of public ones in heavy rainfall scenarios [1]. However, their role in flood mitigation is understudied, and existing research mainly addresses runoff mitigation, overlooking the hydraulic impact on the sewer system. To capture the latter, refined stormwater management models are needed, but the complexity of their outputs limits their use in planning to support the design and prioritization of interventions. The study aims to develop and test spatially explicit hydrologic-hydraulic indicators that capture the role of private green spaces in urban flood mitigation and inform the prioritization of interventions to reduce flood risk. Private green spaces were identified in the city of Trento (Italy), and land cover was characterized using 30 cm-resolution satellite imagery. This data was used to define imperviousness and infiltration parameters in the Storm Water Management Model (SWMM), which simulates the rainfall-runoff transformation by discretizing the urban area in subcatchments (hydrologic component) and modelling water transport in the sewer system, made of conduits and nodes (hydraulic component). To synthesize SWMM outputs and enhance their applicability for spatial planning, two new hydraulic indicators were computed for each subcatchment. The flooding ratio represents the fraction of a subcatchment's runoff volume that contributes to overflow at one or more downstream nodes. The surcharging ratio quantifies the fraction of a subcatchment's runoff volume feeding conduits in a critical state (degree of filling >80%). Combined with the runoff coefficient, these indicators identify critical subcatchments where interventions in private green spaces can mitigate urban flooding. Proposed interventions are defined based on feasibility, including available space and technical constraints. The results show how the newly developed indicators can be used as an additional tool to assess urban flood mitigation and support spatial planning.

Oral presentation

Hidden in the shadow of trees: exploring urban residents' perception of tree-related ecosystem service and its relation to heat-prone areas

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The surface urban heat island (SUHI) effect, a phenomenon responsible for increasing the city's center temperature compared to its rural surroundings, can be effectively monitored using Land Surface Temperature (LST) (Fernandes et al., 2023). Urban landscape influence on LST may be controlled by dividing urban areas into local climate zones (LCZs), a standardized classification method the most commonly used to indicate areas sensitive to high temperatures (Wu et al., 2022). However, their results cannot simply translate into the resident's perception of thermal conditions. Although LCZs have been used for research on thermal comfort, such analysis considers only general patterns, overlooking individual perceptions and experiences (Patel et al., 2024). At the same time, fragility to heat exposure is highly related to individual thermoception (Yáñez Serrano et al. 2024), influenced by many factors, such as sex and age (Agharmolaei et al. 2023). Thus, more humancentric indicators of heat-prone areas are needed to identify locations that require immediate attention regarding climate change adaptation. The presented study is devoted to this issue by investigating tree-related ESs in case study research.

Trees in cities provide many benefits, including a key one in the context of climate change - lowering temperatures in urban areas. Despite this, local decision-makers do not always see it as the leading ecosystem service (ES) trees provide to residents (Przewoźna et al., 2022). In addition, in the public perception, the cultural values of trees are often more appreciated than others, such as shade, which may influence the acceptance of regulations for the protection of old and large trees (Paniotova-Maczka et al., 2023). Thus, the location where trees providing shadow are appreciated more may be a proxy of heat-prone areas from a residents' perspective.

This hypothesis was tested in Poznań, where the relation between the perception of ES provided by urban trees and LST was examined concerning the LCZ characterizing the respondents' residences. The study was conducted using participatory GIS (geo-questionnaires) in the summer of 2020 (Przewoźna et al., 2021) and the LCZs with a raster grid accuracy of 100x100 m (Demuzere et al., 2019). The presentation includes a discussion of the main results and the potential of using the perception of ESs provided by trees to delineate areas where residents are most affected by high temperatures.

Oral presentation

Increasing Competencies and Sensitivity of Vulnerable Groups for Adaptation to Heat-related Health Risks supported by Spatial Data Analysis

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Climate change scenarios predict the increase of heat events in many parts of world. Urban administrations are confronted with heat-related problems because the “urban heat island”-effect has environmental, political and societal impacts. Health issues are related to heat events due to the vulnerability of specific societal groups. Urban governments have to react in a goal-driven manner, thus identifying vulnerable groups, the locations where they live, what the threats are, and what this means for concerned people facing different ailments and illnesses resulting from heat. Enhancing the sensitivity of such groups, and training of competencies to act adequately during heat periods, are main aims of the project “HiLSA”.

Project framework and goals

The project “HiLSA” will contribute to enlighten the risks resulting from heat for vulnerable groups. Two universities work together with stakeholders from practice and decision-makers in administrations. The consortium, consisting of health scientists, sociologists and geoinformatics experts, aims at the investigation of relationships between heat waves, accompanied by increased UV-radiation, and health problems for specific groups, e. g. elderly people, children, handicapped people or people with various kinds of stress or diseases.

The relationships will be analysed based on existing data and newly generated data. The aim is to establish a common understanding of heat-associated health problems, and to increase competencies of vulnerable groups on the other. The knowledge gained in the project will be provided in targeted form to users, thus increasing their knowledge, possibly followed by a changed behaviour when facing heat. Parallel to that, strategies of how to mitigate threats resulting from heat are developed and transformed into recommendations to mitigate such threats.

Important sub goals of HiLSA are:

- Systematic collection of national and international scientific results focusing on the relationship between heat and health
- Identification of heat-related data, indicators, measures, actors and legal regulations
- Quantitative and qualitative interviews of stakeholders
- Production of vulnerability maps and other forms of spatial visualisation using GIS
- synthesis of a transferrable concept of a heat-associated health competency and its operationalisation

Expected results

The project follows a transdisciplinary approach. In particular, the requirements of the vulnerable groups and current policies will be considered. The results will be communicated, among other means, via a platform that includes a GIS-based online mapping system to inform users, in particular vulnerable people, about heat-related threats and to support them when assessing an adequate behaviour during heat periods, thus considering their individual health-related characteristics.

Oral presentation

Behavioural change in the application of appropriate green infrastructure to microclimatic function in the city.

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Sustainable provision of regulatory ecosystem services, such as climate regulation, are essential for reducing the impact of climate change and inducing a paradigm shift in the management of natural resources, to link natural systems and human well-being. However, natural elements and green areas in cities are shrinking and ineffective planning and management of urban systems can considerably exacerbate the negative effects of climate change. Bringing nature-based solutions into spatial planning of urban and semi-urban areas has the potential to supply multiple ecosystem services, which increase the quality of life and mitigate the negative impacts of climate change.

The qualitative research (interviews) focuses firstly on the analysis of climate change risk perception of different actors to understand how collective action can stimulate the adaptive behaviour in a long term. Secondly, study identifies the effective motivations to develop the payments for ecosystem services in public-private partnerships. Finally, the quantitative research is supplemented with data from microclimate measurements for better identification of risk areas, which will help set up management so that its greenery effectively provides regulatory ecosystem services.

Oral presentation

Climate-Hazard NbS Prioritization Index: Linking Key Community Systems to Nature-Based Solutions for Climate Resilience

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This study introduces the Climate-Hazard NbS Prioritization Index (CHNPI) as a tool to define and operationalize climate resilience by linking Key Community Systems (KCS)—encompassing social, economic, ecological, and infrastructural systems—to Nature-Based Solutions (NbS) within a Complex Adaptive Systems of Systems (CASoS) framework. At the core of this research is the strategic application of Geographic Information Systems (GIS) to analyze and map vulnerabilities and adaptive capacities across coastal-urban landscapes. The CHNPI emphasizes spatial heterogeneity and connectivity, recognizing their critical role in mitigating multi-flood risks, including those from sea-level rise, fluvial flooding, pluvial flooding, and storm surges. By integrating multi-criteria spatial analysis, the index identifies priority areas where NbS—particularly urban green-blue infrastructure—can enhance population safety, safeguard economic assets, restore ecological integrity, and reinforce socio-ecological-technological connectivity across various climate scenarios. This study applies the CHNPI to Ostend, Belgium, demonstrating how a landscape-ecological perspective can inform the strategic placement and design of NbS to maximize resilience benefits. The index provides a scalable, transferable tool for resilience planning and hazard mitigation, adaptable to diverse climatic and geographical contexts. Ultimately, the CHNPI offers a data-driven, holistic approach to guiding NbS prioritization, ensuring that interventions are both effective in the short term and sustainable in the long term.

Oral presentation

Green strategy toward sustainable management of green space: A Case Study from Justus Liebig University Giessen

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Urban green spaces are essential for the sustainable development of cities, enhancing their character, improving environmental conditions, reducing carbon emissions, mitigating urban heat island effects, managing surface runoff, and promoting public health. Their role in supporting biodiversity has gained increasing recognition, yet many cities lack a structured concept for their sustainable management. To address this, Justus Liebig University Giessen in Germany developed a comprehensive plan to increase biodiversity, enhance soil carbon and water storage, improve the urban climate, create recreational spaces, and integrate sustainability into education. A detailed green space classification map was created using high-resolution (20 cm) digital orthophotos, while species data and soil samples were collected to assess biodiversity indices and soil health. Based on this, areas were identified for transformation from short-cut lawns into diverse wildflower meadows. The plant selection process followed two approaches: finding suitable plants for a specific location and identifying suitable locations for specific plants. Selection criteria included whether species were native or naturalized, their ecological value, conservation status, site requirements, lifespan, and maintenance needs. Preference was given to plants that support biodiversity, have high genetic diversity, and require minimal upkeep, while toxic plants were avoided near veterinary clinics and playgrounds. The ultimate goal was to establish selected species throughout the city via self-seeding, creating long-term, self-sustaining biodiversity corridors. Public awareness and acceptance being crucial for the success of these transformations, all gathered information—ranging from mapping data to plant selection criteria—was presented through ARCSStory maps, providing an interactive and educational tool for the community. This initiative by Justus Liebig University Giessen serves as a model for integrating sustainable green space management into urban planning and education, promoting ecological resilience and fostering a healthier urban environment.

Poster presentation

The regulatory ecosystem service of flood protection through hydrological modeling

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Ecosystem services (ES) represent benefits from ecosystems that support or improve human well-being. There are several classifications of ES, but the most widely used is the CICES, which divides them into provisioning (productive), regulating, supporting, and cultural services. Cities represent the most altered types of ecosystems with significantly changed physical and geographical characteristics that affect natural processes. Green spaces in cities provide numerous ecosystem services, such as climate regulation, support for life cycles and processes, soil stability, flood protection, recreation, and more. In urban environments, the proportion of green areas is lower, yet it is even more significant for the well-being of city inhabitants as well as for plant and animal species. With changing climate conditions and the increasing number and intensity of natural disasters around the world, regulating ecosystem services are irreplaceable. Flood protection is among the most essential regulatory ecosystem services in urban environments.

Hydrological models play a crucial role—and will become even more important in the future—in the context of flood mitigation ecosystem services. To effectively utilize hydrological models, which allow us to detect flood-prone areas, simulate different scenarios (e.g., simulations of water runoff quantity and quality), and develop predictive models, it is essential to carefully consider and select the appropriate type of hydrological model or the software in which it will be developed. Equally crucial are the field data, which serve as input variables for constructing the hydrological model itself. Soils in urban ecosystems have altered physical characteristics (depth, texture, compaction) compared to non-urban soils. These properties determine the rate and amount of retained water, thereby influencing the flood prevention ecosystem service. As part of our research, we collected soil samples from selected urban vegetation areas, which we then processed in the laboratory to obtain information about the soil's retention capacity. Other data that we obtained and determined were the infiltration capacity of the individual green areas. Based on available published scientific articles, we studied various hydrological models in more detail and selected the one that would be the most suitable for our area.

This study focuses on the assessment of the regulatory ecosystem service of flood protection using hydrological modeling tools and field measurements as well as the interpolation of soil properties.

Poster presentation

Can Blue-Green City Design Unlock the Potential of Small Urban Lots? Integrating Cultural and Regulating Ecosystem Services

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As cities strive to become more resilient and livable, the challenge is not only to introduce Nature-based Solutions (NbS) but also to integrate them effectively into the existing urban fabric. Small urban lots, despite their limited size, hold significant potential for enhancing both regulating (e.g., air purification, stormwater retention) and cultural ecosystem services (e.g., recreation, social cohesion, aesthetic value). However, designing such spaces requires a context-sensitive and participatory approach to ensure that interventions are both effective and accepted by the community.

The euPOLIS project (Integrated NBS Urban Planning Methodology for Enhancing the Health and Well-Being of Citizens: The euPOLIS Approach, H2020) explores such possibilities in Łódź, Poland —a post-industrial city facing environmental degradation, socio-economic inequalities, and public health concerns. The project focuses on transforming a small, neglected urban square into a multifunctional blue-green space that benefits both people and biodiversity.

Using a combination of workshops, surveys, and spatial observations, we identified community needs and expectations while assessing the site's environmental and climate adaptation potential. The resulting design solutions aim to balance climate resilience, urban biodiversity, and social usability, ensuring that the space serves both ecological and human-centered functions.

This case study highlights the importance of collaborative urban design in integrating NbS into compact urban spaces. By aligning scientific research, policy, and local knowledge, small-scale interventions can contribute to larger-scale urban resilience and well-being.

Poster presentation

Theme 3. Responding to changing landscapes

The recent rapidly changing world brought a greater degree of uncertainty in predicting future landscape developments and challenges. The study of the interactions between different elements of the environment and how they respond to different stress factors can provide valuable insights into how landscapes can be managed to better cope with new challenges. Examining the intricate interplay between ecological functions, cultural values, socio-economic factors, and technology allows for better appreciation and protection of our landscapes, ensuring they continue to provide vital services and benefits. For instance, there are increasing efforts in nature and landscape restoration, and approaches such as greening agricultural landscapes, can help steer the future of our landscapes. The theme addresses approaches to improve the efficiency of landscape responses to ongoing challenges, to better plan and manage the response of ecosystems and landscapes to ongoing challenges, as well as the role of policies, planning and emergent governance contexts in promoting sustainable land use practices.

Session 3A – Integrating Local Knowledge into Landscape Research: Toward more Ethical Transdisciplinary Approaches

Symposium

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Keywords: indigenous and local knowledge, environmental justice, landscape sustainability, ethics

Rural landscapes worldwide are experiencing changes at an unprecedented pace, driven by complex interplays of socio-economic, political, and environmental factors. These landscapes, as intricate research objects, encompass both tangible elements such as land uses and infrastructures, and intangible aspects including symbols and meanings. This complexity significantly challenges landscape scientists and raises important methodological and ethical questions. For instance, academic approaches often struggle to capture certain landscape changes, in particular those that are not measurable, not tangible, or too subtle to be monitored. Along with differences in worldviews, this leads to frequent divergences between the perspectives of academic researchers and those of local inhabitants. On an ethical stance, such divergences pave the road to epistemic injustices if local knowledge and perspectives are not acknowledged. Despite the growing recognition of the need to integrate non-academic knowledge into landscape research, fostering effective knowledge coproduction processes remains challenging. This session aims to explore approaches that articulate academic and non-academic expertise and operationalize transdisciplinary consortia. We seek contributions that demonstrate how such approaches can enhance our understanding of landscape transformations and contribute to more ethical research practices. Potential topics include: • Participatory research • Case studies showcasing (un)successful combination of academic and non-academic knowledge • Ethical considerations in transdisciplinary research • Innovative tools and technologies for combining diverse knowledge sources • The contribution of transdisciplinary approaches to landscape research This session aims to contribute to the development of more comprehensive, just and effective landscape research methodologies. We invite researchers, practitioners, and local knowledge holders to share their experiences, challenges, and successes in bridging the gap between academic and non-academic spheres. Ultimately, this session seeks to advance our collective ability to conduct landscape research that not only produces more accurate assessments but also acknowledges the perspectives of those who inhabit and shape these dynamic environments.

From mind to map: Integrating local knowledge and geospatial methods for climate resilient urban landscapes

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Global urbanization is increasingly shifting climate risk profiles from rural areas to cities. The urban landscape plays a crucial role in shaping a city's capacity to cope with and adapt to climate change and its adverse effects that follow. Characteristics of the urban infrastructure, public services, greenery, topography, and cultural practices can either enhance climate resilience or exacerbate the negative impacts of climate stressors on both urban dwellers and the environment. However, understanding climate stressors at the neighborhood scale remains challenging, particularly in rapidly growing cities where up-to-date data on climate phenomena and urban infrastructure are often lacking. While openly available Earth Observation data help address these gaps, they frequently fail to capture the fine-grained realities of local climate impacts and lived experiences of the local communities at the neighborhood level.

To bridge this gap, our research develops an integrated community-based and geospatial approach that highlights the value of local knowledge in understanding climate risks and their effects. This approach was co-created with local communities in Dar es Salaam, Tanzania, using participatory mapping and dialogue to document their experiences on flooding, extreme heat, and air pollution. The communities also mapped those underlying factors in the urban landscape that exacerbate the materialisation and effects of the climate stressors. Furthermore, the approach identifies concrete climate adaptation needs emerging at the local scale and brings together local community members and other urban actors to articulate solution pathways, including changes in the urban landscape, that enhances climate resilience of the communities.

Our findings demonstrate that integrating local knowledge with geospatial methods not only enriches quantitative climate data but also promotes more ethical and transdisciplinary approaches to urban climate adaptation. By bridging the gap between top-down climate strategies and bottom-up actions, this approach underscores the role of local urban communities in building contextually relevant and socially just climate resilience. Ultimately, we aim for the approach to be scalable and transferable to other urban contexts for generating critically needed data and information that integrates local experiences into urban development planning.

Oral presentation

The necessity of effective collaboration - insights gained from a long-term ethnoecological collaboration

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The social-ecological system approach has been demonstrated to facilitate the identification of intricate interrelationships between cultural landscapes, societies managing natural resources, and ecosystems. The application of an ethnoecological framework in the study of cultural landscapes inherently encompasses the potential for collaboration with local communities engaged in the management of natural resources.

The present case study focuses on Gyimes, a typical mountainous cultural landscape in the Eastern Carpathians of Romania. A long-term research was developed with the initial objective being the identification of traditional ecological knowledge of the vascular flora. Subsequent phases of the research project were directed towards the analysis of associated resource management practices. The impact of grassland management on the local flora and its perception was a central focus. These research questions were built on an interdisciplinary project surveying the flora and vegetation of different habitat types, and conducting interviews with local farmers about their perceptions regarding these activities and its impact on the vegetation. Participation in the everyday life and holidays of the local community has facilitated a more nuanced understanding of the human dimension of the social-ecological system. As the research progressed from species knowledge to complex local perceptions related to environmental changes, a strong relationship was forged between researchers and participants, creating a platform for further collaboration.

The evolution of the process resulted in the identification of conservation-relevant grassland management steps that have been the subject of little research, for example overseeding of hayseed. A further milestone was the development of a profound understanding of landscape changes over the last five decades, encompassing the broader context of ecological, social-cultural, economic and governmental drivers. Additionally, the impact of parcel-scale land-use diversity on species-rich meadows was investigated.

Integrating scientific methodologies with local, traditional ecological knowledge has facilitated the promotion of local knowledge and experience, the valorisation of extensive farming, the strengthening of local identity, and the enhancement of the adaptive capacity of cultural landscapes and communities.

Oral presentation

A transdisciplinary journey in olive landscapes: lessons learned from Forum theatre in Morocco

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In Mediterranean regions, the recent expansion of tree monocultures has significantly reshaped rural landscapes, agroecosystems, and local practices. In Morocco, the growth of olive monocultures alongside ancient agroforestry groves is promoted as a solution to challenges related to food security, economic development, and climate change. However, concerns have emerged about the effectiveness of olive monocultures to adapt to climate change due to their reliance on irrigation and low agrobiodiversity. Furthermore, the inequalities produced and/or reinforced by their development have been highlighted as challenging outcomes. Navigating this plurality of perspectives, which reflect the varied stakeholders, values and representations within the Moroccan olive sector, is crucial for identifying sustainable futures for olive landscapes.

The ClimOliveMed research program aimed to explore this complexity through a knowledge coproduction process conducted in the Ouezzane and Meknes provinces, engaging diverse olive stakeholders. The process began with individual surveys and interviews with the actors of the olive sector to capture varied viewpoints on olive landscapes and associated challenges. Insights from these interviews informed the creation of a theatrical play, developed through collaboration between scientists and comedians. The play depicted real-life scenarios related to olive grove management, oil production, and stakeholder interactions, including those between farmers, agricultural support services and researchers.

Three workshops followed in three different locations, featuring the theatrical play and subsequent forums, and in-depth exploration of key challenges and solutions. This transdisciplinary approach enabled an analysis of Forum theatre's potential to facilitate knowledge coproduction in Morocco. It demonstrated the method's effectiveness in expressing diverse viewpoints and amplifying marginalized voices, such as women and small-scale farmers. Additionally, when combined with workshops, Forum theatre opened a new space of deliberation among participants, helping to foster a shared understanding of current challenges and potential solutions. The findings underscore the value of integrating diverse knowledge systems and perspectives to build collective insights on landscape changes, challenges, and pathways toward more desirable futures.

Oral presentation

Rephotography: Communication through images

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The European Landscape Convention defines landscape as “an area as perceived by people, whose character is the result of the action and interaction of natural and/or human factors”. It is thus a broad definition, and one that is based in an assumption that people are conscious about the landscape. How deeply this perception is rooted in knowledge of recent historical landscape development will, however, vary from person to person and maybe even more so between different generations.

In Norway, NIBIO has practiced a popular method for visualizing landscape changes since 2002, namely through rephotography. During these 23 years NIBIO has rephotographed an estimated 9,000 images across the country, with a time span from 1865 to the present day. A main goal of the rephotography project is to increase the Norwegian people’s knowledge of various forms of landscape change, and the images are frequently used in different media platforms – including a 20 year long summer series in the country’s largest agricultural newspaper.

One of the most successful case studies is rephotography within a national priority area called "Selected Cultural Landscapes in Agriculture". Here, 41 out of a total of 51 valuable cultural landscape areas have so far been rephotographed, mainly based on the local population's own private photographs. The images with "before-and-now" situations are then shown in each individual area at open local evening lectures, with the aim of both increasing local knowledge about the recent historical development of the landscape, increasing the residents' pride and sense of identity, and possibly inspiring farmers to various landscape initiatives where old landscape values are restored.

Our experience is that the images often initiate landscape story-telling, where people share their experiences and contribute their knowledge and perceptions about the landscape and its content, including both natural features and cultural heritage elements. Typically, the viewers see different things in the images and connect to the landscape in various ways.

From a methodological perspective, one challenge is related to the images being rephotographed.

People do not take photos randomly but rather tend to focus on beautiful places, good days and memorable situations. Nevertheless, the images visualize a “true” situation, regarding buildings, landscapes, locations, and people, and are less subject to the flaws of memory than story-telling alone. NIBIO's rephotography project is in this respect important in building bridges between farmers and researchers or academic and non-academic understanding. We see the photos being used in many different contexts, as documentation, e.g. of the effects of management, as a basis for discussing next steps regarding management, and to spur interest and engagement among local stakeholders.

Oral presentation

How to establish science-society research collaborations? Insights from five mountainous Biosphere Reserves

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Biosphere reserves (BRs) serve as role models for sustainable development and have evolved into multifunctional areas that extend beyond mere nature protection. They address various topics such as quality economy, education for sustainable development, and climate change adaptation and mitigation. Since the Sevilla Strategy (1996), BRs are expected to transform from their past role as field education sites to sites of inter- and transdisciplinary knowledge co-creation, incorporating endogenous knowledge. However, the extent to which BRs have established this role and the nature of science-society networks within them remain unclear. This study conducts a Social Network Analysis based on qualitative interview material from five mountainous BRs in Austria, Switzerland, and Germany. Using phone interviews and a snowball sampling technique, 50 individuals were identified and interviewed.

The results provide insights into:

- i) the social and scientific actors involved in BR-related research collaborations,
- ii) the initiators of these collaborations,
- iii) the thematic focus and types of collaboration, and
- iv) the role of different forms of proximity (institutional, cognitive, organizational, geographic) in shaping science-society research collaborations in mountainous BRs.

The study reveals that a diverse range of social and scientific actors are involved in BR-related research collaborations. The initiators of these collaborations vary, with most driven by BR management, followed by research institutions, local stakeholders or policy-makers. The thematic focus of the collaborations spans various areas, whereby the main focus is on biodiversity and nature conservation and sustainable land use.

Different forms of proximity play a significant role in shaping these collaborations. Cognitive proximity, which refers to familiarity with BR topics and relevant expertise, was mentioned as most influential when choosing the collaboration partner. Geographical proximity played a subordinate role for the investigated BR-related research collaborations.

Based on these empirical investigations, we aim to draw conclusions on the resilience of science-society collaborations in mountainous BRs and the influence of place-specific institutional conditions on the emergence and establishment of these transdisciplinary collaborations.

Oral presentation

Engaging agroecology to co-assess the impacts of landscape-scale living labs

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Agroecology is based on thirteen principles that support systemic approaches, transdisciplinarity, knowledge co-creation and food system transformation toward sustainability. Although many different tools have been used to assess the impacts of agroecological practices at field and farm scales, co-creating a useful framework to assess food system level impacts of agroecological practices at a landscape or territorial scale is challenging due to a variety of barriers (e.g., appropriate methodologies and indicators, data availability at appropriate scales). Our project (TAE Labs) aims to co-create research to understand the impacts of a landscape scale agroecology living lab on the island of Bornholm (Denmark) along with four other living labs across Europe (3 urban and 2 rural). Our task is to perform ecological and biophysical assessments, focusing on how different configurations of local food systems strengthen ecological sustainability and improve the management of biodiversity by selecting variations in specific farming methods and practices.

In this presentation we will focus on both the logistical hurdles to research projects that include landscape or territorial scale co-creation, as well as the methodological considerations of transdisciplinary research. Methods include participatory mapping, spatial mapping (GIS), and food system scenario development with stakeholders at the landscape scale which will be co-coordinated by researchers at Aarhus University and a community member and agroecological farmer on Bornholm. Engaging and valuing the work of a diverse range of local food system actors will be the point of departure for this iterative process.

Oral presentation

Initiating the utilization of crowdsourcing, mobile technology and GIS for participatory mapping of landscapes in a European scale

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Modern digital technologies can be used to bridge the gaps between academia and society in terms of landscape assessment and mapping. Through the utilization of the technology of crowdsourcing and the digital tool of a mobile app the present research expanded on an analysis of a new scheme of quantification of the perceptions of the public on landscapes and architecture.

Starting in 2021 from developing the project ARCHIMAP that utilized those tools primarily within Greece and then expanding to more European countries, including Italy and France, through PUBLICLAND we investigated if those digital technologies can be used uniformly in larger spatial scales.

The work presents the results from the first stages of public participation for assessing and mapping landscapes, investigating the inferences of the methodology in two distinct areas. Firstly scientifically, by yielding valuable data for analyzing architectural styles, urban typologies, and public perceptions thereof. That way the ground is set for improved quantitative research in the area of culture and humanities by connecting the technology of crowdsourcing, Geographic Information Systems (GIS) and mobile development. Secondly, socially, by evaluating the effect of integrating interactive digital tools that allow democratic societal citizen science and its impact on engaging participants in meaningful discussions and critical thinking about urban landscape quality.

Overall, the results so far have been positive for the potential of the digital technologies for enhancing research and practice in areas associated with landscape perceptions and furthermore also in terms of the capacity of such endeavors to create conditions for improved communication and interactions with universities and the society.

Oral presentation

A participatory mapping approach to assess the risk of scrub typhus in Saen Thong, an endemic area of Thailand

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Chigger mites are Acari vectors of *Orientia tsutsugamushi* the causal agent of scrub typhus, an endemic disease in Southeast Asia. Their sampling is challenging due to tedious sampling methods, such as black plating, limiting knowledge of their distribution and ecology. This gap limits effective monitoring, risk assessment, and prediction of disease transmission to humans. Landscape configuration and composition are known to influence other acari-borne diseases but their impact on scrub typhus risk remains poorly understood.

We conducted a participatory mapping workshop in Saen Thong sub-district, Thailand, an endemic area and a Social-ecological Observatory of biodiversity and health since 2010. Four scrub typhus experts, specialized in human and animal health, wildlife, and medical entomology, were asked to map high and low risk areas of scrub typhus transmission based on their expertise and fieldwork experience. Using a high-resolution land use land cover previously developed, landscape variables were extracted within 100-meter buffers around each point mapped by the four experts and analysed by risk status.

Despite minor variations, experts largely agreed on risk patterns. Distance to land cover edges was the most critical factor, consistently and negatively correlated with scrub typhus risk, indicating higher risk near land cover boundaries. Urban areas were negatively correlated with risk. Orchard, teak, rubber, paddy rice, and bamboo covers were intermittently identified as risk factors. These land covers, situated at the interface between villages and wilderness, appear to facilitate disease transmission according to the expert opinions.

Landscape fragmentation and human-driven land covers contribute to scrub typhus risk. Preserving large patches of land cover could help mitigate risk. Transitional land covers require closer monitoring, but experts also highlighted the need for expanded sampling in neglected natural areas. This innovative approach, tailored to scrub typhus research, provides new insights into landscape risk factors for this neglected tropical disease. These findings will help prioritize risk mitigation areas and inform future research directions.

Oral presentation

Exploring Integrated Landscape Conservation Approaches: The Massiccio del Monte Cairo, Italy

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Landscapes are dynamic entities shaped by the interplay of natural and human factors, playing a crucial role in territorial sustainability by influencing environmental, cultural, social, and economic dimensions. The European Landscape Convention (2000) emphasises the importance of evaluating landscape quality to guide policies for sustainable management and conservation. Yet, pressing contemporary challenges, such as land fragmentation, rapid urbanization, and environmental degradation, necessitate integrated strategies for effective landscape conservation

Under the TOPIO HORIZON-MSCA project, the research focuses on evaluating landscape quality across seven regions in Europe, employing an innovative mix of geoinformatics, Earth Observation (EO), and participatory GIS techniques. A particular case study is the Massiccio del Monte Cairo, situated in the Frosinone province of Italy. This Natura 2000 site has experienced significant degradation, driven by historical human activities, including war-related destruction and subsequent reforestation efforts

The project primarily employs two different methods: remote sensing techniques and field data. Remote sensing techniques utilise deep learning algorithms, vegetation indices, and fragmentation analysis to monitor landscape changes and identify broader areas and landscape types. The project also includes monitoring ecological transformations due to climate change, land use (LULC), and urban pressures.

One of the core aspects of the project is landscape assessment through Participatory GIS (Public Participatory GIS). This approach involves the local community in data collection by expressing public opinions that enhance the understanding of the landscape's characteristics and quality. Public participation is essential to ensure that the assessment goes beyond a technical analysis and incorporates local perceptions and experiences of the landscape. Additionally, the Landscape Character Assessment (LCA) gathers geomorphological, environmental, and cultural data to classify and understand the evolution and characteristics of the landscape, aiming to guide land-use planning in alignment with the provisions of the European Landscape Convention.

The project combines cutting-edge techniques with active local community engagement to foster sustainable landscape management and tackle the pressing challenges of environmental degradation and urbanisation.

Poster presentation

Assessing the driving forces of landscape change in the perspective of Polish residents

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Over the past 20 years analysis of driving forces of landscape change have become a popular research topic, but there is still insufficient amount of research on this issue in the countries of Eastern Europe. This is all the more important as a number of factors have accelerated changes in the landscape in the countries that have joined the European Union in recent years. The results of the research presented in the article concern the identification of those forces that significantly influenced the shape of changes from the perspective of residents living in different types of municipalities from the Lower Silesia region. The research approach used was to identify the landscape transformations that took place in the 3 time intervals 2005–2010, 2010–2015, 2015–2020, and then to present them in the form of a questionnaire to the inhabitants of the 6 municipalities that lived in the study area during the study period, asking them to identify which of the indicated phenomena or processes contributed to the indicated landscape transformations. The driving forces most often indicated by residents of the analyzed municipalities can be categorised as political forces (40.66 %), socio-economic forces (20.74 %) and cultural forces (16.61 %). However, the results showed differences in the reported drivers of landscape change depending on the type of landscape in which the changes occurred. In urban landscapes, the proportion of cultural drivers increased significantly, in contrast to agricultural or forest landscapes where natural and political forces were more important.

Poster presentation

Some ethical issues of European agricultural landscapes - the EUCALAND approach

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The Institute for Research on European Agricultural Landscapes e.V. EUCALAND was established as a non-profit association under German law in 2012. Yet the idea of a network on European agricultural landscapes as a synonym for the ordinary, everyday landscapes all around us and their research began earlier. A constituent meeting was held in 2006 in Cologne/Germany, where 32 persons from 15 European countries presented the recent national state of the art.

EUCALAND currently has 31 members from 16 European countries: Austria, Czechia, Croatia, England, France, Cyprus, Germany, Greece, Hungary, Italy, Netherlands, Norway, Romania, Slovenia, Slovakia, Spain, and Switzerland. Most are institutional members: universities, research units, companies, and administrations.

The primary aim of EUCALAND is to collect national data on European Agricultural Landscapes (EALs), including classifications, descriptions, surveys and mappings. The second goal is to connect actors and to raise awareness. Therefore, the institute regularly organises workshops and conference sessions. Thematic workshops are envisaged once a year, and special sessions at the Permanent European Conference for the Study of the Rural Landscape are organised every second year.

Establishing interdisciplinary dialogue among stakeholders is another important task of the institute. EUCALAND promotes the knowledge of values and meanings of EALs among the wider public, in cooperation with international institutions like UNESCO, the International Federation of Landscape Architects IFLA - Europe, FAO-Globally Important Agricultural Heritage Systems, IFLA-Europe (Intern. Terraced Landscape Alliance) and ICOMOS (Intern. Council on Monuments and Sites).

The acronym EUCALAND stands for European Culture expressed in Agricultural LANDscapes. It withholds the Institute's commitment to supporting local communities, helping them preserve their cultural, agricultural and rural heritage, and educating urban dwellers, other stakeholders and decision-makers on the importance of maintaining vivid rural and agricultural landscapes.

The poster presents the institute and introduces its methodology for describing and evaluating European agricultural landscapes through its achievements.

Poster presentation

Session 3B – Advancing Sustainable Agriculture through Multifunctional Landscapes

Symposium

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Keywords: ecosystem services, biodiversity, agriculture, multifunctionality

In human-dominated regions, landscapes form diverse mosaics of urban, natural, and agricultural patches. The complementarity of these patches enables heterogeneous landscapes to provide multiple ecosystem services, a concept known as ecosystem multifunctionality (Alsterberg et al., 2017 Sci. Adv.). This idea, fundamental to both basic and applied ecology, highlights how ecosystems can support various functions simultaneously. While high land-use intensification tends to prioritize a few services, such as food production, it often negatively impacts biodiversity and other regulating or cultural services (Allan et al., 2015 Ecol. Lett.). In contrast, multifunctional landscapes maintain diverse ecosystem functions and services within the same area (Hector & Bagchi, 2007 Nature). Landscape multifunctionality is not just about which ecosystem services are generated, but also about who benefits from them (Grass et al., 2019 People Nat.). Therefore, sociological, economic, and policy dimensions are critical for enhancing landscape multifunctionality. Despite growing interest, implementation in environmental management remains limited, with inconsistencies in how multifunctionality is conceptualized, quantified, and applied (Hölting et al., 2019 Ecol. Ind.). Our symposium will tackle these issues, focusing on how multifunctional landscapes can transform agricultural practices and contribute to sustainable land-use management. We will discuss how to design landscapes that support diverse ecosystem functions while meeting the needs of different stakeholders, including farmers, land-use planners, and policymakers. The symposium will also explore challenges related to measuring and implementing multifunctionality, particularly in agricultural contexts where sustainable farming is a priority. The overarching aim is to facilitate dialogue on how multifunctional landscapes can serve as a framework for promoting sustainable farming and improving agricultural landscape management. We aim to advance the practical application of multifunctional landscapes in agriculture by bringing together experts from various disciplines.

Landscape drivers of ecosystem services multifunctionality

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Landscape drivers of ecosystem services multifunctionality Increasing pressures on land resources requires the identification of landscape management strategies that simultaneously deliver multiple benefits to a range of competing land users while minimising conflicts. To identify such strategies we combined comprehensive ecological data from German grasslands of the supply of highly demanded ecosystem services (ES) (i.e., climate regulation, biodiversity protection, livestock production, and landscape aesthetics) with information about the ecosystem service priorities of multiple stakeholder groups (agriculture, tourism, local residents, and conservationists) to calculate ES-multifunctionality at the landscape level. We used semi- mechanistic models taking into consideration the interaction between landscape components to upscale local-supply of ES to the landscape-level. Landscape ES-multifunctionality was calculated from these measures as the sum of ES supply within a 100ha landscape, multiplied by specific stakeholders' demand for a given ES. Initial results indicate high synergy on ES-multifunctionality at the landscape level across stakeholders (i.e., the same landscape providing high levels of multifunctionality attending different demands) in the studied system, with slight differences in the overall ES-multifunctionality across groups. We also found that ES-multifunctionality is sensitive to landscape structure, with the emergence of some common drivers of multifunctionality - such as grassland and forest cover, which strongly impact biodiversity-mediated ES in grasslands and consequently, the overall ES-multifunctionality. Our approach quantifying the landscape-level ES-multifunctionality considering multiple stakeholders' demands allows to assess the social impact of land use changes on local communities to be quantified, and it could be applied widely to identify sustainable land use transformations.

Oral presentation

Bringing back Landscape Features in intensively farmed landscapes

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Bringing back Landscape Features in intensively farmed landscapes The European Biodiversity Strategy sets the ambition to increase the amount of landscape elements in agricultural areas to 10 % . This ambition has been incorporated in the EU-Nature Restoration Regulation (adopted in June 2024) that requires action to restore degraded ecosystems and to increase biodiversity, in farmland. One of the indicators for biodiversity in agricultural systems is ‘high-diversity landscape features’ (Nature Restoration Regulation art. 11). These include amongst others: hedgerows, individual trees, tree rows, field margins, ditches, streams, terraces, stonewalls, small ponds and cultural features. High diversity landscape features provide space for wild plants and animals, including pollinators, prevent soil erosion and enhance water infiltration, filter air and water, support climate change mitigation and adaptation, facilitate pest control and raise agricultural productivity of pollination-dependent crops.

The LAFERIA project, funded by Horizon Europe, is developing approaches to restore high-diversity landscape features in intensively used agricultural areas. We assess the presence of landscape features across intensively used agricultural regions in Europe, and quantify them in specific case study areas across different agricultural systems. We assess how these features contribute to landscape connectivity and other services provided by the landscape features. What are drivers and challenges to reintroduce those landscape features? In the end the project will develop business models for different regions and different features with the aim to restore them. These models will be tested and applied in the case study areas. The project has the ambition of restoring at least 10% of landscape features in at least ten Member States. We will focus in this presentation in particular on the quantification of the amount of European landscape features. Which features are present in the EE and are found in the case study areas. Which methods and information sources are available to map these features at different geographical scales. Some of these features can be mapped with European-wide data sources, e.g. the Copernicus Small Woody Features layer, and there is also information from stratified sampling across different agricultural systems, using the LUCAS transect module. Other features can only be mapped using regional or local data. Local maps for the case study areas may reveal some relevant features not covered by European data sources. Several features however are difficult to identify on the basis of the available data, these include stone walls, cairns, some small wet features and field margins. Based on the preliminary results of the project an initial assessment will be presented at EU and local case study level of the type and quantity of these features, and the relation with different farming regions.

Oral presentation

Multifunctional agricultural landscapes in Europe: For Whom, Where and How?

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Multifunctional agricultural landscapes are gaining recognition as a sustainable approach to land management that aims to integrate biodiversity conservation and multiple ecosystem services alongside food production. Land use diversification and the implementation of agri-environmental measures are seen as key approaches to achieving this. However, the implementation of these measures requires careful consideration of where they are most needed, and how landscapes can be designed to meet the multiple objectives of different stakeholders. This presentation will explore the key questions of For Whom, Where and How in the context of European multifunctional agricultural landscapes, emphasising the need to balance the environmental, economic and social dimensions. I will give an overview of our recent research, including different case studies from Europe, discuss the challenge of how to identify regions where multifunctionality is most feasible and beneficial, including trade-offs between different environmental objectives, and examine the role of local context in determining environmental benefits and stakeholder needs. I will also discuss the practical challenges of co-designing agricultural landscapes that can support both agricultural productivity and biodiversity, with a particular focus on agri-environmental measures. Overall, this presentation aims to contribute to the ongoing dialogue on promoting sustainable agriculture through multifunctional landscapes and to provide insights on how we can promote more diverse farming systems.

Oral presentation

Integrating Hedgerows for Landscape Multifunctionality: Ecological and Socioeconomic Perspectives

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Hedgerows play a crucial role in implementing landscape multifunctionality by providing ecological, economic, and social benefits that enhance the resilience and sustainability of agricultural and natural landscapes. As linear landscape elements, hedgerows contribute to biodiversity conservation by offering habitat, food, and connectivity for various species, including pollinators, birds, and small mammals. Their presence supports ecosystem services such as pest control, pollination, soil stabilization, and water regulation, reducing erosion and enhancing groundwater recharge. In agricultural settings, hedgerows function as windbreaks, improving microclimatic conditions for crops and livestock while mitigating the impacts of extreme weather events. Additionally, they contribute to carbon sequestration and climate change mitigation by acting as carbon sinks. The integration of hedgerows into farming landscapes can also promote sustainable agricultural practices by reducing the need for chemical inputs, enhancing soil fertility, and supporting agroecological approaches. Beyond ecological functions, hedgerows have cultural and aesthetic value, shaping landscape identity and maintaining traditional land-use practices. They provide recreational and educational opportunities, fostering human-nature interactions and promoting community engagement in conservation efforts. Moreover, hedgerows can enhance economic resilience by supporting diversified farm incomes through sustainable biomass production, beekeeping, and ecotourism. Effective hedgerow management and policy support are essential to maximize their multifunctional benefits. Strategies such as incentivizing hedgerow planting, restoring degraded hedgerows, and integrating them into land-use planning frameworks can enhance their role in sustainable landscape management. By promoting connectivity and resilience, hedgerows contribute to multifunctional landscapes that balance ecological integrity, agricultural productivity, and socio-economic well-being. This presentation highlights the importance of hedgerows as multifunctional landscape elements and emphasizes the need for integrated management approaches to harness their full potential in addressing contemporary environmental and societal challenges.

Oral presentation

Assessing the contribution of diversified rotations, low-input management systems and hedgerows, at local and landscape scales, to the multifunctionality of agroecosystems

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In the face of climate change and the biodiversity crisis, it is essential to move towards more sustainable agricultural systems that produce sufficiently, guarantee farmers' revenue and well-being, and limiting impacts on the environment. Multifunctional agroecosystems which support several ecosystemic and socio-economic functions simultaneously are a path towards sustainability. Recent studies assessing agroecosystem multifunctionality (MFA) typically compared organic vs. conventional farming and ignored cropping system characteristics that may affect MFA like the diversity of crop rotations or the level of input use. At the landscape scale, the quantity of hedgerows and the spatial diversity of crops are likely to influence MFA by promoting biodiversity and associated functions. However, rare are studies that have examined the relative effects of these factors, at local and landscape scale, on MFA. The study was carried out in the Zone Atelier Armorique in Brittany, northwestern France. A total of 24 winter cereal fields, each bordered by at least one hedgerow and one herbaceous field margin, were surveyed. The 24 fields were selected according to their level of crop diversity in rotation (low/moderate/high defined by the number of crop families grown between 2015 and 2022) and the density of hedgerows in a buffer radius of 1km. MFA was assessed by considering six ecosystem functions (i.e. biodiversity conservation, food production, pest colonisation, pest control, pollination, soil quality). Proxies for each function were measured from April to July 2024 at several distances from the two field borders: 0 m, 2 m, 9 m and 50 m. First results showed that the level of crop diversity in rotations did not affect MFA. The level of input use did not affect MFA, but ecological functions tended to decrease with increasing input use and distance from the field border. The density of hedgerows and the spatial diversity of crops in the landscape did not affect MFA. The lack of effect on agroecosystem multifunctionality may be explained by antagonistic responses of functions to crop diversity in rotation, input use levels, distance from the border, and landscape factors. Our study suggests that, among existing agri-environment schemes in Europe, hedgerow maintenance and low-input management are appropriate solutions to optimise the ecological functions of agroecosystems even if antagonistic effects with food production should not be neglected.

Oral presentation

Multifunctional landscape planning requires a multi-actor approach

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Agricultural land is usually managed to maximise crop production, a single service that typically imposes negative impacts on regulating and cultural ecosystem services. However, in agricultural landscapes, many social actors with differing needs and priorities coexist. Therefore, effective landscape decision-making requires a collective approach, where key stakeholders co-inform a discussion about their ecosystem service priorities.

Here, we explored conflicts and synergies among multiple stakeholders regarding their ecosystem service demands. We administered an online questionnaire with a stratified sampling design across 17 districts in North Eastern Italy, each representing a geographically and socio-economically homogeneous area. We collected a total of 940 responses distributed among multiple stakeholder categories: conservationists, farmers, local residents, owners of tourist facilities, policy makers and researchers.

Our preliminary results show that stakeholder category predicts ecosystem service demand better than geographical or socio-economic context. Most stakeholders demanded the simultaneous supply of multiple ecosystem services, reinforcing the need to plan for landscape multifunctionality. However, a few categories, such as conservationists and farmers, exhibited polarized demands, as they focused on just one or two contrasting ecosystem services, such as agricultural production for farmers. The respondents who strongly prioritised agricultural production were also the least willing to engage in multifunctionality-oriented actions, highlighting potential conflicts among stakeholders. Planning for multifunctionality requires the maintenance of the multiple habitat types underpinning the prioritised ecosystem services. However, we found higher concern for the degradation of ecosystem services than for the loss and degradation of habitat patches, suggesting a lack of awareness of the role of landscape features in delivering services. Our results highlight the importance of involving diverse stakeholders in landscape management decisions. Differences in priorities, and in the features underpinning prioritised services, reflect that maximising landscape management for one group would not benefit all, necessitating compromise and collaboration to collectively maximise landscape multifunctionality.

Oral presentation

Farmers' perceptions of transaction costs in cooperative agri-environment-climate measures – A case study from Lower Saxony, Germany

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The effectiveness of agri-environment-climate measures (AECMs) is limited by their application to individual fields or farms, which does not address the wider habitat needs of many species. Spatially coordinated AECMs at landscape level, in which farmers and other actors are jointly involved, can be a solution for promoting multifunctional agricultural landscapes by bringing together different social, economic and environmental objectives. However, such cooperative AECMs may require more effort and time for coordination and collaboration than individual AECMs. These additional efforts represent transaction costs, which are different from the production costs (e.g. costs of seeds and machinery for establishing wildflower fields) and can be seen as organisational costs. As participation in cooperative AECMs is voluntary, their design should reflect actors' motivations to participate. A key consideration for farmers in their decision to participate is the economic impact on their business. Therefore, transaction costs may be a barrier to farmer participation. Studies have indicated that it is not the actual level of transaction costs but the perception of them that affects farmers. Yet, research on farmers' perceptions of transaction costs is limited, especially in cooperative AECMs. To address this research gap, we investigate how farmers perceive transaction costs in landscape-level cooperative AECMs. To this end, we conducted semi-structured interviews with 10 farmers participating in a cooperative AECM in Lower Saxony, Germany. In the interviews, farmers were asked to rate, on a five-point Likert scale, the perceived time required to carry out various tasks in cooperative AECMs. We then used open-ended questions to understand the farmers' views and motivations for their ratings. We also interviewed 10 farmers who were not participating in this measure to gain insight into farmers' expectations of transaction costs in cooperative AECMs. We will analyse the interview data using qualitative content analysis. We hope that this research will contribute to the development of landscape-level cooperative AECMs that meet the needs of farmers to ultimately increase participation.

Oral presentation

Disentangling the "territorial bipolarity" of rural landscapes in Alentejo (Portugal): implications and requirements for sustainability.

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Introduction. The territory of Alentejo (Portugal) has historically been portrayed as an exemplary mosaic of multi-functional rural landscapes. However, along the last 15 years agricultural landscapes have rapidly shifted, driven by increased availability of water for irrigation, enlarged accesibility to global markets, financialisation and productive specialization. This is impacting agricultural landscapes, which suffer from "territorial bipolarity" with the most productive landscapes rapidly intensifying, whilst marginal areas become uncompetitive and abandoned. Consequences for territorial sustainability are evident, and the policy and governance frameworks in place seem ineffective. In this paper we examine the process of "bipolarity" and hint at pathways that can lead rural landscapes of Alentejo towards enhanced territorial sustainability. **Methods.** Based on multiple research projects we quantified and mapped the spatial trends of change in agricultural land-use and landscapes, focusing on identifying local hot-spots undergoing either: i. concentration and homogenization of land-use, landscapes and territorial economics, or ii. abandonment and marginality in remote and least productive areas. Then, revieweing results from interviews, surveys, focus groups and workshops with farmers and others we identified the drivers underpinning each of these two trends. Last, we institutionally mapped the governance structures underpinning each of these territorial trends and identified trade-offs. **Results and discussion.** We idenfied sectors and mapped local areas of relevance for the intensification trend, including recent plantations of almonds and olives, whilst the agro-silvopastoral Montado, traditional olive groves and small-scale horticulture were linked to the extensification and abandonment one. Through our assessment of drivers, we confirmed how it is mainly the availability of natural, financial and industrial capital that drives the intensification trend, with a focus on a global scale. In contrast, local and marginal extensive farming is influenced by subsistence and heritage mind-sets and strategies enacted a the farm to local scales. Last, our results reinforced the fragmentation of governance instruments and objectives across institutional levels and policy sectors, which contributes to perpetuate the breach amongst intensive and extensive territories, thus consolidating the "bi-polarity" of the agricultural sector in Alentejo, a problem that strongly contribues to the current decline of landscape sustainability standards. **Conclusions.** The empirical confirmation of the multiple challenges linked to the "bipolar territorial" character of rural landsapes in Alentejo demands the need for more creative and innovative solutions to plan for the future. Alternative models are on the table, including "sustainable identification" and finding the right balance between land sparing and land sharing. However, it is only when more effective coordination and coherence can be reached amongst different policies, plans and actions across scales from the regional to the farm that such targets can be effectively achieved.

Oral presentation

A Life cycle assessment approach to account for the benefits of extensive grazing in wildfire and landscape management

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Rural abandonment is a common issue in many Southern European countries. Various cultural factors, along with challenging work conditions and limited job opportunities, are driving younger generations to seek better prospects in urban centres. This migration leaves many rural areas unattended and unmanaged, increasing wildfire risks, especially in the context of climate change. To address this, it is essential to diversify and promote new agropastoral economic activities that are both socially and environmentally sustainable, to attract and retain younger generations in rural areas. One promising alternative is sustainable extensive livestock farming. This multifunctional activity not only boosts the local economy but also enhances biodiversity, contributes to land management, and reduces the risk of severe wildfires. Life cycle assessment (LCA) is a standardized method for evaluating the environmental impacts of products. LCA assesses around 15 environmental issues, such as carbon footprint and water footprint. However, one limitation of standard LCA practice is that it focuses on evaluating negative impacts and overlooks the potential environmental benefits associated with extensive grazing, such as its positive effect on wildfire risk reduction, compared to intensive livestock farming. In this study, we developed an approach to account for the role of grazing in wildfire prevention within LCA. To do so, we explored the benefits of extensive herding as a wildfire management tool in Southern Europe through a comprehensive literature review. The information gathered was interpreted in terms of so-called causality chains in LCA, which establish relationships between the activity (i. e., grazing) and the environmental benefits, such as wildfire reduction, on ecosystem quality and human health. From the various causality chains that we built, we selected one focusing on accounting for the role of grazing in the reduction of greenhouse gases and other pollutant emissions resulting from biomass burning in the event of a wildfire. This indicator will be tested in a case study in Vilamòs (Aran Valley, in the Pyrenees mountains, northeast Spain). Our next step is to generalise the approach and make it operational in other regions with extensive grazing or with plans to introduce such activities. Accounting for the ecosystem services of extensive farming provides a fairer basis for comparing extensive, multifunctional systems with intensive ones, which only provide food.

Oral presentation

Addressing landscape multifunctionality in conservation and restoration

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To counter the challenges at the nexus of the biodiversity crisis, climate crisis, food security, and social inclusion, major parts of the planet need to be dedicated to biodiversity conservation and ecosystem restoration. Likewise, increasing competition on land exacerbates the need for multifunctional approaches that balance multiple uses at landscape level. In this contribution, we present a review that examines scientific concepts and practical approaches of landscape multifunctionality from different continents and across time. Our results show that multifunctional land-use systems move beyond sectorial approaches to biodiversity conservation and ecosystem restoration. They are diverse but have in common to pursue biodiversity conservation, food production, well-being, climate mitigation, and other sustainability goals jointly, rather than separately. Multifunctional land-use systems can inform an inclusive and context-sensitive implementation of key biodiversity conservation strategies, such as protected areas, indigenous and community conserved areas, and ecosystem restoration. To unlock further potentials of multifunctionality, future research might link with the emerging fields of regenerative, socially inclusive, and transformative approaches to conservation.

This contribution has been invited by session organizers Costanza Geppert and Peter Batary.

Oral presentation

Grassland restoration increases multitrophic biodiversity and boosts ecosystem multifunctionality

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Semi-natural grasslands and their biodiversity are increasingly threatened by afforestation, conversion to intensive agriculture, urban development, and by the abandonment of traditional management practices. The extensive loss of these grasslands undermines the sustainable provision of ecosystem services and the overall ecosystem multifunctionality of agricultural landscapes. To mitigate further decline and restore some of the lost ecosystem functions, ecological restoration must be implemented.

By comparing ecosystem service provision before and after grassland restoration, we assessed how restoring overgrown and afforested semi-natural grasslands influences nine key ecosystem services: habitat maintenance, soil condition maintenance, soil carbon storage, pollination, pest regulation, wild food and medicinal herb availability, forage production, wood production, and recreation. Additionally, we examined the relationship between ecosystem restoration, ecosystem multifunctionality, and multitrophic species richness.

Our findings indicate that within just a few years of restoration, multitrophic species richness and ecosystem multifunctionality increased significantly. However, while there was a strong positive relationship between multitrophic diversity and ecosystem multifunctionality before restoration, this link weakened post-restoration. We suggest that the homogenization of biodiversity across formerly distinct habitat conditions and the disrupted transitional nature of the ecosystem may explain this shift. Also, severe drought conditions in the year preceding post-restoration monitoring affected some species groups and ecosystem service supply, overshadowing the true impact of restoration.

Semi-natural grasslands are critical biodiversity and ecosystem service hotspots in European landscapes, and their restoration substantially enhances the potential for delivering essential ecosystem services.

Oral presentation

Reconnecting landscapes: from their multifunctionality to prioritizing interventions for maximize both ecological benefits and human needs

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Territorial changes induced by anthropogenic factors in recent decades have led to habitat fragmentation, thereby endangering biodiversity and natural elements. Initial solutions to these challenges were associated with in situ conservation methods, followed by the large-scale implementation of the Natura 2000 network. In certain areas of the Romanian Carpathian ecoregion, landscapes benefit from conservation measures; however, to maximise ecosystem services, detailed connectivity analyses are necessary. It has been observed that network-level conservation is more effective than in situ conservation. In this context, modelling ecological, natural, or landscape networks constitutes a powerful approach to enhancing both ecological benefits and human needs.

Our work explores the potential for reconnecting fragmented landscapes through multifunctional landscape networks that prioritize interventions for maximum ecological and human benefits. Our results highlight the role of spatial prioritization GIS tools in creating landscape networks that balance biodiversity conservation with socio-economic needs. The main GIS functions utilised in this context will be spatial tools that play a crucial role in identifying optimal connections between different landscapes. By doing so, they facilitate the formation of a coherent and well-integrated network. Circuitscape is among the most optimized and effective tools for this objective due to its computational efficiency and accuracy in modeling connectivity. The process of modelling such a network is predominantly grounded in ecological principles, as it seeks to enhance landscape connectivity and promote ecological flows. However, the multifunctional character of this network can be more comprehensively demonstrated by incorporating zoning methods and integrating the weights of multiple socio-cultural factors (heritage elements, deforestation patterns, agriculture). By considering these variables, the model captures both ecological dynamics and the landscape's socio-cultural complexity, highlighting the network's multifunctionality and significance.

In conclusion, through spatial analysis, this study aims to show that although the zonation of multifunctionality is often limited by the lack of clear tools and methodologies, we propose a model that can capture the interdependencies between different landscape functions.

Oral presentation

Multifunctional landscape management – a governance perspective

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Effective multifunctional landscape management requires innovative governance approaches that foster collaboration between multiple stakeholders and actors. Governance, in this context, refers to the dynamic interplay of stakeholders working together to achieve shared goals through the exchange of knowledge, resources, and the establishment of mutually agreed-upon rules. This presentation will explore participatory and governance strategies for multifunctional landscape management. Drawing on insights from eleven case studies in six different countries of the Central European Alpine Region, namely in Austria, France, Germany, Italy, Slovenia, and Switzerland, this talk will synthesize innovative governance practices and highlights key mechanisms that enable multifunctional landscape management.

Oral presentation

Interactions between Agriculture and Ecosystems in Saxony-Anhalt (Germany) – A Bayesian Network Approach

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A major challenge of the 21st century is to maintain or enhance beneficial contributions of nature to a good quality of life, especially in the tension between food production and ecosystem functionality. The resilience of agricultural landscapes offers an opportunity to integrate agricultural production and agroecosystem functions. Resilience is the ability of a system to continually change and adapt while remaining within critical thresholds and has three resilience capacities: Robustness, Adaptability, and Transformability. To date, agricultural resilience has mostly been researched from an economic or farming perspective, but less from an ecological perspective (e.g., ecosystem functions or biodiversity). Therefore, we aim to (i) identify key indicators for agroecological resilience in an intensive, large-scale agricultural landscape in Germany, and (ii) quantify agroecological resilience using a participatory expert modelling approach, specifically a Bayesian Network (BN) implemented in Netica (Norsys, 2010). The initial BN showed indicators of agroecological resilience including ecological, social, and economic variables, and critical feedbacks between them. As complex landscapes have a significant positive impact on biodiversity and thus provide benefits for resilient agricultural ecosystems and a secured production (Estrada-Carmona et al., 2022), we focused in our initial BN on the hurdles that arise when it comes to establishing complex landscape structure in European agricultural systems, taking into account agroecological resilience. A qualitative approach was used to interview experts (practitioners, scientists, NGOs from agriculture and nature conservation) on key indicators for agroecological resilience in Saxony-Anhalt (Germany). The results were presented in a first BN, which maps the impact of agricultural management and natural disturbances on agro-biodiversity and yield as key indicators of resilience. The initial BN was discussed and validated at an expert workshop. A further parameterization of the BN through qualitative and quantitative data offers the possibility to analyze how changes in the network affect the resilience indicators and thus agroecological resilience itself. We anticipate that the final BN will be useful in identifying crucial factors affecting resilience that may be bound to governance and agricultural management. Further development into a spatially explicit BN could provide in-depth information on the resilience of agricultural landscapes and, with slight adaptations, allow regions to be compared at a broader scale.

Oral presentation

Identifying Priority Areas for Establishing New Hedgerows in Germany

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Hedgerows in agricultural landscapes offer multiple ecosystem services, including erosion control, improvement of the microclimate or habitats for flora and fauna. Notably, hedgerows can sequester almost as much carbon per hectare as forests, serving as effective carbon sinks. Hedgerows can play an important role in achieving climate protection and biodiversity goals. However, extensive removal of hedges has occurred due to land consolidation practices in Germany. Consequently, there is a critical need for new hedgerows which varies regionally.

Utilizing landscape and agricultural structure data, this study aims to (1) analyze the distribution of existing hedgerows and adjacent production systems in Germany, (2) define priority areas for the establishment of new hedgerows and (3) determine the potential for new hedgerow planting and their contribution to climate protection goals. Analyses were conducted based on a novel hedgerow map for Germany derived from remote sensing data and agricultural land management data obtained from the Integrated Administration and Control System (IACS). The objective of defining priority areas was twofold: firstly, to identify regions where new hedgerows would maximize environmental benefits; secondly, to identify regions where implementation constraints were minimized. Environmental, economic and policy aspects (e. g. conflicting bird protection goals) were considered.

Data pertaining to biodiversity effects, erosion and landscape aesthetics were taken into consideration to identify regions with high need for new hedges. Subsequently, key parameters influencing hedgerow distribution in Germany were identified using generalized additive mixed models including agricultural use, field size, location in protected areas, distance to forests and relative height. The results were used to ascertain areas where new hedges would be most compatible with the prevailing agricultural structure, thus reducing spatial constraints. The potential of new hedgerows was determined based on field boundaries to minimize operational constraints. Various planting scenarios were then calculated, and their respective climate protection effects estimated. Regions of high demand and high feasibility have been identified where planting is particularly advantageous.

This study demonstrates that the implementation of new hedgerow planting initiatives can enhance carbon sequestration capacity within the land use sector. It is the first study to encompass the distribution of hedgerows on a nationwide scale in Germany. These findings can inform the development of targeted subsidies for hedgerow expansion and support climate change mitigation and biodiversity efforts.

Oral presentation

Optimizing soil biodiversity, multifunctionality and yield when transitioning to organic farming

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Agricultural intensification increases crop production often causing declines in soil biodiversity and functioning, threatening sustainability. To buffer them, environmental policies aim to increase the amount of organic farming, potentially compromising food supply and nitrogen availability. Which is the optimal proportion of organic management in agricultural landscapes in order to maximize the environmental benefits while minimizing its potential costs? Where should we prioritize this shift in agricultural management? To address these questions, we measured soil biota diversity (combination of taxonomic identification of soil fauna and DNA sequencing of microbes) and abundance (both with the microscope and through lipid fatty acids [PLFAs/NLFAs]) in 179 croplands differing in their soil degradation levels and environmental contexts. And we did so together with the measurement of 22 soil functioning indicators plus in situ crop yield measurements. We found that landscapes with 50% organic agriculture, higher than the envisioned proportion by current EU objectives, optimize both crop yields and environmental sustainability (biodiversity and multifunctionality). Our results further suggest that prioritizing the transition to organic farming in moderately to highly degraded soils would maximize its benefits while minimizing yield loss.

Oral presentation

Investigating the effects of organic farming and multiple representations of landscape heterogeneity on agroecosystem multifunctionality: a case study in French cereal fields

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Given the significative negative impacts of intensive agriculture on human and environmental health, it is crucial to make a transition towards more sustainable farming systems that rely on biodiversity and the multiple ecosystem services it sustains. The reduction of chemical inputs, diversifying crops and incorporating semi-natural habitats at both local and landscape scales, are considered effective strategies for shifting towards biodiversity-based, multifunctional agriculture. While the effects of these strategies are well documented for many biodiversity taxa, their impact on the multifunctionality of agroecosystem (MFA) remain poorly studied. In particular, the relative effects of local farming type and landscape heterogeneity – whether related to semi-natural and cropped habitats or farming practices - are still underexplored. In this study, we investigated the effects of local farming type (organic OF vs. conventional CF) and of landscape heterogeneity using multiple landscape representations (semi-natural habitat vs. crop matrix; habitat mosaic; farming practices mosaic) on MFA. We assessed MFA using proxies of the ecological (pollination, pest control, pest infestation, biodiversity conservation), agronomic (yield) and socio-economic (semi-net margin and working time) performances of agroecosystems in 40 cereal fields (20 under OF and 20 under CF) located in the LTSER Zone Atelier Armorique, France. Landscape composition and configuration were described within 250 m to 1km radius buffers around fields. Our results show that OF crops exhibited higher levels of ecological functions, lower yields and comparable socio-economic performances compared to CF crops, leading to similar overall MFA for both farming types. Landscape heterogeneity did not significantly impact MFA but influenced ecological and agronomic performances differently depending on the landscape representation used. Habitat diversity in surrounding landscape was the main driver of pest control, pest infestation and crop yield, whereas biodiversity conservation was driven by the percentage of semi-natural habitats. The percentage of OF fields had no effect on agroecosystem performances. Our study suggests that implementing OF at the field scale and restoring complex habitat mosaics at the landscape scale are key strategies for enhancing the ecological functions underlying MFA, despite strong trade-offs with agronomic performance.

Oral presentation

Intersecting different connectivity patterns to better understand the ecological value of landscape multifunctionality along the Albertine Rift Valley of Rwanda

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Assessing connectivity in a multifunctional landscape is essential for identifying key areas beneficial for the dispersal of organisms, to increase ecosystem resilience, for effective conservation and restoration, and for the maintenance of ecosystem services. The landscape of the Albertine Rift Valley in western Rwanda has experienced severe forest degradation and fragmentation in the past but also received considerable forest restoration efforts in recent years, predominantly comprising exotic trees like Eucalyptus or Pinus. The current landscape is composed of a mosaic of land uses including Afromontane rainforest, subsistence agriculture, woodland plantations, tea plantations, and urban areas, which provide distinct habitat for different plant and animal species. Through building landscape resistance models for two broad ecological groups of birds (Afromontane forest specialists and homegarden generalists), we aimed to compare likely patterns in habitat connectivity and to identify areas with a relatively high probability of use by either group as ‘future restoration priority areas’. We applied circuit theory and used the Omniscape algorithm to model connectivity based on resistance layers, which were built by combining several group-specific habitat factors (e.g. percentage land cover, housing density, distance to nearest protected area). Our results suggested that Gishwati-Mukura National Park and Nyungwe National Park would likely facilitate movement of forest specialists, whereas rural areas with houses and associated homegardens likely provided connectivity for generalist species. Based on these findings, we propose two complementary ways to enhance connectivity within this multifunctional landscape: (i) for the group of Afromontane specialists, we support the conservation concept of ‘land sparing’, i.e., conserving the existing forest remnants and designing new stepping stones or a new corridor of native forest to link these remnants; (ii) for generalist species, we recommend a “land sharing” strategy that specifically recognizes the importance of currently underappreciated homegardens. The long-term ecological sustainability of the multifunctional landscape investigated thus appears to hinge on a combination of protecting relatively undisturbed locations with integrated use strategies for the agroecological landscape matrix.

Oral presentation

Finding solutions for biodiversity: co-creating multifunctional landscapes with farmers

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Agricultural landscapes have traditionally supported a significant portion of Europe's biodiversity. However, the past century has witnessed a sharp decline in biodiversity within agroecosystems due to changes in agricultural practices. This decline in diversity and multifunctionality negatively impacts the quality and sustainability of food production, which relies heavily on the surrounding biodiversity, soil health, and our capacity to mitigate and adapt to climate change. Therefore, there is an urgent need to restore biodiversity and ecosystem functioning in agroecosystems and find practical solutions for balancing biodiversity conservation and food production.

The LIFE-IP ForEst&FarmLand project brings together scientists, farmers, and policymakers to test the impact of selected agroecological interventions on biodiversity and yield. Each intervention is tailored to its surrounding landscape and the farmer's preferences. We experiment with landscape elements that diversify landscapes and enhance ecosystem services, e.g. natural pest control and pollination. Specifically, we establish grassland strips with native flowering plants, plant hedgerows, and create rocky mid-field habitats. At each site, we monitor how these landscape elements affect landscape multifunctionality, biodiversity, potential pest control, and soil parameters and biota. We also assess the interventions' effects on management costs, crop yield, and farmer knowledge and motivation to apply agroecological practices.

By working closely with the farmers and policymakers, we aim to optimise the legislation and subsidy systems to enhance farmer uptake of ecological intensification practices. A clearer message of the importance of biodiversity and ecosystem services in agroecosystems needs to be conveyed through the subsidy system and to the wider public to ensure general support and funding for more nature-friendly options in farming. Similarly, there is a need for a more user-friendly subsidy system and an improved advisory system for farmers to support agroecological practices. Close collaboration with farmers and policymakers will help identify the most suitable agroecological interventions and management practices for restoring multifunctional landscapes and ensure the practical usability and uptake of sustainable practices by farmers.

Oral presentation

Modeling the effects of agri-environmental policies in multifunctional agricultural landscapes

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The Common Agricultural Policy (CAP) plays a crucial role in shaping multifunctional agricultural landscapes that balance food production with biodiversity conservation and the provision of ecosystem services. Despite €12.1 billion spent annually on environmentally oriented measures, significant gaps remain in achieving environmental targets. This presentation highlights findings from the Horizon 2020 project BESTMAP, which integrates advanced modeling approaches to evaluate the effects of agri-environmental measures on farmland biodiversity (e.g., farmland birds) and ecosystem services (e.g., food and fodder production, water quality, carbon sequestration). By focusing on five diverse case study regions—Czechia, Germany, Spain, the UK, and Serbia—this research underscores the importance of multifunctional landscapes in delivering environmental and socio-economic benefits. The insights aim to inform the design of future rural policies that enhance the multifunctionality of European farmland, ensuring they contribute to sustainable agriculture and resilient agro-ecosystems across Europe.

Oral presentation

Towards agro-ecological practices in the context of the CAP in Slovakia: initial socio-ecological research at the farm level

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The Strategic Plan of the EU Common Agricultural Policy (CAP) for Slovakia 2023–2027 better reflects global environmental changes compared to previous CAP plans. Environmental measures aim to reduce large arable land plots through green belts, increase non-productive areas, and provide better support for grazing. However, how do the size, structure, and management of agricultural plots affect biodiversity and ecosystem services? The connection between scientific outputs and policy design is often lacking. Specifically, research results are not directly linked to the CAP measures, and there is a lack of data for harmonized spatial units used by farmers.

The main aim of our research is to achieve a better scientific understanding of the influence of landscape-ecological parameters and farming practices on the species and ecosystem diversity of the agricultural landscape at the farm level, especially in the context of the CAP. We have selected several research sites in Slovakia, where socio-ecological research commenced in 2024. While it is too early for solid conclusions, some introductory knowledge can already be shared with experts and the public. For example, the way green belts are created on intensive arable land affects vegetation type development. We found that ruderal and weed species dominate in the first years if the land is simply left unmanaged. Green belts created in less intensive plots, e.g. areas previously cultivated with clover mixtures, are covered by clovers and grasses typical of mesic grasslands, with an admixture of ruderal species. Furthermore, when a green belt is established, the agrobiont spider species dominating the fields tend to give way to species from grassland or xerothermic habitats that would otherwise not find a place in intensively used plots. Regarding pollinators, we observed the highest species diversity and abundance in flowering green belts, with no differences in other green belt types compared to intensively used arable land. For both studied animal groups, a higher species spectrum was recorded in lowland green belts compared to mountainous ones.

We must emphasize that enhancing farm agroecology should not negatively impact farmers' time and resource consumption. Due to time constraints and a limited focus on ecological issues, farmers are often unable to fine-tune CAP interventions to increase biodiversity while maintaining farm economic viability. Researchers face the challenge of contributing to this topic by providing extended expertise and conducting long-term monitoring at the local level.

Poster presentation

How can farmers contribute to enhance peri-urban landscape assessment? The case study of Stupinigi Royal Natural Park (Metropolitan City of Turin, Italy)

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To identify a methodology able to conjugate cultural and historical values with socio-economic trends an integrated empirical work was developed. The method was applied in Stupinigi Royal Natural Park, a protected area of Piedmont Region, recognized in 1997 as a World Heritage Site by UNESCO in the serial site "Savoy Residences". In the past, the Stupinigi Royal Park was used by the Royal family for hunting. The protected area (1700 ha) is located in the peri-urban of Turin city and now it is characterized by several agricultural patterns, land uses and natural woodlands (oaks and hornbeams). Firstly, for identifying cultural and historical features of rural area and theoretical qualifying elements, historical and landscape analyses were performed. The first part of our research was carried out by analysing documents and references from historical archives and libraries: historical literature, cartographies, figured land registers, iconographies and cadastral maps historical from the XVIII and XIX centuries were collected. Traditional cultivations such as crops, woods, and grassland pasture were maintained for centuries. Historical farm buildings, ancient hunting routes and hedgerows were recognized as historical permanences. Secondly, to evaluate ecosystem services provided by local farmers, a participatory approach was adopted: 29 face to face interviews were performed (100% of the sample). Using a qualitative semi-structured questionnaire, these topics were investigated: farms' main characteristics, land uses, presence and roles of hedgerows and tree lines, multifunctionality attitude, supply chains, product transformations and farmers' perception regarding the natural landscape in the protected park. This research demonstrates how farmers' participation contributes to enhance landscape assessment in a protected area. Stupinigi Royal Natural Park can be considered a complex system in which agriculture and natural resources are combined. Local farmers provide several ecosystem services, and with their activities they contribute to maintain rural landscape and conserve natural and historical heritage.

Poster presentation

FarmBioNet - Farmer-focused Biodiversity and Agricultural Knowledge Network

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The poster presents the Horizon Europe project, FarmBioNet, whose ambition is to enhance biodiversity-friendly farming practices in Europe by stimulating knowledge exchange between farmers, foresters, researchers, advisors, and other key stakeholders. This exciting new initiative is coordinated by Teagasc, and the coordinator in Slovakia is the Institute of Landscape Ecology of the Slovak Academy of Sciences. FarmBioNet will run for three years (January 2025–December 2027). The project solution is planned in 10 work packages. The first two WPs include analysis of the state of current biodiversity-friendly farming (BFF) practices and collection of research findings & best practices.

At the core of FarmBioNet is the establishment of a European network encompassing a variety of national networks. These networks will facilitate the exchange of both traditional and evidence-based actions that promote biodiversity on farms. Members of the NN in each country should include the following categories where possible: Farmers practicing biodiversity-friendly farming (BFF); Farmers not yet practicing BFF; Agricultural advisors and consultants; Researchers and academics in agroecology and biodiversity; Policy makers and governmental agencies related to agriculture and environment; Representatives from operational groups (OGs), where they exist; NGOs focused on sustainable farming and biodiversity; Agri-business representatives and cooperatives; educational institutions involved in agricultural training, etc.

The poster will present first experience with establishing a national network of biodiversity-friendly farming in Slovakia.

The national networks will include farmers, farming organisations, researchers, advisors, other relevant actors, and national/regional sub-networks.

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Poster presentation

Integrating Socio-Spatial Approaches for Sustainable Multifunctional Landscapes: Insights from Southwestern Ghana

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Mosaic landscapes, shaped by both natural and human influences, provide diverse ecosystem services that are crucial for sustainable land management. Understanding the composition, configuration, and dynamics of these landscapes is essential for maintaining ecosystem multifunctionality. In southwestern Ghana, rapid land-use changes driven by plantation agriculture, oil and gas activities, illegal mining, and urbanization threaten the provisioning of ecosystem services. This study employs an integrated socio-spatial assessment in a mixed-methods approach using spatial, quantitative, and qualitative methods to analyze the structural dynamics and spatial challenges of this mosaic landscape.

This research follows a three-pronged approach. First, spatiotemporal analysis of Landsat imagery (1986, 2002, 2015, and 2020) reveals significant land-cover transitions, highlighting settlement and rubber expansion as primary drivers of landscape transformation. Second, participatory scenario-building workshops capture land-use actors' perceptions, identifying key ecosystem services, business-as-usual scenarios, and alternative multifunctional landscape designs. Third, a spatially explicit simulation assesses trade-offs and synergies between land-use change patterns and ecosystem service provisioning. Results indicate that rubber plantations have expanded more than threefold, while settlements have grown over four times their original size, leading to trade-offs where expansion reduces essential ecosystem services. Alternative landscape scenarios, however, demonstrate synergies between multifunctional land-use configurations and ecosystem service provisioning.

The study underscores the importance of integrating socio-ecological perspectives in land-use planning. Recognizing stakeholder collaboration and sustainable practices as key to successful multifunctional landscapes, this research provides a framework for spatially explicit and participatory approaches to sustainable landscape management. Findings contribute to bridging gaps between science, policy, and practice, offering actionable insights for designing multifunctional landscapes that balance ecological and socio-economic needs.

Poster presentation

Session 3C – The Green Transition of European Landscapes – from Ambitious Spatial Plans to Comprehensive Land Use Changes

Symposium

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Keywords: land use changes, climate action, green deal, spatial planning approaches, sustainable transition

The green transition towards climate neutrality by 2050 will have a comprehensive impact as driver of land use changes of the European landscapes: The Green Deal calls for actions concerning both decreased greenhouse gas emissions e.g. through identification of new and less intensive use of carbon-rich soils and restoration and construction of wetlands, as well as increased greenhouse gas uptake through changes in crop regimes, low impact livestock management, and increased afforestation initiatives. However, the green transition is not only about reaching climate neutrality but should also address other current crises related to biodiversity, and pollution of the aquatic environment and how synergies can be achieved when addressing these crises together. This session will explore: 1) How spatial plans for the green transition has been formulated through both top-down and bottom-up planning processes across European countries; 2) How and to what extent have land use changes already been experienced, and which scenarios are expected; and 3) Which knowledge gaps exist in relation to assure a sustainable land use transition.

Supporting the green transition through local dialogue-based planning processes

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The ambitious goal related to the green transition should be accomplished soon and nations struggle to implement the needed measures, interventions and land-use changes to achieve a reduction of the net greenhouse gas emissions by at least 55% by 2030 (compared to 1990 levels) and climate neutrality by 2050. The implementation of the right measures is at the center of the agricultural transition and part of the discussion on implementation pertains to how landowners should be motivated to change their production, land use, and agricultural practices. Should they be subsidized, should it be based on voluntary agreements and action, or should collaboration with external funding bodies be the way forward?

One way of engaging local stakeholders to contribute to the green transition is through development of a holistic landscape strategy. In a local landscape across two Danish municipalities (Odense and Assens) such landscape strategy was developed during the spring and autumn 2024 engaging around 30 local stakeholders of different backgrounds (e.g. landowners, farmers, agricultural advisors, NGO representatives, and municipal officers). The plan consists of a vision, a set of agreed goals, a spatial plan, and a suggestion for strategic projects to be implemented from now and until 2045.

In the presentation it is discussed how local processes can contribute to the implementation of ambitious national programs, and further, how plans and projects potentially can deliver to the fulfillment of the national and European goals for the green transition.

Oral presentation

Mapping vanished woodland in the late medieval Netherlands, in context of the Dutch New Forest Strategy 2030

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In the Netherlands, the Ministry of Agriculture & Nature presented ambitious plans to significantly expand the Dutch forest area. The new Forest Strategy 2030 aims for 37,000 hectares more forest. To achieve that goal, a lot of planting will still have to be done because the forest area has decreased net by about 5,400 hectares in the period 2013-2017. The question is where that forest should be located and what it should look like. And the choice of one location or one type of forest is also more logical in terms of landscape history than another. But there is no country-wide overview of the historical distribution of forest in the Dutch landscape, at least not for the period before approximately 1850.

When searching for locations for new forests, existing forest sites or places where forests are known to have existed are often initially looked at. The problem is that forests only appear on maps in a comprehensive and detailed manner from around 1850. Moreover, that is precisely the moment when the Netherlands had become almost completely deforested: only 1% was covered with forest. This has become apparent from a study of the oldest topographical and cadastral maps. Before 1850 the picture is fragmentary, certainly cartographic. Historical studies emphasize past forestry and other ways in which forests were used by humans but does not provide a geographical overview. Even on the basis of botanical research (particularly of old pollen), only a coarse-grained and lacunae picture of the historical geography of the Dutch forest can so far be derived.

The National Cultural Heritage Agency (RCE) is also involved in the development of the Forest Strategy. Partly because of the expected landscape effects of large-scale forest plantings, the RCE set up the Forest in Motion project to gain a better spatial insight into the former presence of forests in the Dutch landscape. A big data analysis was carried out on a national scale to gain insight in the distribution and character of woodland in the late medieval period (1000-1500). Starting point was a database containing all 6284 Dutch place names. Medieval place names that refer to (the use of) woodland in general or to specific types of woodland were selected and mapped. The resulting distribution shows interesting regional differences but is distorted and incomplete. The next step is to supplement it by using national inventories of 'ancient woodland', historically known medieval woods, archaeological data on medieval charcoal burning sites and perhaps also known sites of 'ancient woodland' plant species. Regional inventories of field names will then be used to validate resulting spatial patterns.

In this presentation we will elaborate on the method and first results of this experimental study to gain insight into this. By way of introduction, we will pay attention to some important insights into the forest of the past.

Oral presentation

Exploring Synergies Between Biodiversity Conservation and Drinking Water Protection in an Intensive Agricultural Landscape in Slovenia

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Agricultural intensification is one of the main threats to biodiversity, often leading to conflicts between agricultural production and nature conservation. To identify areas where reduced farming intensity could promote biodiversity, we examined drinking water protection zones (WPZ) in the Lower Savinja Valley, Slovenia, and compared their role in enhancing the connectivity of high nature value (HNV) farmland with the Natura 2000 network.

HNV farmland covered 25.8% of the study area, with 6% protected under Natura 2000 sites and WPZ in nearly equal proportions. Zonation prioritization analysis assigned higher average scores to cells in WPZ compared to Natura 2000 sites and unprotected areas, highlighting their significant contribution to HNV farmland connectivity. Depending on the connectivity scale, between 23% and 70% of WPZ received the highest Zonation prioritization scores. A simulation of converting arable land within WPZ to HNV farmland resulted in an additional 58.2 ha of HNV farmland, increasing overall HNV farmland cover from 25.8% to 26.3% and further reinforcing the role of WPZ in landscape connectivity.

Our analysis focused on the spatial configuration of HNV farmland but did not account for habitat quality, species presence, or management practices within WPZ. Further studies of the effect of WPZ management restrictions on biodiversity are needed.

Drinking water protection zones under different levels of protection cover approximately 20% of Slovenia's territory. Given their large extent, we recommend evaluating WPZ for their conservation potential and integrating them into ecological network planning, particularly in intensive agricultural landscapes. This study highlights the need to seek synergies between environmental policies to balance agricultural and conservation goals.

Oral presentation

Action plans to meet green transition targets for whole landscapes - example from the Inner Limfjorden Catchment

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The aim of this paper is to report results from a pilot project, where Coastal Councils were formed to propose action plans to meet the EU Water Framework Directive targets set for selected estuaries and related watersheds in Denmark.

In particular we look into the critical case of Inner Limfjorden, and the process around the scenario development, facilitated by our work in a technical support group. The core aim of this work was to propose different pathways and sets of measures to meet the official Nitrogen (N) reduction target, which is particularly high for this watershed caused by shallow waters, a relatively large catchment, and a very high pressure from intensive agriculture and livestock production. Overall, the work was successful, and many lessons were learned to balance the different interests around the table – for instance in relation to the use of geographically targeted measures, and alternative measures to reduced N use and pollution (e.g. land use changes with more permanent crops, inducing more renewable energy and bioresources, marine measures, and reduced erosion and Phosphorous losses, which also can help to get a better water environment). The quantified needs and effects of suites of measures are presented and formed bases for more detailed and multifunctional analyses in the Hjarbæk Fjord Catchment. Over the past couple of years, we have followed a special action group formed by the municipality of Viborg for this area, with some of the very highest reduction targets to be met. The analyses include land use changes needed and the effects of different hierarchies of priorities, ranging from different degrees of nature protection, wetland construction, afforestation and other potential types and land use changes in the agricultural practices. Finally, it is discussed how these results can now be used during the implementation of the Danish Tripartite agreement in this area, meeting significant green transition targets for Danish agriculture, related to reduced nitrogen pollution and greenhouse gas emissions in combination with significantly more room for biodiversity and nature protection.

Oral presentation

Wind power planning through spatial multi-criteria analysis adapted to real-world planning: A case study from Sweden

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Energy generation in Sweden has seen a significant increase, with electricity production from wind growing tenfold from 2010 to 2023. From a climate perspective, a continued expansion is desirable, however impacts on biodiversity as well as social values must be avoided or minimised. For sustainable wind energy planning, Spatial Multi-Criteria Analysis (SMCA) has been widely applied for siting of wind farms globally. This process involves a multitude of criteria corresponding to rapidly evolving concepts of sustainability that vary significantly among stakeholders, locations, and time periods. Even if SMCA is designed to handle complexities and interdisciplinarity, these still pose challenges for planning, and there is as well a need for adapting the methodology to planning reality. The aim of this study is to understand methodological shortcomings and to further develop the SMCA-based REWIND planning support framework for real-world wind power planning in Sweden. Our study combines a systematic literature review with a case study in the ÖMS regions, consisting of seven counties in mid-eastern Sweden.

The literature review covering 62 European studies published over the past decade explored key themes such as scale and administrative level of the study, weighting method and decision hierarchy, sensitivity analysis, stakeholder involvement, and real-world planning context. The findings indicate that while SMCA is useful for handling complex planning problems, there is significant room for improvement to enhance its applicability, especially in addressing the complexities of stakeholder involvement and decision rule uncertainties. Building on the findings of the review, the REWIND framework was applied in the ÖMS case study, to design and evaluate onshore wind power planning alternatives, considering techno-economic, ecological and social aspects. The framework was further developed with a novel weighting method and expanded stakeholder involvement, while investigating robustness and uncertainties in the decision rules by exploring different interpretations of criteria and weights in scenarios. Expected outcomes are detailed suitability maps for wind farm locations and an improved methodological framework to support knowledge-based and inclusive wind power planning. It can be used in a supportive collaboration platform, linking regional and municipal planning levels. The research contributes to the development of a more practical and sustainable wind power planning approach in Sweden and beyond.

Oral presentation

The Green transition as a driver for new climate and environmental policies in Denmark

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Radical land use changes as well as transformation of governance regimes are needed to solve societal problems related to climate, biodiversity and environment and new goals and policies are being formulated from global to local level to address these critical challenges. In Denmark a new agreement on a green transition has been adopted in 2024. The green transition agreement is entered by the government, the Danish Nature Conservation Association, Agriculture and Food (the agricultural interest organization), the Association of Local Authorities and four trade unions and later passed in the Parliament by a vast majority. The implementation of the agreement is considered to take place in a collaboration between municipalities, local nature conservation associations and agricultural organizations. When the agreement is fully implemented by 2045, it is expected that 15-25 % of the agricultural land has changed land use. Changes include conversion of farmed carbon rich wetlands and soils with low nitrogen retention capacity to natural habitats or extensive use and 250.000 ha of new forest and natural woodland. 5.7 bill Euro has been allocated to support the transition. In the presentation we describe the background and content of the agreement and its subsequent policy initiatives. We take a critical perspective on the organization of the implementation which on the one hand do represent an innovative governance approach but on the other hand face potential barriers such as dependency on voluntary agreements, time pressure, and asymmetric distribution of resources and power between the actors in the process. We close with a brief outline of examples on local solutions to land use changes and their landscape impacts and link up to the wider European perspectives including the coming revision of the CAP.

Oral presentation

Monitoring of nature infrastructure - Skill acquisition fOr NATure-bAsed solutions

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The localization of new forests is not unambiguous. Several factors can inform both where forest could be located to meet some of the co-benefits mentioned, but also where it is better to suggest other land uses than forests.

Oral presentation

Session 3D – Planning Approaches to Reconcile Growing and Emergent Demands on Landscapes

Symposium

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Keywords: planning, response, evaluation

The recent rapidly changing world has shifted the significance of driving forces in landscape transformation and new conflicts have emerged. Increasing urbanisation, the need for energy and food production, nature conservation and recreational use are placing growing and often conflicting demands on landscapes. Balancing these demands often requires efficient and innovative planning tools and approaches. It also requires stakeholder cooperation at different levels, local, national and beyond. The objective of this symposium is to assemble talks that: • explore the substantive and procedural challenges in balancing these demands while maintaining the benefits that landscapes provide to both humans and nature, • showcase planning tools and approaches for addressing the growing demands on landscapes, in their various forms ranging from targeted land-use policies to integrated strategic approaches for setting effective and long-term visions. We welcome presentations which address the role of planning and policies in responding to changing landscapes at any step in the planning cycle. This session builds upon previous symposia being organized during the European or World Landscape Ecology Congresses in Gent (2017), Milan (2019) and Warsaw (2022) and Nairobi (2023). Through this session, we expect that the community of landscape ecologists whose work addresses the political drivers of landscape change will strengthen their networks and find common ground for their research. This symposium is a contribution of the IALE Working Group Landscape planning (<https://www.landscape-ecology.org/page-18081>). We expect the session to be the basis for the coordination of the development of a scientific paper addressing the proposed topic.

Exploring local and regional impacts on ecosystem services and green infrastructure for scenarios of urban development in Stockholm, Sweden

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Urban development policies tend to promote denser cities that are more energy-efficient and less transport reliant than urban sprawls. This will strongly affect ecosystem services (ES) that cities are dependent on but tend to disregard. If a shift is made towards prioritizing ES and planning with nature-based solutions whilst also meeting the need for new housing, urban regions could become forerunners in planning for a sustainable transformative change. These sometimes conflicting demands need to be balanced to inform critical urban policy and planning decisions, which require planning support tools that can analyze and assess such conflicts. According to the main policy of the regional plan for Stockholm, urban densification is a leading principle so urban growth will be promoted in already established urban cores throughout the region up until 2060. Simultaneously, the County Administrative Board has launched an action plan for green infrastructure (GI), aiming to strengthen biodiversity and ES of the region. The aim of this study is to explore local and regional impacts on ES for two different future scenarios of urban development and compare them with the GI plan to discuss scale problems, spatial mismatches and possibilities for multi-functionality, related to planning practice.

The study area is the southern part of Stockholm metropolitan region, embracing three neighbouring municipalities in a gradient from urban to peri-urban. The dense scenario simulated the expected urban densification with no regard to local greenery, while the green-dense scenario simulated dense housing units but scattered enough to allow at least 30% canopy coverage within 300 m from residential buildings. ES capacities were estimated for mitigation of heat island effect and flood risk, and access to local and regional nature-based recreation. This was compared to the GI plan to estimate overall regional scale impacts. The results showed that urban dense development had apparent drawbacks from a local ES perspective, while the green-dense scenario left room for local ES but instead spread more in the landscape; impacting on regional recreation values and GI. Proportions and location of nature areas related to urban densification versus sprawl need further attention for balancing different types of ES. The methodology is useful for urban planning support and will thus enable integration of ES in policy and planning decisions of metropolitan regions, with the goal to increase their sustainability.

Oral presentation

Can spatial planning effectively address spatial inequalities? The Case of São Paulo's Master Plan

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Despite the crucial role of urban planning in regulating urban growth, it has fallen short in effectively controlling rapid expansion and steer development toward reducing social and spatial disparities in LAC urban areas. While progress has been made in evaluating spatial planning outcomes, most studies have focused on its role in controlling built-up growth. There remains a significant need for robust methods to assess the causal relationship between planning goals and outcomes, considering the diverse types of urban land change, such as expansion, sprawl, and compaction. This research evaluates the effectiveness of the 2014 São Paulo master plan five years after its implementation using Partial Least Squares Path Modelling. São Paulo is a city with a high level of spatial inequality. Its central areas, where jobs and services are concentrated, are sparsely populated and mostly accessible to the upper classes. Meanwhile, a large part of the population lives in densely populated peripheral areas, which have less infrastructure and are far from job opportunities. To address this inequality, São Paulo's master plan aimed to better connect housing and employment while curbing the city's rapid expansion at its outskirts and preserving green and agricultural areas. To achieve these goals, the plan focused on three key strategies: (1) increasing housing units and (2) promoting densification and compact development in central areas, and (3) controlling urban expansion and sprawl at the outskirts. To evaluate landscape density after the spatial plan's implementation, built-up growth was categorized based on whether it occurred alongside a population increase or not. To assess sprawl, we adopted a landscape perspective, analysing the configuration of built-up areas and calculating the Weighted Urban Proliferation. Preliminary results suggest that strategies to control built-up growth were ineffective in containing urban expansion and sprawl. Likewise, strategies for urban compactness did not significantly influence patterns of urban land change. However, the housing promotion strategy appears to be more effective in fostering compact development. We aim for this research to aid policymaking in finding solutions that address the complex combination of factors that persist despite advancements in territorial planning policies.

Oral presentation

Regional parks and green belts in Germany: An empirical analysis of the interplay of drivers supporting the creation and implementation of long-term urban-regional open space strategies.

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In the face of increasing land consumption, urban sprawl and its negative impacts on climate and biodiversity, more sustainable land-use policies to protect landscapes and open spaces are urgently needed. But what are the political drivers that support the development of such policies? How are these policies implemented and what makes them successful or not? In our contribution, we present the preliminary findings of our empirical research funded by the German Research Foundation (DFG). It includes three German case studies, the Regional Park Rhein-Main, the Emscher Landscape Park and the Green Ring Leipzig. The cases can be reasonably seen as successful examples of active, long-term open space strategies that have gradually achieved physical-material enhancements, serving both recreational and ecological purposes, that have changed the perception of landscapes in conurbations and that have promoted inter-municipal collaboration in a complex, multilevel governance setting. The creation and implementation of urban regional open space strategies is therefore seen as a means of integrating sustainability policies in a subnational spatial planning context. The idea of linking open spaces at a regional scale and thus creating an urban regional open space network is the starting point of such strategies which combine formal with informal planning approaches. Our research aims to disentangle the dynamics of (political) drivers that make this idea emerge, prevail and perdure by drawing on a policy process theory from political science, the Multiple Streams Framework (MSF). In doing so, we make critical use of the concepts of windows of opportunity and contingency in order to capture crucial turns and moments in the development of these urban-regional open space networks. We also include the concept of policy entrepreneurship to depict the role of agency in the creation and longterm implementation. In our analyses we highlight the similarities and differences of the three cases along the MSF and address potential implications for planning theory and practice. We conclude our presentation by discussing the issues of 1) transferability to other contexts than the German one, 2) the usefulness in explaining not only successful but also failed urbanregional open space strategies and also 3) the suitability of regional parks and green belts as “tame” solutions to the wicked problem of sustainable spatial planning.

Oral presentation

Planning for the Future: Ecological Infrastructure as a Tool for Managing Land Use and Climate Change Impacts

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Climate change and rapid land-use changes in central Chile are threatening biodiversity and diminishing essential ecosystem services. To address these challenges, landscape planning must integrate ecological infrastructure—a strategic approach that combines biodiversity conservation, biological corridors, and ecosystem service provision—to enhance resilience and mitigate impacts. This need is particularly urgent in dynamic regions where urban expansion places increasing pressure on remaining natural habitats and their ecological functions. This study simulated two contrasting metropolitan growth scenarios and a blended “preferred” scenario using GISCAME, a spatially explicit land-use model, to assess changes in land cover and the integrity of the ecological network. Biodiversity impacts were quantified using a habitat vulnerability model, mapping habitat loss risks under each scenario. Additionally, climate change impacts were analyzed with national climate risk maps, evaluating wildfire exposure in native forests, climate-driven wetland degradation, altered river flows, and shifts in ecosystem service availability projected for the mid-21st century. Results indicate that all urban development scenarios led to the degradation of key ecological infrastructure components. Biodiversity and connectivity indices declined across all cases, with losses reaching up to 3% even in the most conservation-focused scenario. The sprawling development scenario resulted in the greatest increase in habitat loss risk compared to the integrated scenario. Similarly, the potential for ecosystem service provision declined as natural land was converted, with key regulatory services—including air and water quality, as well as flood control—showing significant reductions, signaling a weakening of overall landscape functionality. Climate change is projected to further exacerbate these trends. Water supply capacity could decline by more than half, while other critical services, such as water quality regulation and air purification, are expected to deteriorate significantly. The risks to biodiversity will also intensify: nearly one-third of native forest core areas may face high wildfire risk, and most coastal wetland cores are classified as moderately to highly vulnerable to climate-related degradation, further disrupting species connectivity. These findings highlight the urgent need to integrate biodiversity, connectivity, and ecosystem services into landscape planning. The projected losses under business-as-usual development reinforce the inadequacy of traditional planning approaches. To build resilient landscapes, decision-makers must adopt integrated, nature-based strategies, prioritizing the protection of core habitats, the establishment of ecological corridors, and the guidance of urban expansion away from sensitive areas. Such hybrid approaches are essential for strengthening landscape resilience in the face of climate change and ongoing land-use pressures.

Oral presentation

What factors shape the relationship between land take and soil sealing in European cities?

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Soil sealing occurs when soil is covered by impervious materials, typically due to land take from urbanization and infrastructure development. These processes have steadily increased in European cities in recent decades due to rising demand for urban land. The relationship between land take and soil sealing varies across contexts, with research showing that sealed soil in areas affected by land take ranges from 30% to 75% in European cities, reflecting different urban development types. From an urban policy and planning perspective, it's crucial to consider both the land converted to artificial uses (land take) and the portion that will be sealed. The European Commission has set two targets for sustainable urban development: no net land take (in the "Soil Strategy", first mentioned in 2011) and no net soil sealing (in the "Soil Mission").

Our study explores how urban spatial patterns and different types of urban development shape the relationship between soil sealing and land take over time. Two hypotheses were tested: (1) the ratio of soil sealing to land take is higher in greater urbanization degree areas; (2) the ratio increases when cities become more compact, as soil sealing tends to grow faster than land take when densification and infill strategies are implemented, as opposed to sprawling development. To test the hypothesis, we computed the soil sealing to land take ratio for each Functional Urban Area (FUA) in Europe in 2012 and 2018 (latest available data). The analyses were broken down by considering multiple factors (geographical location, land use prevalence in the FUA) and then analyzing their correlation with the ratio. To test hypothesis (1), we quantified the population share living in different urbanization degree areas. The other (2) was tested using three landscape metrics describing different compactness/sprawl aspects: shape irregularity (edge density), patch dispersion (nearest neighbour), and patch aggregation (patch cohesion).

Preliminary results show a general ratio reduction, with a median of -0.36 from 2012 to 2018, indicating a trend toward lower-intensity urban development. The UK-Ireland saw a greater decrease, while southern macroregions had a smaller reduction. The developed land use prevalence in FUA tends to increase the ratio, while agricultural decreases it. Moreover, the results show a weak correlation between the ratio and the urbanization degree and a stronger one with compaction strategies. The study's outcomes, especially the spatial patterns in different cities and regions, can support policy design at various planning levels to achieve European sustainable urban development targets.

Oral presentation

Do governments dream of operational landscapes? The shifting role of governments in development of land for production, storage and distribution of goods

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In his 1968 science fiction novel – *Do Androids Dream of Electric Sheep* – Philip K. Dick envisions a world where androids evolve from robotic servants into empathic beings capable of dreaming, striving to elevate their status in the world. This transformation from passive recipients of orders to proactive being is central to the novel. In the real world, it is not the androids but rather the governments that are undergoing changes regarding their roles in how the urban space is created, specifically regarding spaces dedicated to production, storage, and distribution of goods. Traditionally, the development of these spaces was seen as a process where governments regulated land supply, while private companies shaped demand as developers and operators. Recent studies reveal that the governments' role is shifting to "private-sector like" efforts. Governments develop, operate and lease land for warehouses, logistics spaces and industrial zones. Individual projects for these developments cluster spatially to form what Neil Brenner called operational landscapes, term that we adopt here. These landscapes are marked by large functional buildings exhibiting architectural uniformity, extensive networks of roads, rail tracks and parking spaces, and relatively few green areas. Governments view these areas as generating economic growth and employment opportunities. Yet, their development represents as a process of "boxification" of the landscape. Here we document the shifting role of governments to reveal a) mechanisms that they use to pursue their new roles and b) means through which their efforts lead to the creation of operational landscapes. We use five study areas in Romania to illustrate governments' proactive roles in planning, implementation and operation of spaces dedicated to production, storage, and distribution of goods. Methodologically, we rely on content analysis of planning documents, local and county council decisions, activity reports. Findings show that governments mix political and entrepreneurial goals using various mechanisms, including establishment of public companies with joint shareholder, joint provision of land for development, collaborations and negotiations with private actors and across planning levels. Strategic projects are used as the main means through which developments are pursued. Findings are discussed in the context of neoliberal approaches to spatial planning. Further, we discuss how spatially clustered individual projects, over time, culminate in the formation of landscapes with distinct characteristics.

Oral presentation

When good intentions lead to bad results - maladaptation in ecosystem and landscape management

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Ecosystem and landscape management (ELM), including nature-based solutions (NBS) are widely promoted as sustainable strategies for climate resilience, biodiversity conservation, and sustainability. Yet well-intentioned interventions can sometimes lead to maladaptation, when actions intended to solve environmental problems instead create new risks, exacerbate existing ones or just fail to deliver intended benefits. These situations remain a significant concern among environmentalists, both within academia and practice. This research critically examines maladaptation in ELM and NBS, with a focus on adaptation to climate change in urban green spaces, forests and agricultural areas. The qualitative research involved surveying a diverse group of experts (in the field of nature conservation, landscape architecture, spatial planning, forestry and agriculture) using a questionnaire distributed through the snowball sampling method. This approach enabled the collection of in-depth insights on adaptation challenges and management practices by reaching out to professional networks of specialists, both researchers and practitioners. The findings indicate how misaligned policies, incompetent activism, short-term planning, incorrect implementation of appropriate recommendations, and insufficient understanding or lack of scientific evidence can undermine adaptation goals. Examples include planting of tree species not resistant to climate change, invasive species introduction through rewilding practices, green walls that frequently suffer from high water demands, flower meadows not adjusted to highly urbanized settings, trees in pots as a common urban greening strategy, that offers minimal ecosystem services while being vulnerable to extreme weather conditions. These examples highlight the risk of superficial approaches that fail to integrate principles of environmental resilience and adaptation to climate change effectively. This study underscores the need for evidence-based planning, context-specific solutions and implementation, and long-term management strategies to prevent maladaptive outcomes in ELM and NBS initiatives. The findings emphasize the importance of adaptive management and continuous monitoring to avoid unintended consequences in environmental and landscape decision-making, as well as environmental education, academic projects, ESG initiatives, and NGOs campaigns. This research contributes to a more nuanced understanding of how good intentions can lead to negative outcomes, offering insights for policymakers and other entities seeking to implement more resilient and ecologically sound solutions.

Oral presentation

Private allotment gardens as a threat to peri-urban agricultural landscapes: the Fuenlabrada Agricultural Park, Spain, as a case study

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Spain's agricultural landscape has faced major challenges since joining the European Economic Community (now European Union) in 1986. The agricultural population has shrinking and ageing, compounding long-existing problems like scarce economic diversification, stringent CAP requirements, and poor adaptation to the global agri-food market. Beyond the traditional function of food production, the agrarian landscape is incorporating new functions and activities that are diversifying its economic activity. However, these compound the processes of deagrarianization in the Spain's rural landscape. These new activities, such as second homes or agrotourism, are steadily gaining ground, fuelled by great demand from urban dwellers seeking close contact with nature. Nevertheless, agricultural spaces in peri-urban areas persist today, with farmers maintaining agricultural or livestock use, despite knowing they cannot compete agri-industrially. The number of private allotment gardens in peri-urban agricultural landscapes has grown rapidly in recent years and are swiftly consolidating their position in the previous agricultural landscape, as they guarantee the landowner a higher income than traditional agricultural use. Although many allotment garden users prioritise recreation over cultivation in these spaces, these gardens still ensure that agricultural land use is preserved, and urbanisation-related land speculation is restricted. Having said that, they do result in a move away from traditional cultivation, combined with the fragmentation of the previous agricultural landscape. Given the above, urgent regulation of this activity is required within legal channels to prevent the fragmentation and commodification of these agricultural landscapes. Our research, based on the Fuenlabrada agricultural park and private allotment gardens existing within it, not only provides deep insight into the threats that private allotment gardens pose to the peri-urban agricultural landscape, but also proposes possible regulatory solutions.

Oral presentation

A Transdisciplinary Conceptual Framework for Understanding Social and Cultural Values in Land Use

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In Slovakia, land has always been essential in forming social and cultural values; its use is still intensively debated. Conflicts between many stakeholder interests are becoming more apparent as land, especially in response to sustainability projects and climate policies, becomes more under demand. Usually, these conflicts impede the changes in sustainable land use. Although participatory decision-making is generally seen as a vital tool for democratic and open government, poorly planned participation events run the danger of encouraging short-term thinking and widening divisiveness. Dealing with these difficulties calls for fresh ideas and methodologies based on co-creation of knowledge and group solutions for sustainable land management. Emphasising its influence on identities, social conventions, and economic possibilities, this talk will provide a research approach conceptualising land as both a social and cultural capital. Land binds communities via everyday encounters, local networks, and jobs as social capital. While legislative and economic frameworks impact access and governance, cultural capital - that which shapes regional and national identities - along with landscape character influences. The suggested framework combines various points of view to remove the obstacles in society allowing for sustainable land use changes. Three main components define the research approach. First, it looks at social values as drivers of land-use choices, differentiating them from more easily measured and anticipated economic values. Emerging from interactions among people, stakeholders, and institutions, social values are dynamic and context-dependent. Second, the framework suggests a method to detect and combine soft and hard data reflecting these qualities. Although statistical databases, including property ownership records, real estate prices, and socioeconomic indicators, offer quantifiable insights, qualitative data on social preferences and cultural landscapes are still largely underused. We intend to propose a solution for methodological difficulties in aggregating many data sources under consideration of political and ideological aspects of geographical representation. Applying a multidimensional Bourdieu's capital approach and the CHANS (Coupled Human and Natural Systems) framework to synthesise data and insights, the paper finally presents an analytical model for evaluating land use policies in Slovakia. National statistics, studies on land use and agriculture, and real estate market data will all provide the empirical basis for use. Furthermore, it is suggested to increase the applicability of the framework by conducting a social survey on willingness to pay for environmental enhancements. Contextualising results and guaranteeing complete knowledge of land use patterns will then depend on qualitative approaches. This contribution is supported by the project Horizon Europe no. 101081307 EUROPE-LAND: Towards Sustainable Land-use Strategies in the Context of Climate Change and Biodiversity Challenges in Europe, and by the Recovery and Resilience Plan project no. 09I01-03-V04-00094 Socio-economic and environmental aspects of land use patterns in Slovakia: implications for public policies.

Oral presentation

Towards nature-based planning in metropolitan regions - lessons from a case study

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Sustainable development of metropolitan regions implies energy and transport effective urban growth, while simultaneously promoting ecosystem services (ES) and biodiversity (BD). Nature-based solutions (NBS) have been put forward to address the complex and often conflicting demands on landscapes. However, despite high ambitions, NBS is not well integrated in the spatial planning activities on municipal and regional levels that largely shape the development of metropolitan regions. To avoid fragmented and disconnected planning efforts and silo thinking, transformative change of the spatial planning system would be required, addressing emerging environmental and societal challenges. The aim of this study was to explore planning activities for promoting ES and BD in current planning practice in Sweden, related to the rapidly growing metropolitan region of Stockholm. Targets are to investigate challenges and opportunities of the current planning processes on different levels, and a joint co-creation of new avenues for a better integration of main sustainability aspects in urban planning.

To meet the aim, we conducted interviews with experts and planners on municipal and regional levels, as well as a series of workshops and related focus group interviews with practitioners from three adjacent municipalities in a gradient from urban to peri-urban landscapes. Questions focused on perception of ES and BD values, planning activities for supporting these, knowledge transformation into action, roles and coordination between planning levels, success stories and failures, and prospects for change. We found a pattern of different activities related to ES and BD, each linked to certain areas in space, with different legislation, policy, priorities and routines. These planning geographies overlap to some extent and may change over time, but are quite distinct: protected areas with related regulations and management; designated areas of high values for ES or BD without protection, which are stored in a knowledge database with unclear status; urban areas with main focus on ES and small-scale NBS; and larger-scale municipal and regional green infrastructure plans, with varying but rather weak or no connection to spatial planning, even if used e.g. for certain specific efforts of inter-municipal collaboration. Despite high ambitions in policy and plans, planning often seems to be reactive, and in late stages of e.g. urban development, many NBS initiatives are lost due to economic priorities. Success stories tend to relate to proactive and long-term joint activities related to individual municipalities. We found an overall lack of coordination and joint framework to promote ES and BD across the landscapes. Ways forward would be to enhance integrated landscape thinking across planning siloes, merging the currently rather separate planning geographies into a proactive nature-based planning, jointly addressing main sustainability issues.

Oral presentation

Animal green bridge in landscape planning

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Landscape connectivity is important for the functionality and vitality of ecosystems and for the movement of wild animals. Urbanization and the linear constructions (highways, motorways, and railways) create barriers between individual habitats. Line construction designers try to include different types of wildlife migration objects into the projects and also accept the need to create different types of habitats near by the line constructions.

The research answers the questions what is the appropriate procedure for locating a green bridge in a landscape within spatial planning and how effective is green bridge in addressing landscape connectivity and mitigating barriers in the landscape? We examined the planning process of the design of the largest green bridge in Slovakia which is built above the road, a stream and a railway line. Based on the proposed criteria, we assessed the quality of the whole planning process which included the selection of the location of the green bridge. At the same time, we evaluated the green bridge from an ecological and economic point of view. The ecological losses and benefits brought by the green bridge were also assessed.

Oral presentation

Ecosystem conservation and restoration at the landscape scale: Land use change impacts and Green Infrastructure proposals for five Spanish cities.

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Green infrastructure (GI) is often associated with the restoration or creation of green space in degraded urban or peri-urban areas. However, individual interventions within city limits are rarely sufficient to safeguard key ecosystem services. Broader initiatives are necessary to restore ecological connectivity between urban areas and their wider hinterland and buffer their ecological impacts through transitional spaces with agricultural, semi-natural and natural characteristics. Urban transition zones of this kind help regulate the climate, manage water resources, preserve biodiversity and mitigate the impacts of climate change by absorbing CO₂ and other pollutants. They can also help to prevent natural disasters such as floods and landslides.

In this paper we describe the development and application of cellular automata-based land use model (APoLUS) to explore possible future land development in the surroundings of 5 Spanish cities, Madrid, Barcelona, Zaragoza, Caceres and Leon. We project land use changes based on historical tendencies to the year 2050, allowing potential future land use conflicts and areas of ecosystem degradation to be identified, in particular related to the expansion of urban areas and intensive agriculture and the loss of natural and forest land. In the context of rapidly worsening climate change impacts such as heat, floods and drought, the transformation of these urban hinterland zones along the lines implied by our model would have significant negative impacts. To address this, rather than taking a traditional “Green belt” approach, which may be ecologically incoherent as well as politically unpalatable, we propose instead a connectivity-based “Green Infrastructure” approach to ecosystem conservation and restoration in the immediate environs of these cities. Under this model, specific “at-risk” areas are purposefully connected through the integration of woodlands, agricultural areas, wetlands, and peripheral ecological corridors. Our work allows us to identify areas of priority for policy action, leading to the development of specific proposals for the creation of green infrastructure to safeguard essential services and ecosystem functions in the hinterland of major cities.

Oral presentation

Interaction among various key actors in the process of formulation Landscape Policy and preparation of the Landscape Plan methodology

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The Council of Europe Landscape Convention calls for political responsibility for the landscape. It emphasizes a transdisciplinary approach, monitoring of landscape changes, landscape planning, and the integration of landscape into sectoral policies at all hierarchical levels. Several European countries have adopted landscape policies and introduced landscape planning. The obligation to prepare landscape plans and their binding nature at individual hierarchical levels varies from country to country, as well as the connection to spatial planning.

In the Czech Republic, we haven't had coordinated and hierarchical landscape planning until now. Instead, we have a whole range of sectoral policies and instruments that deal with landscape issues. Unfortunately, their goals and measures are often uncoordinated, sometimes even contradictory. We haven't had a comprehensive document that would integrate the view of the landscape as a whole. Various actors understand spatial planning as the most important planning tool that can replace the landscape plan, although it cannot deal comprehensively with ecosystems and their functions.

Almost 20 years after the ratification of the Council of Europe Landscape Convention, we started to formulate a strategic document, Landscape Policy. The Landscape Research Institute, together with other scientific and professional organizations, began to cooperate on the document. The aim is to define the priorities for landscape policy, harmonize existing strategies, and evaluate existing tools. In this context, the Landscape Planning Methodology is also being prepared, and scenarios have been created for its integration into the current legislative framework.

However, the path to the landscape plan is thorny. The aim of our presentation will be to describe the experiences from the process of preparing the Landscape Policy and the Landscape Plan methodology. Cooperation at the level of ministries, as well as individual sectors at various administrative levels, is important in the entire process. The importance of mutual cooperation and the willingness of individual key actors to move things forward is demonstrated. The barrier is the unwillingness to listen to each other's opinions, to step out of established practices, and to accept new solutions. The inability to have a longer-than-short-term perspective and a small will to a comprehensive solution also play a role.

Oral presentation

Interventions for transforming land use planning and decision-making systems in Europe: Lessons from 12 case studies

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Land use planning and decision-making require systemic transformations through targeted interventions to address climate, environment and biodiversity, and human well-being challenges. Gaining insights into these interventions and exploring pathways for change requires transdisciplinary research that bridges civic society, businesses, practice, decision-making, and academia. Our study is part of broader efforts in the PLUS Change project, which examines how decision-making, governance and planning processes interact with diverse actors and incorporates multiple perspectives to envision future land use, providing valuable insights for decision-makers and planners. In this study, we investigated land use planning and decision-making by analysing policies and actors across the 12 different cases in Europe. We conducted mix-methods case-based research to gain insights from actor and policy surveys, and participatory workshops. The study was conducted in collaboration with practitioners, policymakers, and local stakeholders representing cases that span nature conservation, natural resource management, rural and urban development, providing diverse perspectives on land use decision-making and planning grounded in national and EU policy frameworks. The study highlighted trends and gaps associated with land use related policies and actors, as well as opportunities for transformative interventions in land use decision-making and planning. We outlined how the change could be catalysed through enhancing actor participation and collaboration, decentralising decision-making, enhanced cross-sectoral integration, strengthening policy accountability, or adapting policies to external trends and opportunities. These findings form a foundation for further inquiries into transformations in land use systems, including the scalability and applicability of interventions across diverse sociopolitical contexts with long-term impacts on climate, environment and society.

Oral presentation

Environmental Policies in Agricultural Landscape Management: Challenges for Biodiversity Conservation

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Introduction. Agricultural landscape transformations are increasingly accelerated by rapidly changing global pressures. In the context of growing demands on agricultural landscapes, biodiversity conservation policies must respond to the dramatic decline in farmland biodiversity. Thus, the research focus aims to explore policy directions focused on preserving extensive and traditional agriculture, which could also support biodiversity conservation requirements.

Methodology. In a first stage, the research aims to present the policy instruments designed to respond to the growing demands on traditional agricultural landscapes and implicitly on biodiversity conservation, in a case study on the South East Development Region of Romania. The second stage of the research focuses on emphasizing the role of the Natura 2000 network in balancing the pressures on traditional agricultural landscapes with the requirements of farmland biodiversity. We aim to analyze the implemented management measures that could influence the conservation status of the identified key agricultural habitats and species, using cause-effect diagrams and multi-criteria analysis.

Results. For Romania, among the most important environmental policy instruments aimed at reducing pressures on agricultural landscapes, in order to conserve biodiversity are: the Biodiversity Conservation Strategy; The Common Agricultural Policy, respectively the Strategic Plan 2023-2027 of Romania, with emphasis on the implementation of support schemes; the legal framework of the Natura 2000 network, including related funding programs. For the South East Region, we identified 6 natural habitats that are completely dependent on extensive agricultural management and 61 potentially protected species associated with low-intensity agricultural systems.

Conclusion. The management plan is an essential tool for an effective response to the pressures on agricultural landscapes and the biodiversity requirements in Natura 2000 sites. According to the research, management plans should integrate biodiversity conservation policies and specific measures under the Common Agricultural Policy, as well as align with the Natura 2000 network regulations, aiming to protect key agricultural habitats and species.

Oral presentation

Ecological Planning and Design Education Network for Environmental Safety through Sustainable Landscape Structure

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This contribution presents a forthcoming project aimed at managing natural hazards and disasters across Europe through spatial planning tools. The project's objective is to collaborate with universities, non-profit organizations, designers and businesses to identify fundamental principles for developing a versatile planning tool. This tool will be used in various planning processes and will assess the demand for its features among different stakeholders, including decision-makers, government authorities, local administrations, planners, and the public. The project seeks to enhance resilience and preparedness by integrating innovative planning methodologies that address the complexities of natural risks. By leveraging interdisciplinary expertise and stakeholder engagement, the project aims to create a robust framework that supports sustainable development and disaster risk reduction. The outcomes will provide valuable insights into the practical application of spatial planning tools and their effectiveness in mitigating the impacts of natural hazards.

Poster presentation

Session 3E – Sustainable Management and Communication of Changing Landscapes

Symposium

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Keywords: rural sustainable development, managing changes, gentrification, subsidiarity, local stakeholders, sustainable communication, community involvement, citizen science

Europe is changing, and so are European landscapes. If we aim to achieve long-lasting results in landscape conservation or restoration based upon skilful biotic data collection, we have to manage the changes sustainably and apply integrative methods, where community involvement and the participation of local stakeholders play an equally important role. Focussing on the interdisciplinary methods of Citizen Science, we would like to provide best practices of the interplay between ecological functions, cultural values, socio-economic factors and technology. In this context we also ask the question on How to interest geographical regions and their communities in their own ecological, social, and economical well-being? In our workshop/round table discussion, we would like to show and discuss ways of how to better understand the socio-economic changes of Europe's rural landscapes. In our work we aim to look at landscapes in a holistic way, understand the landscapes' history and dynamics, furthermore the vision for the future of their local communities. We ask also if these elements can be adequately considered when involving local citizens in scientific work? Do regional partnerships between stakeholders within a region and citizen involvement (e.g. Citizen Science), furthermore teaching and learning in general strengthen the framework and the goals of landscape conservation and restoration? What is the potential of European landscapes and their communities regarding a sustainable future? We are looking for participants who are familiar with ecological challenges and who see their communities' growing understanding of democracy, subsidiarity and the necessity of nature-based solutions as well as for discussion partners, who experience the exact opposite, e.g. the decline of socio-economic achievements of the last 30-35 years while working for the ecological restoration of landscapes.

Navigating conflict in landscape transitions – the impact of large grazers on nature-based recreation and local communities

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In the realm of biological conservation, there has been extensive discourse on the most effective methods for protecting, conserving, and restoring biodiversity. Ecosystem management using year-round large grazers has garnered significant international attention in recent years as an effective strategy for nature and biodiversity conservation, demonstrating benefits for a wide range of species through the maintenance of habitat structure. In Denmark, the implementation of large grazers, including domestic cattle and ponies, in conservation projects has seen a substantial increase. These animals have become integral to the landscape, serving as focal points for both large-scale national strategies and smaller local projects. The fundamental principle of this approach is to allow the animals to be situated on the site year-round. However, increasing the presence of large herbivores in the landscape has led to debates about whether this alienates people, such as nature-based recreational users and local communities, from the landscape. This study investigates local communities and stakeholders' perspectives on the landscape changes and how it impacts their local use of the areas. Results indicate that case-specific insights, context, and engagement approaches are important drivers/barriers to people's acceptance levels of changing landscapes

Oral presentation

Interactive spatial tools for socially inclusive integration of energy transitions and ecosystem restoration

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Compromise solutions between renewable energy infrastructure development, ecosystem restoration and other land use interests require cooperation between people with strongly diverging viewpoints and backgrounds. Landscape planning often involves a) negotiating different interests of diverse actors and b) the use of maps, aerial imagery, and spatial models as a base for negotiation and decision-making across actors. Landscape planners face the task to engage with a wide range of actors, however, not everyone involved in transdisciplinary and participatory processes is able to handle and interpret spatial information in the same way, which hinders equity. It is therefore surprising that accessibility and interpretability of spatial data are rarely questioned in the context of sustainable landscape planning.

In this talk, we will present, discuss and synthesize approaches from three different projects that aim to engage in participatory planning processes based on accessible spatial tools for landscape decision-making. These contrasting tools and approaches support inclusive negotiations and decision-making on energy infrastructure development and ecosystem restoration at the landscape level, using spatial visualizations at different scales and from different regions in the world:

- 1) An assessment of the interpretability of drone-based aerial imagery across village councils, farmers and public administrators and the potential of such imagery to improve participatory landscape planning.
- 2) An exploration and discussion on the potential use of 3D-visualizations for participatory scenarios for ecological restoration of streams and rivers in urban and rural contexts, including the use of generative AI.
- 3) An interactive GIS Tool for spatially explicit negotiations on renewable energy infrastructure allocation at municipal level with the goal to make the German energy system 100% renewable by 2040. Co-designed with municipalities, the goal of this tool is to allocate sufficient wind turbines and solar panels in the urban and rural landscape to contribute the fair share of each municipality.

The unifying features between these three approaches are that they all make complex landscape patterns and processes visible and tangible for a wide range of stakeholders with contrasting backgrounds. The spatial tools thus serve as boundary objects that help participatory landscape negotiations. However, each of the tools and approaches come with their own technical challenges and we will discuss their specific applicability for different planning purposes.

Oral presentation

The Illusion of Stability: Military Expansion and Landscape Perceptions

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The long period of relative stability in the world after the end of the Cold War created the illusion that the world had become calm again and that the future was bright. Some spoke of the end of history, while others made long-term development plans and dreamt that the landscape was set, allowing everyone to live happily ever after. However, the various crises of recent years have challenged this illusion. This paper seeks to explore this disillusionment through a case in southern Estonia, where the revitalization of a former military training area is the subject of heated debate and conflict, and where (mis)communication once again plays a crucial role in any potential resolution.

This paper has two starting points. First, there seems to be a common understanding that people resist change when they perceive the landscape they inhabit as complete, with no need for further modification. This idea aligns with the concept of climax thinking, recently introduced by Sherren and colleagues. As Sherren (2020: 2) states, “We often perceive our lived landscapes similarly as progressing from ‘pioneers’ on up to what is seen locally as a mature or ‘climax’ state.” Once this perceived optimal stage is reached, people see no reason for further change. The problem, of course, is that—just as in ecology—this climax state is an illusion. Landscapes are never truly stable, nor are they designed for a single, permanent function. People are often unaware of past changes and resistant to future alterations.

Second, the war in Ukraine and the resulting global security crisis have increased the demand for land to be used for security purposes. Large areas will remain inaccessible to humans for decades until demining efforts are completed. We are witnessing the re-emergence of military landscapes reminiscent of the Cold War era, with an increased need for military training areas and fenced borders that impact not only people but also the environment. In addition, global economic shifts are restricting various forms of communication between societies and fostering distrust. Furthermore, in recent decades, Western nations have focused on addressing the climate crisis, with much of (landscape) planning driven by environmental considerations. This raises an important question: how will security and climate concerns intersect, interfere with, or potentially undermine each other?

These two starting points define the framework for an ongoing planning debate. On one side, the Estonian Ministry of Defence seeks to (re)expand the military training ground to meet the evolving demands of global security. On the other side, local residents argue that this development would destroy their homes, alter a landscape that has remained unchanged for generations, and threaten the area's natural values.

Oral presentation

The principles of integrated water management in Slovakia

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Water management represents a broad platform in which the interests of protecting water bodies, protecting aquatic ecosystems, protecting the environment and human health from the adverse effects of water meet, and of course the platform also includes the use of water for various economic purposes. When analyzing the relationships between individual parts of the platform, it is currently possible to identify conflicting goals and interests. Moreover, in Slovakia, certain parts of the water management platform are addressed separately and there is no harmonization of the interests of individual departments. Such an approach causes problems in planning processes of landscape. The paper is therefore focused on assessing the possibility of integrating relevant segments of water management at several levels: strategic, legislative and implementation. The aim of the work is to propose a new approach to water management so that it is functional, sustainable and creates conditions for the country's water resilience.

Poster presentation

Session 3F – Conserving Biodiversity in Changing Landscapes

Symposium

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Keywords: biodiversity, nature conservation, land-use, ecosystem services, nature contribution to people, ecological connectivity

This session explores the integration of landscape ecology and conservation biology, focusing on biodiversity across multiple levels of biological organization—from genes to ecosystems—and across a range of spatial and temporal scales. It will examine the dynamics of individuals, populations, and metapopulations, as well as species, communities, and meta-communities, to understand how biodiversity patterns shift over space and time. It will address all facets of biodiversity, including taxonomic, functional, phylogenetic diversity, encompassing the entire tree of life. A core focus will be on how land use and climate change drive biodiversity change, and what are the consequences for nature's contributions to people (NCP) and overall quality of life. It will also address the strategies and actions to conserve and restore biodiversity in transformed landscapes. For example, key themes include the restoration of ecological connectivity in fragmented landscapes and the role of ecological infrastructure in sustaining biodiversity and NCP. Through an interdisciplinary approach, this session will bridge theory and practice, incorporating traditional and novel methods in field studies, data integration and modelling. Ultimately, this session will serve as a platform for discussing evidence-based conservation of biodiversity in changing landscapes.

Combing graph theory and eco-evolutionary simulations to analyse functional connectivity through time and space

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Genetic diversity loss, a key yet often overlooked component of biodiversity, affects population fitness, adaptive potential, and species extinction risk. A crucial strategy for mitigating this loss and enabling species to adapt to changing climates and landscapes is to enhance landscape connectivity. Connected landscapes facilitate species range shifts, promote gene flow among fragmented populations, and support biodiversity conservation. Assessing connectivity in dynamic ecosystems requires effective methods, yet most existing frameworks assume static landscapes. In reality, landscapes evolve due to natural processes and human-driven changes. This static assumption can lead to underestimations of available habitat and overestimations of isolation and extinction rates. Research suggests that historical connectivity often better explains present-day biodiversity patterns than current connectivity, underscoring the need for temporal dynamics in connectivity assessments. Despite technological advancements, a comprehensive methodological framework integrating temporal dynamics remains lacking, prompting calls for approaches that incorporate both spatial and temporal connectivity to improve conservation decision-making. Graph theory has been used to quantify spatio-temporal connectivity, yet existing frameworks addressing temporal dynamics are limited. Expanding the spatio-temporal framework presents a promising opportunity for more accurate assessments of connectivity. To fill this gap, I have developed a mathematical framework to represent spatio-temporal landscape connectivity using graph theory. By leveraging multi-layer networks, the framework captures the functional connectivity of species across space and time, providing a more comprehensive understanding of landscape dynamics. The framework will allow users to represent and evaluate connectivity using a variety of network metrics and will be implemented as an R package, LandscapeConnectR. A key strength of LandscapeConnectR will be the seamless integration with the R package of the eco-evolutionary modelling platform RangeShifter (<https://rangeshifter.github.io/>). This integration will enable users to perform in-depth connectivity analyses following their process-based simulations. By linking eco-evolutionary dynamics with spatio-temporal connectivity analysis, the package will enhance the ability of researchers and conservation practitioners to make informed decisions about managing habitats and conserving biodiversity. LandscapeConnectR will provide a powerful methodological framework to advance connectivity research in an era of environmental change by overcoming the limitations of static models and incorporating temporal complexity.

Oral presentation

Mobilizing opportunistic records to infer land use and climate change impacts on biodiversity trends: macrolepidoptera in the Finnish landscapes

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Assessing the drivers of distributions and dynamics of biodiversity at large spatial and temporal scales is challenging. The development of “citizen science” and the extensive data provisioning it offers is often viewed as a great opportunity to address these challenges. However, such data may include geographical biases and irregular sampling intensity over time that need to be managed. Using the example of macrolepidoptera in Finland, we explore how opportunistic records can be used to infer the combined and interactive effects of land use and climate change on biodiversity. Over 4 million species occurrences spanning from 1993 to 2022 were extracted from the Finnish Biodiversity Information Facility (FINBIF). We used accumulation curve analyses and careful data filtering to explore how the macrolepidoptera species richness have changed in Finland at three spatial scales: nationwide, in the 21 bioregions, and in 10x10km grid squares. The results show a general increase in species richness at all spatial scales. However, the changes were more pronounced in the northern bioregions. In addition, local trends were more diverse as species richness significantly decreased in a minority of the 10x10km squares. The proportion of 10x10km squares experiencing decline in species richness increased over time, showing accelerating biodiversity loss in some areas. Finally, biological traits analysis showed winner (generalist and good dispersers) and loser (overwintering as larva) species, suggesting ongoing decline of particular species and biotic homogenization. Further analyses will be conducted to examine how observed changes are linked to land use and climate changes at the finest scale. We conclude that understanding the drivers of biodiversity changes can support conservation efforts by identifying landscape features that mitigate or exacerbate the impacts of climate change.

Oral presentation

Identifying Alpine-Dinaric macro-regional ecological connectivity using the Continuum Suitability Index

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Ecological connectivity between biodiversity-rich Alps and Dinaric Mountains is increasingly important in the context of climate change, as species migrate northward and to higher altitudes. To assess the current state of landscape connectivity and identify key geographical areas for preservation of species movement and the flow of natural processes between northern Greece and northern Italy we used the Continuum Suitability Index (CSI) in combination with a least-cost path (LCP) model.

Our analysis revealed that 21.2% of the study area exhibited high permeability with functional ecological linkages named Strategic Connectivity Areas (SACA1). The proportion of national territory assigned to SACA1 varied considerably among countries from 7.2% in Bosnia and Herzegovina to 31.3% in Albania.

Existing environmental protection covered 82% of the SACA1 area; however, there were notable differences between EU and non-EU countries. On the other hand, a considerable proportion of nationally designated protected areas fell outside SACA1 in Slovenia (52.9%), Croatia (47.0%), and Greece (36.1%). These countries also had the most fragmented landscapes, as indicated by low average fragmentation indicator values.

The identified macro-regional LCP covered 105,669 km², interlinking 52% of the SACA1 surface. The highest proportion of the identified south-north connection was under environmental protection in Slovenia (79.4%), Croatia (63.7%), and Greece (43.5%). Nearly half of the SACA1 were of transboundary, highlighting the need for coordinated cross-border conservation efforts and spatial planning.

Our structural connectivity model provides valuable insights for policymakers at the macro-regional scale. However, future research should focus on functional connectivity at local and regional levels.

Oral presentation

Hiding inequalities behind richness: how urban landscapes shape wild bee communities.

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Post-industrial landscapes such as the one found in Northern Europe Belgium are home to an impoverished community of pollinators, probably as a byproduct of ever increasing urbanisation and intensive agriculture. Yet, cities within this kind of environments have been found to host surprisingly diverse assemblages of bees around the globe. As a result, local policies may want to take advantage of this phenomenon as a lever for conservation, rather than extending their network of nature reserves. However, the apparent richness found in urban areas may actually hide ambiguous patterns of diversity, especially when it comes to the distribution of rare or endangered species.

Our aim was to determine the effect of urbanisation on wild bees richness and evenness using increasing orders of entropic diversity. Conservation significance was also assessed by quantifying IUCN threatened species. The relative significance of protected areas in the conservation of wild bees was examined by comparing their patterns of diversity to the one found in unprotected areas. Our results suggest that while urbanisation may not have a positive effect on raw species richness, urban areas harbor a more diverse set of dominant species, albeit with a conspicuous absence of threatened ones. Conversely, nature reserves may superficially look as diverse as other types of sites, but they do concentrate rare and declining species.

This research underscores the need for a nuanced approach to biodiversity conservation, emphasizing the unique contributions of nature reserves in safeguarding vulnerable bee species.

Oral presentation

Conserving Red List Species through Managing Landscape Fragmentation and Permeability

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Habitat fragmentation represents a major threat to vulnerable plant species listed on the IUCN Red List, affecting seed and pollen dispersal, reducing natural regeneration, and disrupting ecological flows. At the opposite end, landscape permeability naturally supports genetic flow and species dispersal, helping populations remain connected. Managing landscape fragmentation and permeability can be a useful tool in prioritising conservation actions.

This study aims to identify populations of these species and assess connectivity to support their conservation within a fragmented landscape in Transylvania, which still preserves valuable natural elements. By integrating species distribution data with GIS models, biodiversity hotspots are identified, and landscape permeability is evaluated, considering the habitat preferences of target species and environmental variables. Using the Linkage Mapper tool, potential connectivity pathways between fragmented populations are analysed based on the permeability characteristics of the landscape.

The results highlight priority areas for conservation, identifying favourable zones that can be connected to support species survival. The study also underlines the importance of traditional agricultural landscapes in maintaining ecological connectivity, as they provide corridors and refuges for vulnerable species. Ensuring long-term success requires the involvement of local communities and the promotion of traditional farming practices that help preserve the integrity of natural habitats.

This study provides a scientific approach to managing landscape fragmentation and permeability for the conservation of Red List species, combining spatial analyses with community engagement strategies.

Oral presentation

Forest management: effects on Great Tits' breeding success and nestlings' health status

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European conservation strategies have emphasized habitat heterogeneity to maintain forest biodiversity and strengthen forest resilience. While diverse habitat structures can improve habitat quality and resource availability for forest birds, little is known about how forest management influences their breeding success and health status. We assessed how habitat parameters associated with forest management (e.g., forest type and forest use intensity) affect Great tit (*Parus major*) breeding success and nestlings' health status. We used a multi-scale approach to disentangle potential effects from the immediate surroundings of the nest box to the landscape level. We regularly monitored 40 nest boxes across forest types (i.e., beech vs. mixed forest stands) and forest use intensities (i.e., core zone and management zone) in the Vienna Woods Biosphere Reserve, Austria, in the 2024 breeding season. We used morphological asymmetry and the scaled mass index (SMI) as proxies for health status. We measured clutch success (by determining clutch size), hatching success (by the proportion of hatched eggs), and nestling success (by the number of live chicks on day 15). We found that clutch size was explained by the elevation in the immediate surroundings of the nest box and by the average temperature during the laying period for the nest box and the territory level. In addition, the proportion of spruce and pine around the territory had a positive effect on clutch size, whereas area-weight mean patch size had a negative effect. Hatching success was positively associated with the proportion of oak in the territory and area-weight mean patch size, whereas the proportion of spruce and pine around the territory was negatively associated with hatching success. Regarding the nestlings' health, ectoparasites were negatively associated with SMI at all levels (i.e. the nest box, the territory, and the landscape level). Overall, this study highlights that forest composition and configuration influence Great Tit breeding success and nestlings' health status under current forest management.

Oral presentation

Historical legacies of changing landscapes in the Swiss plateau and its impact on biodiversity

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Biodiversity in changing landscapes is shaped not only by contemporary habitat configurations but also by historical legacies that persist through time-lagged ecological processes. In the Swiss Plateau, past landscape structures continue to influence present biodiversity patterns, revealing mechanisms that extend beyond immediate species-habitat relationships. This synthesis draws from three studies investigating how historical habitat availability and metacommunity structures shape present-day species diversity. First, by identifying metacommunities based on historical habitat networks over 110 years, we show that augmenting spatial metacommunity delineation with historical proximity strengthens associations with biodiversity patterns. Metacommunity spatial extents defined by past configurations more accurately reflect beta and gamma diversity than those based solely on present-day landscapes.

Second, an analysis of habitat availability over 113 years demonstrates that historical trajectories significantly predict contemporary species occurrences. Time-series clustering of habitat availability identifies strong time-lagged responses, with habitat availability from 1933 showing the highest correlation to current species richness. This underscores the importance of considering long-term habitat dynamics rather than relying only on contemporary landscape assessments.

Third, metapopulation persistence is explored through the lens of species traits, landscape metrics, and simulated landscape trajectories. While habitat area remains a crucial factor, species persistence is further shaped by dispersal processes and competitive interactions. Simulations reveal that varying rates and magnitudes of landscape change create diverse persistence outcomes, with patterns driven by interactions between species traits and historical landscape trajectories.

Together, these findings highlight the necessity of integrating historical landscape data into biodiversity research and conservation planning. Time-lagged mechanisms ensure that past legacies persist in present biodiversity estimates, reinforcing the need for conservation strategies that account for both spatial and temporal complexities of landscape change.

Oral presentation

Enhancing Urban Forest Connectivity: A Multispecies Modelling Approach in Helsinki

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Enhancing and conserving connectivity is essential for the viability of populations, species' persistence and thus biodiversity more broadly, particularly in fragmented urban landscapes. Nevertheless, we still have limited knowledge about how the characteristics of different species affect functional connectivity in urban contexts. There is a need for multispecies connectivity studies in urban contexts which capture the fine-scale habitat requirements and species tolerance of the matrix. Ideally, these approaches are embedded in relevant city planning processes to maximize functionally connected urban greenspace networks.

We modelled connectivity of urban forests based on a green wedge configuration in Helsinki with three contrasting species: Siberian flying squirrel (*Pteromys volans*), common lizard (*Zootoca vivipara*) and European crested tit (*Lophophanes cristatus*) using expert-based parameters. We first created fine grain size and species' specific land cover data to identify species' specific requirements for habitat and effect of the matrix on landscape resistance. We used Graphab and Circuitscape to model the current connectivity. We then compared current connectivity with intended existing connections and future connections to test functionality of these city plans developed by the city of Helsinki.

We found that the green wedges were isolated for all the three species. However, we found clear species-specific differences. For example, whereas the crested tit's dispersal was limited by habitat and landscape resistance, the flying squirrel was more swiftly capable of dispersing within the matrix, if only tall-enough trees exist. The landscape was highly fragmented for common lizard, our representative of short-distance disperser and terrestrial species. City plans of existing connections were excessively optimistic for connectivity, whereas planned future connections enhanced connectivity, particularly if they are of high-quality.

We suggest a webbed forest network with new habitats and high-quality connections between the wedges. The new green infrastructure should be tailored spatially for different species' groups. Multispecies functional connectivity is essential in city planning to support biodiversity and to highlight the various needs of species.

Oral presentation

Integrated spatial planning for the identification of conservation and restoration opportunities in a cross-border region

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Many landscapes under conservation management are under increasing pressure by societal demands, climate change and non-enforcement of environmental policies. Conservation and restoration, if carefully and strategically implemented, can help to bend the curve of biodiversity loss while maximizing benefits of Nature contributions to people. We investigate conservation and restoration options within Lake Neusiedl / Fertő and the surrounding cross-border region, situated in Austria and Hungary. This region contains the largest central-European endorheic lake, rare ecosystems such as soda pans and provides a habitat for many endangered species. Critically it is a cultural landscape with a complex governance system, competing sectoral demands between agriculture, water management, and future climate risks, give rise to a series of conflicts with biodiversity.

Here we present the first results of an integrated spatial planning assessment at landscape scale. Using state-of-the-art remote sensing, machine learning and spatial optimization approaches, we identify conservation and restoration priorities for this landscape. Particular focus is placed on how societal demands and values, evaluated from stakeholder interviews, can be met by jointly determining benefits for biodiversity and people, for instance by aligning resource (water) and land demands. Our results highlight in a spatially-explicit and data-driven way opportunities towards implementing nature-positive regional policies and management actions.

Oral presentation

Connecting Green Spaces for Urban Biodiversity Conservation: A Case Study of Tangerang Selatan, Indonesia

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Rapid urbanization has significantly impacted biodiversity and fragmented habitats, extending from urban centers to their peripheries. Southeast Asia, including Indonesia—a global biodiversity hotspot—faces escalating threats from urbanisation. To prevent further biodiversity loss, it is crucial to identify and connect each type of public and private urban green spaces in urbanising areas before they are lost to development. This study aims to examine ecological connectivity in periurban Jakarta, focusing on mammal guilds in Tangerang Selatan, a rapidly developing city in Banten province in the Jakarta Metropolitan Area. Using GIS-based connectivity models and land use maps, we assessed habitat fragmentation and identified potential movement patterns for different mammal dispersal groups. The results revealed that small-sized mammals perceive the landscape as highly fragmented, while larger mammals benefit more from existing connectivity. However, such suitable connectivity of large enough patches was only present in the southwestern part of the city. Key habitat patches and ecological corridors were identified as critical for facilitating species movement and mitigating fragmentation impacts. The study examines peri-urban areas like Tangerang Selatan, where emerging private cities such as BSD City is located, to assess their role in supporting green space connectivity and their potential for integrating ecological connectivity into urban planning in rapidly urbanizing regions.

Oral presentation

Biodiversity in Agroforestry landscapes

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Biodiversity loss and climate change are the twin challenges of future agricultural landscapes. What if there were opportunities to tackle both challenges with holistic actions? Agroforestry is a traditional agricultural practice which has been rediscovered and modernized for the European context in recent years. It offers the opportunity to mitigate climate change through tree planting and improve biodiversity through enhanced habitat availability while minimizing economic conflicts. Therefore, novel agroforestry systems have been reestablished in many (European) countries.

For meeting the environmental objectives for biodiversity in agricultural landscapes, it is essential to monitor the effect of these systems on biodiversity. In a Swiss case study, acoustic loggers were used to study the effect of agroforestry systems in cropland on bird diversity, as compared to arable fields without trees. The recordings were analysed using the bioacoustic software BirdNET. We assessed the difference in bird communities between agroforestry and arable fields, focussing especially on priority species as specified in the Swiss agri-environmental objectives. The results show no effect of young agroforestry systems, but positive effects of older systems. Especially priority species benefit from agroforestry, while there are loser and winner species. There was also an important role of the surrounding landscape context which influenced bird diversity in the studied systems. The results contribute to the understanding of the effect of establishing agroforestry systems on bird diversity and highlight the importance of considering landscape perspectives in such evaluations. The outcomes can help to build multifunctional agricultural landscapes by balancing the needs of nature and society.

Oral presentation

Conserving biodiversity in cities: the importance of multi-species habitat connectivity in urban planning and mitigation actions

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Land use changes caused by urbanization are one of the main reasons for biodiversity loss. Urban development decreases the amount and quality of habitats but also reduces habitat connectivity, which is a crucial component for the long-term persistence of species. To mitigate biodiversity loss caused by development projects, policies supporting no net loss (NNL) of biodiversity have been widely adopted. The NNL of biodiversity can be achieved by following the mitigation hierarchy, where impacts of development should first be avoided, then reduced and restored, and finally, remaining impacts should be offset. However, NNL rarely accounts for habitat connectivity and is usually assessed for one project at a time, thereby ignoring the effects of multiple projects on landscape-level connectivity. This study aims to develop methods for conserving multi-species habitat connectivity. By applying the mitigation hierarchy to landscape-level land use planning, we seek to achieve NNL of connectivity for biodiversity during urban development. We will use the city of Jyväskylä as a case study, but the aim is to develop flexible and robust methods to diverse urban areas and development scenarios. Our methods will integrate species distribution modeling, incorporating opportunistic species records and urban-specific environmental variables, with spatial graphs representing multi-species connectivity. The effect of urban development on multi-species connectivity and optimal mitigation actions needed to reach NNL of connectivity will be assessed using scenario analyses and spatial statistics. We will study and account for various types of uncertainty associated with the modeling approaches at each step of the process. The results will improve city land use planning and advance the ongoing research about connectivity conservation and biodiversity offsetting. Ultimately, our goal is to provide practical solutions for sustaining ecological networks in dynamic urban environments while promoting biodiversity to enhance climate resilience and human well-being.

Oral presentation

A landscape approach to the identification of agricultural genetic resource hotspots in Norway

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The value of genetic resources in agriculture is hard to overestimate as they are decisive for food safety, provide options for adaptation of future diet needs, and underpin a vast amount of biodiversity. To enable an effective conservation of these resources, we need knowledge about where they are located. The EU project GenRes Bridge showed that this knowledge is indeed modest at the European level. A source of genetic resources with particular potential for use in agriculture, e.g. related to the future adaptation to climate change, are crop wild relatives (CWR). Crop wild relatives are plant species categorized as wild relatives of cultivated plants and are used here as an indicator of genetic resources in the landscape. We therefore wanted to explore new ways of identifying hotspots of genetic resources, highlighting the landscape as a starting point. It is well established that landscape heterogeneity is closely related to biodiversity, although to our knowledge studies hitherto have rarely looked at the relation between landscape and genetic resources. Focusing on crop wild relatives, used here as an indicator for genetic resources in the landscape, we wanted to assess whether we could identify how landscape variation in topography and land cover has consequences for the spatial distribution of genetic resources that may be important in the future development of agriculture.

Here we report the results from this pilot study where we have tested whether there is a correlation between landscape heterogeneity and agricultural genetic resources, using 5 x 5 km grid cells as spatial units. We used the presence of the crop wild relatives (CWR) which are prioritized for conservation in Norway as indicators of agricultural genetic resource diversity and extracted landscape heterogeneity descriptors from publicly available sources. The results from our study do suggest that landscape diversity could be a path worth following in searching for these resources in the landscape, and thus also important in decision-making on planning and management in these diverse landscapes.

Oral presentation

Using eDNA metabarcoding as a tool to monitor biodiversity across different landscapes

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Biodiversity monitoring plays a critical role in assessing ecosystem health, identifying shifts in species distributions, and guiding effective conservation strategies. Recent advancements in environmental DNA (eDNA) offer a non-invasive and efficient biomonitoring tools, enabling the detection of biodiversity across a wide range of ecosystems. Specifically, moss-accumulated eDNA has emerged as a promising tool for monitoring terrestrial vertebrates, providing a passive, long-term source of environmental DNA that can be sampled without direct disturbance to the habitat. Here, we explore the potential of moss-accumulated eDNA to detect vertebrate diversity across different landscapes along a tropical elevational gradient in Peru. We sampled moss patches across a diversity of habitats including Puna grasslands, elfin and cloud forests, varzea and terra firme habitats within tropical rainforests spanning elevations from 400 m to 3,010 m above sea level. We will characterize both bird and mammal communities from the moss samples through eDNA metabarcoding. Overall, the results will offer a unique opportunity to investigate the possibility of surveying biodiversity and community changes across a broad elevational and ecological gradient using moss-accumulated eDNA. Furthermore, we expect the method to capture a range of cryptic species that are difficult to detect with traditional techniques. This study will provide valuable insights into the applicability of moss-accumulated eDNA as a tool for monitoring biodiversity in tropical ecosystems and contribute to the development of cost-effective, non-invasive approaches for conservation efforts in changing landscapes.

Oral presentation

Effects of the surrounding landscape on hedgerow-associated plants and arthropods

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Hedgerows in agricultural landscapes are ecologically important because they provide habitats and other resources to a wide range of species. Especially when possessing a hem, they incorporate a gradient from closed habitats similar to forests to open-land conditions. In addition, they are assumed to make a contribution to habitat networks by connecting habitats. The effects of local, hedgerow-specific characteristics such as height or woody species composition are well-known for many species. In contrast to this, the effect of the surrounding landscape, including the effect of the landscape-level hedgerow density, on hedgerow-associated species has been studied to a much lesser extent. Within the project “CatchHedge – Carbon sequestration of hedgerows and field copses” of the Thünen Institute of Biodiversity in Germany we analyse landscape effects on hedgerows in agricultural landscapes. We want to find out which landscape parameters influence the occurrence of plant and arthropod species (total and trait-based groups). One of our main questions is: Does the density of hedgerows in the surrounding landscape have an effect and if yes, how many hedgerows are needed to support biodiversity? Field work was done in 2023 and 2024 in 7 (plants) and 8 (arthropods) regions, respectively, across Germany, with 3 to 6 sampling points in each region. Mostly, sampling points were located at different hedgerows. At some sites, two sampling points were located at one hedge that was at least 160 m long (100 m distance between sampling points and 30 m distance from sampling point to end of the hedgerow). We investigated hedgerows and their hems at agricultural fields. We examined the plant species, their cover and structure applying the Braun-Blanquet scale within 32 plots of 25 m², and several arthropod groups which were caught using three funnel pitfall traps per sampling point at 34 sampling points in total. In a first step, regression models are calculated with species number as the dependent variable and local and landscape parameters (e.g., hedgerow density, density of vegetated strips such as margins, share of different land-use types, in different radii of up to 1000 m) as explaining variables. In a following step, we are going to conduct a connectivity analysis on both the plant and animal data to further analyse the role of hedgerows as connecting elements and prerequisites in terms of placement in the landscape.

In my *Oral presentation* I would like to present the current results of my work and discuss the resulting implications.

Oral presentation

Global impacts of habitat loss and fragmentation on forest vegetation phenology and ecosystem function

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Plant phenology, the annual recurring events in the plant life cycle, serves as a crucial indicator of environmental changes. Phenological shifts significantly influence ecosystem functions and services, such as plant productivity and carbon exchange. Therefore, understanding the drivers of phenology changes and their ecosystem-level consequences is essential for effective ecosystem conservation and management strategies. Although existing research has established clear connections between phenology and various abiotic and biotic drivers, including climate change and plant functional traits, the critical roles of habitat loss and fragmentation on phenology remain poorly understood. These processes, recognized as primary threats to biodiversity and ecosystem integrity, create heterogeneous environmental conditions (e.g., light availability, wind patterns, and temperature regimes) that potentially influence plant phenology. In this study, we focus on global forest ecosystems, which have undergone and continue to experience substantial area reduction and fragmentation. We aim to quantify the independent effects of habitat loss and fragmentation on phenology and ecosystem function, and clarify when and how these processes matter. We analyzed global patterns of habitat amount (proportion of forest area), habitat loss (difference in habitat amount between 2000 and 2020), and habitat fragmentation (number of forest patches). Our preliminary findings show that both habitat amount and fragmentation have a direct positive effect on the length of growing seasons. Habitat amount demonstrates direct and indirect positive effects on net primary productivity (NPP), mediated through growing season length. Fragmentation exhibits a direct negative but indirect positive effect on NPP, also mediated through growing season length. These effects, however, show significant variation across ecosystem types and depend on the degree of habitat loss.

Oral presentation

Methods to prevent bird-window collisions in urban environment

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This study examines bird-window collisions in urban environments, emphasizing the evaluation of protective measures to mitigate their impact. Glass surfaces near vegetation frequently reflect their surroundings, creating the illusion of open space for birds, leading to high mortality rates due to fatal impacts. As urbanization progresses and glass architecture becomes more prevalent, this issue is intensifying, necessitating effective interventions to reduce avian fatalities.

Our research employs targeted monitoring using strategically placed cameras in high-risk locations to systematically document collision occurrences. By analyzing spatial and temporal patterns of bird strikes, we aim to identify key environmental and architectural factors contributing to these incidents. In addition, we conduct a comparative evaluation of various protective elements currently implemented to prevent collisions, ranging from stickers to UV-reflective materials. Understanding the efficiency of these mitigation strategies will allow for data-driven recommendations for urban planners, conservationists, and policymakers.

Beyond its ecological significance, addressing bird-window collisions has broader implications for biodiversity conservation and urban sustainability. By identifying the most effective prevention methods and the primary risk factors associated with collisions, this study seeks to contribute to the development of evidence-based solutions that can be adapted to various urban settings. The findings have the potential to significantly reduce avian mortality and support the long-term preservation of bird populations, not only within Slovakia but across urban landscapes globally.

Oral presentation

Conservation aspects of traditionally managed chestnut orchards. An example from the Emilia-Romagna landscape (Northern Apennines)

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Traditional management of agro-forestry ecosystems has played a central role in the cultural, economic and environmental heritage in Europe, with *Castanea sativa* orchards being a key element of the mid-mountain southern European areas. The chestnut orchards landscape has been maintained through the centuries with low-intensity management regime involving the mowing or grazing of the understorey vegetation and the pruning of trees. These practices, which act as an intermediate disturbance, together with the open forest aspect, make chestnut orchards able to support a high-level vascular plant diversity. Biodiversity encompasses several species of conservation interest, which are at risk of disappearing with the cessation of management practices. This aspect constitutes a further element in favour of the maintenance or recovery of chestnut orchards.

In Spring 2021, we started a voluntary collaborative project aimed at collating a database of plant species of chestnut-dominated formations (Habitat 9260, according to the Council Directive 92/43/EEC) of the Emilia-Romagna region. The database comprises data collected during the project and previous records, including those derived from herbarium samples, historical textual sources, and floristic and vegetation surveys. The earliest documented record dates to the second half of the 18th century (*Cephalanthera rubra*). The database was further enriched with contributions provided by chestnut growers. In this paper we focus on species of conservation interest (rare and/or protected) within chestnut orchards. A large amount of the species of conservation interest are orchids. The most frequent is *Dactylorhiza maculata* subsp. *fuchsii*. The other species are mainly typical of open habitats (i.e. *Dactylorhiza sambucina*), followed by those of mixed oak or lower-mountain beech woods (*Platanthera* spp., *Cephalanthera* spp.) Among orchids, some are extremely rare in the region (e.g. *Dactylorhiza insularis*), and some expand (e.g., *Himantoglossum adriaticum*). Data about species of conservation interest were analyzed through the environmental and management gradients over the Emilia-Romagna landscape to find frequency and local specificity. Our research allowed us to detect two interlaced points: biodiversity could act as an additional strong point for preserving traditionally managed chestnut orchards, and chestnut growers and owners could act as custodians of this biodiversity.

Oral presentation

Research trends in ecological studies on the effects and drivers of Solidago invasion

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North-American goldenrods (*Solidago* spp.) rank among the most ecologically impactful invasive plant species, capable of reshaping entire ecosystems through habitat modification and competitive interactions. Despite extensive research on their invasion dynamics, critical knowledge gaps remain. Are the effects of *Solidago* invasion predominantly negative, or can they also be neutral or even beneficial? Which landscape types and habitats are most frequently affected? Furthermore, which *Solidago* species are most frequently studied, and what is the prevailing trend in research regarding temporal scale - do studies primarily focus on short-term impacts, long-term consequences, or intermediate timescales? An equally pressing issue concerns the methodical aspect of invasion research. How are data collected and analysed? Which traits are prioritized as explanatory versus response variables? Addressing these questions is crucial for improving predictive models and refining conservation strategies.

To answer these questions, we conducted a systematic review of 307 peer-reviewed studies from the Scopus database, selected using a carefully designed keyword search. Our analysis involved study selection, categorization, data extraction, and synthesis of findings. A central aspect of our review is to explore both sides of the invasion process, the impact of *Solidago* on ecosystems and the influence of ecosystem conditions on its success. We identify the most commonly reported ecological effects, key drivers facilitating its spread, and the interactions with other organisms that underpin its invasiveness. Additionally, we examine how research biases, such as geographic and habitat preferences, may shape study outcomes. Our review also highlights the diversity of methodical approaches, from field observations to controlled experiments, and evaluates trends in data usage for statistical analyses. The insights gained from this review may contribute to the development of more effective conservation strategies, aimed at both controlling the spread of this species and preserving biodiversity.

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Oral presentation

Implications of carnivore context-dependent behaviour for connectivity conservation in Europe's evolving landscapes

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As large carnivore populations recover across Europe's modern landscapes, urban expansion and climate change pose challenges to their survival, increasing human-wildlife conflicts and hindering their movements. Securing habitat linkages and movement corridors for these species is essential for individual adaptability and coexistence in human-modified landscapes. Moreover, the long-term viability of carnivore populations contributes to the success of biodiversity conservation efforts in Europe. Among the four European large carnivore species, the brown bear (*Ursus arctos*) shows a broad range of behavioural adaptations in response to anthropogenic and environmental changes. Thus, this species serves as a good biological model to study landscape connectivity and inform conservation efforts for carnivores in the face of future developments. Here, we investigate brown bear connectivity patterns across three different scenarios of human alteration: Finnish-Russian Karelia, Slovak Carpathians and Romanian Carpathians. Using GPS data of 108 brown bears, we integrated step selection analysis and circuit theory to identify (a) movement preference (b) identify dispersal corridors across the three geographical contexts. Preliminary findings reveal population-specific movement strategies in response to human features, emphasising the role of local conditions in shaping individuals behavioural traits. Our main aim is to produce more realistic, robust and ecologically meaningful connectivity assessments, contributing to the improvement of human-carnivore coexistence in Europe's evolving landscapes.

Oral presentation

Factors affecting urban vegetation change and its implications for ecological maintenance

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In recent years, urban vegetation has been recognized as an interesting source of biodiversity and a refuge for relict species and vegetation types. Understanding the dynamics of urban vegetation can lead to better utilization of its potential for mitigating climate change, biodiversity loss, and increasing the resilience of urban landscapes. In our research, we focused on analyzing landscape and vegetation changes in three Czech cities – Prague, Kladno, and Žatec. In these cities, stratified sampling was used to conduct phytosociological surveys of representative habitats along a gradient from the city outskirts to their historical centers. Data were collected in 2006 and the survey was repeated in 2024. The data were processed using Turboveg and Juice software, and the influence of environmental factors on the current state of vegetation was assessed using multivariate analysis. The environmental factors we hypothesized to be highly significant included distance from the center, moisture conditions, nutrients, light conditions, surface structure, and the intensity of human-induced disturbances. Additionally, the influence of city size and history was tested, evaluated based on three map sources – the stable cadastre, aerial photography from the 1950s, and orthophotos from 2003. Of the original set of 128 vegetation plots, only 88 remained in 2024, with the rest having disappeared between the two time points. Younger habitats on the city outskirts disappeared more frequently, while older habitats, present since the stable cadastre, survived in the urban landscape to the present day. Greater dynamics of vegetation changes and species spectrum changes were observed in Prague and Kladno, while the smaller city of Žatec was significantly more conservative. Distance from the center is a good indicator of "urbanity" in smaller, simply structured cities like Žatec, whereas it plays almost no role in the decentralized mining city (Kladno) or the metropolis (Prague). Factors with a predominantly significant influence on vegetation change include human disturbances and history (smaller city), light, nutrients, and xerothermic conditions (larger city). In all cities, the Shannon-Wiener biodiversity index and soil reaction significantly decreased over the observed period. The results suggest that urban vegetation is becoming simplified and impoverished, especially in larger cities. Practically, it is recommended to support the biodiversity of short-lived and edge-located habitats, which are most threatened by extinction, primarily due to rapid suburbanization of the landscape.

Oral presentation

Graph theory-based connectivity models as a potential management tool for endangered grassland habitats in an anthropogenically influenced mountain protected area: the example of the Krkonoše Mts National Park.

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The mountain grassland habitats of the Krkonoše Mts National Park represent a crucial part of biodiversity at both the regional and Central European scale.. These anthropogenically shaped habitats, largely dependent on traditional extensive farming, are currently facing an ongoing threat due to land abandonment, changing agricultural practices, and increasing tourism pressure. The fragmentation and loss of habitats threaten the ecological stability of these semi-natural grasslands, making a connectivity assessment necessary for their conservation and management

The study presents a graph theory-based connectivity models to design a potential ecological networks for endangered grassland biotopes in the Krkonoše Mts region. The analysis, using variety of softwares (such as Linkage mapper, GUIDOS, Circuitscape) integrates Least-Cost Path (LCP) models and Circuit-based connectivity assessments to identify core areas, stepping stones, and potential dispersal corridors. Additionally, structural characteristics derived from landscape fragmentation indices provide insight into the degree of anthropogenic impact on connectivity.

Initial results indicate a fragmented spatial distribution of habitats, with key corridors disrupted by urban expansion, infrastructure development, and increased tourism density. Graph theory-based modeling highlights alternative dispersal routes, which could enhance ecological permeability if properly managed. The findings emphasize the necessity of an adaptive landscape planning strategy, integrating ecological network principles with sustainable land management to mitigate the ongoing degradation of these areas.

Study demonstrates the potential of connectivity modeling as a decision-support tool for biodiversity conservation of specific habitat types. By refining connectivity frameworks, integrating them into existing ecological stability networks, and adapting conservation strategies accordingly, we propose an approach that can help preserve the remnants of these slowly disappearing habitats.

Oral presentation

Bridging theory and practice: Supporting management strategies for mountain hay meadows in Europe

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Species-rich grasslands such as mountain hay meadows (MHM) make an important contribution to biodiversity conservation. As semi-natural grasslands, the maintenance of their typical species composition depends strongly on regular human activities such as mowing or grazing animals. Although MHM are a strictly protected habitat type under EU law, there are currently few clear recommendations on how to manage MHM to maintain or restore a good conservation status. Reason for this is also the diversity of MHM in terms of their floristic characteristics and underlying site factors. This leads to uncertainty for farmers, but also many open questions for advisors. The relevance of these knowledge gaps is mirrored not to the least in recent Court ruling (November 2024) against Germany for failing to adequately protect the MHM habitat type protected as part of the Natura 2000 network. Building on this background we aim to answer the following questions:

1. How can MHM in a good conservation status be categorised in terms of site factors and vegetation characteristics?
2. Which management practices are associated with MHM in a good conservation status?

To answer these questions, we apply a mixed-methods approach. We start with an analysis of vegetational characteristics and site conditions of 19 selected MHM in a very good conservation status in Austria and Germany. This is complemented with semi-structured interviews with farmers managing these best-practice sites, yielding detailed information on management practices as well as the history and the socio-economic and cultural context of the meadows. Vegetation and site characteristics and management practices fostering a good conservation status are integrated, leading to a typology of MHM and their management. In order to further refine and substantiate this typology and obtain robust management recommendations, we conduct a review of scientific literature on the linkages between management practices and conservation outcomes for semi-natural grasslands. By integrating local analysis and management insights with scientific findings, this study bridges the gap between theory and practice, providing an evidence-based framework for assessing and optimizing management strategies that effectively support the long-term conservation of MHM and other semi-natural grasslands.

Oral presentation

Assessing the impact of landscape structure and management on selected ecosystem service providers within agricultural systems across Europe: insights gained from spatially explicit simulations of species population dynamics

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The ongoing loss and simplification of natural habitats, coupled with the intensification of agricultural practices and increased agrochemical application, significantly contribute to biodiversity decline, making conservation a critical issue within agricultural landscapes. In this study, we utilized high-resolution dynamic landscape models and advanced spatially explicit population modeling to evaluate the impact of landscape structure and management on the population dynamics of selected ecosystem service providers (ESPs) in agricultural landscapes across Europe. We selected 60 landscapes, each 10x10 km, located in six countries (Poland, Denmark, Germany, France, Finland, and the Netherlands), representing various pedo-climatic zones and cropping systems of Europe. Highly detailed, dynamic landscape models of these areas were generated, integrating information on land use and land cover, agriculture, vegetation, and soils. These models capture landscape and agricultural heterogeneity with a spatial resolution of 1m² and simulate daily changes in vegetation patterns and farming activities associated with each crop, farm, and field.

These landscape models formed the basis for an integrated system to test the impacts of altered management practices. To realize this system, landscape models were combined with a set of species models within the ALMaSS (Animal, Landscape, and Man Simulation System) open-source modeling framework. The model species represented key animals in agricultural systems, chosen to represent pollination (*Osmia bicornis*), pest control (*Bembidion lampros* and *Erigone atra*), and vertebrate biodiversity objectives (*Alauda arvensis* and *Lepus europaeus*).

We tested various management scenarios, including modifications to crop rotations (e.g., increasing set-aside), farming operations (e.g., reducing the toxicity of applied pesticides), and landscape structure by introducing additional field margins and flower strips. Simulations were run using high-performance computing resources, and we analyzed changes in population size and the Abundance Occupancy Ratio index, which accounts for changes in spatial distribution.

Overall, field margins and set-aside were found to have the most positive effects across all species. This confirms the importance of semi-natural linear structures in agricultural landscapes as a measure to support multiple species, including beneficial invertebrate predators, pollinators, farmland birds, and small mammals. Our analysis highlighted the critical role of local context in determining species responses to landscape and farm management.

Oral presentation

Bumblebee Response to Flooding Events

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Bumble bees (*Bombus* spp.) are essential pollinators in terrestrial ecosystems, yet their populations face escalating threats from climate change, including more frequent and intense flash floods. These sudden, unpredictable events can inundate ground nests—a primary habitat for many species—potentially disrupting colony development, foraging behavior, and survival. Despite their ecological significance, the specific effects of flash floods on active bumble bee colonies remain unclear, with research gaps hindering conservation efforts. This knowledge gap is critical, as flash floods could exacerbate declines in already vulnerable species and impair pollination services in flood-prone regions. Our study addresses this by examining bumble bee resilience and behavioral adaptations to simulated flooding events under controlled laboratory conditions.

Conducted at the University of Wisconsin-Madison (from February to March 2025) we utilized microcolonies of *Bombus impatiens*, a model North American species, sourced commercially. Each microcolony initially comprised 8 worker bees, with 24 microcolonies per round across four experimental rounds (N=96 total). We applied four treatments: control (no flooding), short-term flooding (10 minutes), medium-term flooding (2 hours), and long-term flooding (12/24 hours), with six replicates per treatment per round. Flooding involved complete nest immersion to mimic flash flood conditions. Behavioral responses were monitored using BumbleBox, an automated tracking system integrating high-resolution cameras, infrared lights, and computer vision with ArUco markers for individual bee identification. Observations spanned seven days—two days pre-flood and five days post-flood—capturing activities like nursing, patrolling, and inactivity via daily nest mapping. Colony performance was assessed by weighing microcolonies and counting live, dead, and newly emerged bees (noting developmental deformities, e.g., wingless or underdeveloped individuals) before and 5 and 12 days after flooding.

Preliminary findings reveal striking differences across treatments. All bees and most brood survived 10-minute and 2-hour flooding events, suggesting resilience to short- and medium-term inundation. However, 24-hour flooding resulted in 100% mortality of adult bees, indicating a clear threshold for tolerance, and in stark contrast to previous research demonstrating that hibernating *B. impatiens* queens can survive more than a week of inundation without significant impacts on mortality. Behavioral data analysis, focusing on activity patterns and nest recovery, is ongoing and will be fully presented at the conference. These initial results highlight that while *Bombus impatiens* colonies can withstand brief flooding, prolonged exposure exceeds their adaptive capacity, likely due to oxygen depletion. This study provides the first experimental evidence of flooding impacts on active bumble bee nests, offering critical insights for predicting population responses to extreme weather and informing conservation strategies as flood risks intensify globally.

Poster presentation

Priorities for enlarging Czech National parks and Protected landscape areas

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The expansion of Protected Areas (PAs) is essential to prevent further biodiversity loss. Therefore, European Union adopted “European Union biodiversity strategy for 2030” with ambitious targets to protect 30 % of the EU’s land and sea and 10 % under strict protection. However, European landscape is extensively inhabited and transformed by human activities, which threatens biodiversity through processes such as habitat loss, landscape fragmentation and land cover change. Therefore, the crucial question is how to protect biodiversity and landscape effectively, because current extent of PAs is insufficient. To address this, we applied spatial conservation prioritisation as a tool for achieving the conservation goals based on expert knowledge and objective data. Using the Zonation software we identified priorities for new potential national parks and protected landscape areas within Czechia to fulfil mentioned goals of the EU Biodiversity Strategy for 2030 to enhance adequately the protected areas network. Our approach integrates systematic conservation planning principles to create protected areas that maximize conservation outcomes while balancing real-world priorities and competing interests. We considered both species and ecosystems in our planning, analysing data related to species distributions and landscape characteristics. We organized the data into four categories essential for protection: biodiversity, natural landscape quality, cultural landscape quality, and anthropogenic transformation. For biodiversity, we used habitat suitability models for 199 selected animal species across six taxonomic groups, plant databases were used for the layer of potential occurrence of endangered plant species. Natural qualities of landscape were characterized by geodiversity, habitat diversity, representativeness and quality, number of species, landscape diversity and distribution of natural and primeval forests. Furthermore, data on potential presence of historical cultural landscapes and anthropogenic transformation of the landscape were used as well. The Zonation software analysis was conducted in 100 x 100 m grid across the entire Czechia with the aim to find suitable areas larger than 50 km² for potential new national parks and protected landscape areas. We identified tens of compact areas, showing significant landscape and biodiversity values including long-time discussed areas and newly detected ones as well.

Poster presentation

Conflicts of interest as a significant aspect in proposals for planting non-forest woody vegetation to support ecological stability in the cultural landscape.

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Spatial demands of economic sectors lead to conflicts of interest and the emergence of environmental problems in cultural landscapes. These problems are often associated with threats to ecological stability and biodiversity, threats to natural resources and human health. Since ecological stability is considered the basis for evaluating all conditions and assumptions for the use of cultural landscapes and its evaluation forms an important part of several spatial planning documents, it is important to know where it is threatened. The aim of the presented contribution is to process the regionalization of the territory of Slovakia by spatial syntheses and classifications of spatial databases based on the ecological stability of cadastral territories of urban and rural settlements of the Slovak Republic (i) and on the basis of conflicts of interest between positive socio-economic elements and selected stress factors (ii). Subsequently, to specify regions of landscape ecological problems with different degrees of ecological stability and different categories of real conflicts of interest in which it is necessary to increase ecological stability by planting non-forest woody vegetation (NFWV) with a specific amelioration function (iii). Non-forest woody vegetation fulfills several functions in the cultural landscape. In the territories of specified conflicts of interest, it will mitigate the negative impacts of stress factors on humans, soil, water, forest and biotic resources and contribute to the improvement of the overall ecological state of ecosystems. In landscape planning, it is therefore important to prefer native species that are resistant to local climatic and soil conditions when planting native species. In addition to the cultivation and ecological requirements, it is important to accept the appearance and aesthetic characteristics of the trees as well as the locations of identified conflicts of interest, since this is where planting of NFWV with such a function can be recommended in order to restore the heritage features to the greatest extent possible and to preserve the traditional character of the area with its high-quality environment and rich diversity of plant and animal species. The research results are of a recommendatory nature and are made available in the form of maps, tables and graphs on the website ILE SAS to a wide range of users.

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Poster presentation

The importance of traditional rural landscapes for biodiversity preservation: the case of the UNESCO site of the Prosecco Hills of Conegliano and Valdobbiadene (Italy)

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Cultural landscapes are often characterized by a complex landscape structure providing different habitats, nesting place, food reservoirs and ecological networks, for different fauna and flora species. Edges between different land uses can be assimilated to ecotones, and land uses changes over the years also affect ecotones characteristics and associated biodiversity. This study intends to contribute to the understanding of the relation between land use changes and ecotone characteristics and changes in an Italian cultural landscapes inscribed in the UNESCO World Heritage List, the Prosecco Hills of Conegliano and Valdobbiadene. In the last six decades agricultural areas decreased with consequent increase of forests and shrublands, affecting ecotones presence and density. Findings highlighted an overall reduction of ecotones total length (–6.4%), in particular of the first level ecotones (the ones between forests and agricultural areas). In addition, the spread of new modern vineyards is reshaping the boundary between the forest and the cultivated areas. Despite this, the maximum density of ecotones remains high (424 m/ha) testifying how the preservation of a traditional landscape structure can bring multiple benefits to the society and the environment, including the preservation of the ecological network and of the local biodiversity. Policymakers and planners should pay attention to the shape of the ecotones between the forest and the new vineyards to mitigate the negative effects on biodiversity and on the perceived landscape.

Poster presentation

Impact of aged biochar on earthworm communities (Lumbricidae) in field conditions

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The long retention time of pyrogenic carbon in soil makes it a promising tool for carbon sequestration and climate change mitigation. As a result, biochar has gained increasing attention for its potential to enhance soil fertility, boost crop yields, and support land reclamation and remediation efforts. Research in this field largely focuses on how biochar influences soil's physical and chemical properties, as well as its effects on soil microorganisms. However, most studies have been conducted under laboratory conditions, while field research remains limited, typically addressing only short- (<1 year) or medium-term (1–3 years) effects. To date, no study has examined the environmental impacts of aging biochar (resulting from long-term environmental processes) and its reapplication in agricultural settings, particularly in relation to soil macrofauna. Considering the crucial role of soil fauna in ecosystem functioning, it is essential to understand these potential impacts. This study aims to assess how biochar-enriched soils affect earthworm communities, as earthworms serve as key bioindicators of soil health. Specifically, the research will: (a) compare earthworm communities in soils with and without biochar, (b) analyze how biochar dosage and application patterns influence earthworm populations, and (c) evaluate whether nitrogen fertilization enhances biochar's effects on earthworms. The research is taking place in experimental fields at SAU-Nitra (Slovakia) on Haplic Luvisol soils. A unique aspect of this site is its long-term biochar application history, with single and repeated treatments (from 2014 and 2018) at varying doses (10 t and 20 t), both with and without nitrogen fertilization. The work aligns with priority scientific actions aimed at developing solutions to environmental challenges, including soil degradation, the negative impacts of climate change, and the sustainable use of agricultural waste. By integrating the biological aspects of soil into the principles of sustainable development, the research contributes to the broader goal of environmental protection and agricultural sustainability.

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Poster presentation

Session 3G – Interdisciplinary Responses: Perspectives for Grassland Research and Conservation Projects

Symposium

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Keywords: grassland, socio-economic responses, management, institutions

This session aims to bring together the contributions of advances in identifying, assessing and applying strategies towards grassland conservation at different spatial and temporal scales. It focuses on contributions presenting advantages of multi-sectorial research of semi-natural grasslands, i.e. those which require human management for maintenance and conservation. The session will address also different forms of incentives (rule, economic and information based ones), approaches of practical management as well as questions related to legal aspects like ownership and other property rights influences. In this context, we particularly look at the approaches to capture responses to maintain or restore species-rich, grassland-dominated landscapes, as well as their productivity and dynamics. We are welcoming contributions especially – but not exclusively – on: • changes in grassland diversity associated to land use changes and socio-economic transitions • specific policy measures active on the grasslands that addresses changes in grassland flora and fauna at the interface with the agricultural management and applying a multidisciplinary approach combining agronomy, botany, ethnology and geography • assessing the importance of social science inputs in practical grassland conservation and restoration • policy mixes and instrument mixes • the role of institution such as ownership forms and other property rights The symposium is expected to serve as a platform for mutual knowledge exchange, for instance, across relevant Horizon Europe-cofinanced Biodiversa+ projects.

Restoration of semi-natural grasslands in Scania (Southern Sweden) – examples with focus on farming perspectives

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Semi-natural grasslands in Sweden are one of the most species rich ecosystems and are a fodder resource for grazing animals used in food production. Today less than 10% of the area of semi-natural grasslands (predominately pastures) compared to 1850 are remaining, covering about 1% of Sweden's area. The trend of abandonment of semi-natural grasslands is still ongoing, caused by abandonment or intensification of agriculture. To reverse the negative trend of biodiversity loss and enhance grazing area for sustainable food production, restoration of semi-natural pastures is an important measure. Restoration of abandoned and previously grazed pastures is labour-, time-intensive and costly. Here, we studied examples of restoration of semi-natural pastures in Scania, Sweden's most Southern province, to identify motivation of animal/land owners to restore semi-natural grassland in this region. We also aimed to highlight positive examples as inspiration for others. Our method were talk and walk interviews with the animal/landowner walking over the restored pastures. Motivation for restoration, restoration procedures, as well as successes factors and challenges were in the focus of our interviews.

Our examples show, that restoration was carried out on both owned and leased land. Animal owners had different backgrounds, being farmers, part-time farmers or having income from other sources. The predominant grazing animals were cattle, followed by sheep and one example included goats. All farmers aimed for a sustainable way of meat production, which is a main incitement. For farmers who have their main or part of their income from meat production, the restoration of pastoral land was seen as a possibility to enhance production. However, other than economic reasons were important, when deciding on pasture restoration. Landscape restoration, nature conservation, aesthetic aspects or cultural heritage reasons were named. For almost all, financing via agri-environmental schemes and cooperation with regional or local authorities was essential. However, regulations within these schemes were also seen as one of the most challenging factors.

The project is carried out within a larger research project, SustAinimal, located at the Swedish University of Agricultural Sciences (SLU), with the aim to increase knowledge on sustainable food production (animals) in times of climate change and biodiversity loss.

Oral presentation

Can Automated Monitoring Enable State-Dependent Conservation?

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In contrast to traditional conservation management which relies on generalized practices or historical data, potentially leading to inefficient use of resources, the concept of state-dependent conservation promises an adaptive management strategy that uses (near) real-time ecosystem or species presence data to make targeted decisions about implementing conservation measures. However, given that the monitoring requirements for state-dependent conservation are much higher, the concept has largely been dismissed as being unfeasible. With the rise of automated monitoring technology and increasing capabilities of AI assisted species classification, overcoming this barrier might have become possible. Against this backdrop, we set out to revisit the concept of state-dependent conservation. This study integrates Passive Acoustic Monitoring (PAM) technologies, AI assisted species classification and cost-effectiveness analysis in agri-environment schemes (AES). We present a proof-of-concept case study where PAM is deployed across agricultural plots to detect meadow-nesting birds during their breeding season that will be conducted in the Spreewald Biosphere Reserve in spring 2025. We assume varying probabilities of bird presence and analyze the costs of monitoring and compensating farmers for state-dependent and conventional conservation measures. This state-dependent approach, facilitated by novel monitoring technologies, theoretically allows more targeted conservation actions only when necessary, potentially reducing overall expenditure or freeing up resources for other conservation targets.

Comparative analysis with conventional AES approaches will investigate trade-offs between fixed conservation payments and dynamic, monitoring-informed actions. Our analysis aims to identify conditions under which state-dependent AES can outperform conventional approaches in maximizing conservation outcomes relative to cost.

This approach may have implications for policy-makers and conservation managers seeking economically sustainable and ecologically effective AES solutions. By leveraging advancements in monitoring technology, state-dependent conservation schemes could potentially improve biodiversity outcomes in managed agricultural landscapes.

Oral presentation

Spatial diversity of the use of EU CAP subsidies for grassland conservation in the Polish Carpathians

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Grasslands, the most biodiversity-rich habitats in Europe, are disturbance-dependent ecosystems that often require human activities, such as mowing or grazing, to maintain their species richness and productivity (Pazúr et al., 2024). In Europe, the decline in grassland area in recent decades is mainly due to land abandonment, forest expansion and housing development (Huyghe et al. 2014). Numerous studies highlight that the decline of traditional grassland management has been driven by changes in rural populations, and low yields, making farming economically unprofitable (McGinlay et al., 2017). This is particularly the case in mountainous regions with challenging environmental conditions for agriculture. Therefore, maintaining or restoring grassland management requires financial support for landowners and managers, which in Europe is mainly provided through the Agri-Environment and Climate Schemes (AECS) founded by the European Union's Common Agricultural Policy (CAP) (Batáry et al., 2015). However, the subsidies vary spatially, and financially supported habitats do not always match desired natural and ecological potential. For instance, the grasslands in the Polish Carpathians, the largest mountain area in the country, are at risk of disappearance, being biodiversity-rich at the same time. Therefore, our aim was to identify what is the scope of grassland subsidies under the CAP, determine which grasslands receive financial support in the Polish Carpathians, and investigate their spatial diversity. We analyzed the natural and socio-economic factors that influence the distribution of grassland subsidies. We harmonised spatial data about various forms of CAP support and compared it with a contemporary grassland map based on the remote sensing products. The results show that there are significant regional differences in the proportion of landowners and managers receiving grassland subsidies. These differences are most evident in the eastern part of the Polish Carpathians, where the percentage of subsidised grassland are the highest, while in the north and west the percentage is much lower. While environmental factors play a role locally, the primary drivers of this variation are economic and social conditions, especially the high degree of land fragmentation and the relatively small plots, which are often not profitable enough for the farmers.

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Oral presentation

Grassland Research and Conservation: An Interdisciplinary Journey

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Land-use changes resulted in a decline of biodiversity in recent European agricultural landscapes. Nevertheless, regions practicing sustained low-input farming continue to harbor most of Europe's high-nature-value grasslands.

Vegetation scientists often capture only a single moment in a study plot's development, but long-term observations are necessary to fully understand temporal variability and trends in vegetation dynamics. To address this limitation in grassland research and conservation, we applied an interdisciplinary approach integrating botany, ecology, remote sensing, history, and ethnology. Our study focused on two villages, Radenka and Suvi Do, in the Serbian Carpathians - one of the region's biodiversity hotspots. By assessing plant diversity and grassland management practices, we explored how traditional low-input farming sustains semi-natural grasslands and how land-use changes impact biodiversity

.Our findings reveal that the semi-natural grasslands in both villages exhibit remarkable plant diversity compared to other temperate meso-xeric and mesic grasslands in Europe. The persistence of historical farming practices, such as spring and autumn grazing of hay meadows and mowing schedules tied to traditional feasts, plays a crucial role in maintaining biodiversity. However, a comparison of management intensity over the past 36 years highlights gradual abandonment in all studied parcels due to depopulation, declining livestock numbers, and a shift from milk to meat production. These socio-economic changes threaten the long-term sustainability of traditional grassland management.

Remote sensing, particularly NDVI time series, provided valuable insights into historical variations in grassland management intensity. However, accurately interpreting these data required social insights from farmer interviews. Ethnological perspectives not only contextualized remote sensing and biological data but also clarified causal relationships between land-use practices and biodiversity patterns.

Our study demonstrates the importance of integrating ecological and social sciences to understand human impacts on semi-natural grasslands. In regions with limited research and inconsistent vegetation monitoring, interdisciplinary approaches can complement or even replace long-term ecological studies and experiments. To maintain biodiversity, we advocate for conservation policies that support traditional management practices.

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Oral presentation

Environmental landscape governance: the ALPMEMA approach

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Environmental landscape governance faces multiple societal challenges, among them overuse and underuse of natural assets. ALPMEMA stands for Alpine Meadows management, is a HorizonEurope-cofinanced project running from 2023 till 2026 and inter alia assesses the role of governance in maintaining best conservation management outcomes. The overall aim of ALPMEMA is to identifying best practices to maintain a favorable conservation status of mountain hay meadows despite the threat of underuse and to explain the influence of different ownership regimes as well as the location of such meadows inside of protected areas on these best practices.

In a transnational meta-analysis in 4 countries, an interdisciplinary research team in close collaboration with local stakeholders comparatively

- identifies, based on established knowledge in case studies, current best practices related to the maintenance of a favorable conservation status in such meadows
- identifies innovative management tools, coalitions of actors and other new methods that are additionally suitable for the management of such meadows,
- explains the significance of different legal ownership regimes and the significance of whether the areas are located in or outside formally protected areas
- describe the condition linked to the use of these meadows through remote sensing and outline the main actual and potential spatial effects of underuse of such meadows using geographical information systems and
- develop scenarios for the management of mountain hay meadows in 2030 and 2050 through playful approaches with different right- and stakeholders.

The current presentation will particularly present first results on the enabling character of governance, different governance instruments providing support for the maintenance of such meadows, and links rules with policy assessment frameworks of society.

It provides an example of the complex environmental and societal surrounding, governance is often embedded, several concrete solution approaches and first blueprint perspectives for globally similar situations.

Oral presentation

Stakeholder perception of the aesthetic value of meadows differing in management intensity

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The management of nutrient-poor meadows (NPM) in the Trudner Horn Nature Park in South Tyrol (Italy) has a long-standing tradition. These ecologically valuable grasslands are usually unfertilised and mown once a year. The aim of our study was to investigate how different occupational groups perceive the visual attractiveness of NPM compared to more intensively managed grasslands (IMG). To achieve this, an online survey was conducted, targeting grassland farmers, apple and wine growers, and people not employed in the agricultural sector. Participants were asked to evaluate the aesthetic value of landscape images depicting NPM and IMG at three different phenological vegetation stages: the start of the growing season (SGS), the growing season before flowering (GBF), and the flowering stage (FLO). All groups expressed the highest ratings for NPM at the FLO stage. The difference in rating between NPM and IMG, however, was greater for farmers than for the other occupational groups, suggesting that farmers distinguish more clearly between NPM and IMG at the peak of aesthetic value. Grassland farmers, moreover, rated both IMG and NPM higher than the other groups at the start of the growing season. This indicates that grassland farmers have a stronger aesthetic appreciation for grasslands than the other occupational groups, even at the start of the growing season, when flowers are absent and biomass is scarce. They also expressed a slightly higher appreciation for NPM than for IMG, suggesting that they were also able to distinguish between NPM and IMG. At the intermediate phenological stage, i.e. before flowering, all occupational groups rated IMG slightly higher than NPM.

Oral presentation

The role of fertilisation in plant diversity in grasslands in the Central Alps

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Extensively managed meadows and pastures are not only some of the most biodiverse ecosystems in the Alps and Carpathians but are also of high cultural value. Nevertheless, the abandonment and intensification of these grasslands have long been an issue, which is still ongoing. To investigate the role of the nutrients input and the land use intensity in terms of mowing frequency and grazing intensity, we conducted vegetation relevés in a north-south transect in the Alpine region and collected detailed information about the management and fertilisation regime of the meadows from the respective farmers.

Preliminary results from 4920 vegetation surveys show that the number of species of vascular plants with intensified use drops from an average of 41 species on nutrient-poor meadows that are only mowed every two years and not fertilized to an average of 17 species with three fertilization events per year. In the case of nutrient-poor pastures in particular, the site factors have a significant effect: wet nutrient-poor pastures are home to an average of only 29 species, neutral to acidic locations 41 species, and alkaline locations 51 species.

The final results of the Biodiversa+ project “G4B: Grasslands for Biodiversity” will help decision-makers and public institutions to improve the system for conserving species-rich grasslands in the Alps and Carpathians and ensure its protection in line with European nature conservation objectives.

Oral presentation

Stakeholder perception of the management of species-rich grasslands in mountain areas.

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Extensive mountain grasslands represent an important ecological value, characterized by high biodiversity. However, in Europe, these habitats are undergoing a gradual decline both in terms of their extent and of their biological diversity. This decline is driven by several factors related to the current socioeconomical trends. On the one hand, a natural succession process begins with the abandonment, which ultimately leads to reforestation below the natural tree line. On the other hand, intensive use, which is related to increased yield and forage quality, leads to a loss of biodiversity.

In view of the increasing loss of species-rich grasslands, this one in particular is of great importance. In this context, the Biodiversa+ “Grasslands for Biodiversity (G4B)” project aims to deliver solid knowledge to improve the protection and the conservation of species-rich grasslands in the Alps and the Carpathians. One essential aspect to design and implement viable measures and achieve acceptance by the relevant actors, is to understand their perceptions in order to develop conservation strategies that take local communities' opinions into account. Therefore, the G4B project collected the opinion of seven important categories of stakeholders in seven European countries located across the Alps and the Carpathians. Through a questionnaire, stakeholders were asked to express their perception on the relevance of aspects that influence farmers' final decisions regarding grassland management, the effectiveness of the measures applied and the main risks for the conservation of species-rich grassland. The stakeholder categories were chosen to represent all those directly or indirectly involved in the discussion and implementation of policies for the protection of these mountain habitats: administrators of protected areas, policymakers and regional administrations, farmers' unions and organizations, farm advisors (including veterinarians), nature conservation organizations (NGOs), foresters and hunters, and researchers from relevant scientific fields.

A preliminary analysis of the data collected in South Tyrol (Italy) and Tyrol (Austria), where more than 90 institutions were invited to participate (30 in South Tyrol and 61 in Tyrol), reveals a consistent opinion of the stakeholders concerning the aspects affecting the farmers decisions, regardless of their category. It turns out that public payments play a key role for farmers in maintaining grasslands. In contrast, ecosystem services are perceived as less relevant.

Oral presentation

Session 3H – River landscapes towards restoration: challenges and opportunities between nature and culture

Symposium

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Keywords: nature restoration, green blue infrastructure, landscape values, climate change, human nature interactions, ecosystem services

Climate and social changes are currently challenging traditional approaches to planning and design cities, prompting new attitudes toward seizing human-nature relationships in their varying features. In 2024, the European Parliament approved the Nature Restoration Law, which aims to reverse the drastic decline of Europe's nature, with the goals of restoring 25,000 km of rivers and 20% of the EU's land and sea areas by 2030 and achieving full health by 2050. Rivers play a pivotal role in the Nature Restoration Law as key components of ecosystems that require restoration and protection. Indeed, restoring rivers not only helps to preserve and enhance habitats for aquatic species but also strengthens the overall health and resilience of ecosystems. Additionally, the law acknowledges the cultural significance of ecosystems by emphasizing their role in providing recreational opportunities, supporting local economies, and preserving cultural heritage. Waterways are key elements of the green-blue infrastructure, they have historically shaped cities and landscapes over time and likewise have been influenced by human activities and urbanization. River landscapes are also destinations for recreation and are sensitive to climate change impacts. They can thus represent peculiar case studies to analyse the relationship between tangible and intangible values, ecological and cultural values. This call seeks to gather examples of landscape design and planning at different scales across Europe, focusing on sustainable strategies that integrate human-nature relationships. We look for case studies and innovative approaches that address the ecological, cultural, and societal challenges of river restoration and sustainable water management. Contributions highlighting the intersection of tangible and intangible values are encouraged. Furthermore, the call welcomes studies, both qualitative and quantitative, that address how restored river landscapes can impact urban development, local economies, and community resilience.

Teaching Rivers. Educating students to integrate cultural ecosystem services in riverscape planning and design

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Rivers, as vital ecological and cultural systems, hold immense significance for communities and environments. However, they face growing threats from urbanization, climate change, and environmental neglect. To address these challenges, the Erasmus+ PlaCES project (Improving Landscape Planning and Design with Cultural Ecosystem Services in HEIs) put rivers at the center of an innovative educational framework within European Higher Education Institutions (HEIs). The project focuses on equipping future landscape professionals with the tools and knowledge to integrate Cultural Ecosystem Services (CES), such as aesthetic, recreational, cultural, and spiritual values, into riverscape planning and design, fostering sustainable practices that harmonize ecological preservation and community well-being. PlaCES aims to embed CES into HEI curricula to prepare students to tackle the complexities of riverscape management. By cultivating interdisciplinary expertise, the project ensures that graduates can address real-world challenges, balancing development and conservation while safeguarding cultural and ecological integrity. This abstract presents the PlaCES framework and its early activities, illustrating how innovative educational approaches can empower students to address pressing environmental and cultural challenges.

WP2: Share and Transfer Knowledge forms the educational foundation of the project. A comprehensive syllabus and thematic webinars introduce students and faculty to key concepts, including spatial planning, heritage conservation, river restoration, and open space design, all interconnected under the CES framework. These tools prepare students to approach riverscapes as dynamic systems, integrating natural and cultural dimensions. The theoretical groundwork is further reinforced through WP3: Test and Exchange, which emphasizes experiential learning. Riverscape Fieldworks and a transnational intensive course allow students to apply their knowledge to real-world contexts across diverse European riverscapes. Collaborating with local stakeholders, participants analyze site-specific conditions, identify CES, and propose innovative strategies for conservation and enhancement. This hands-on approach deepens their understanding while fostering teamwork, critical thinking, and cross-disciplinary collaboration. To amplify the project's impact, WP4: Impact and Dissemination ensures that the educational model developed through PlaCES is scalable and replicable. A modular e-learning platform and a collaborative sharing platform focused on riverscapes provide accessible resources for HEIs and practitioners. Dissemination activities, including an international conference and academic publications, aim to embed CES-focused methodologies into HEIs across Europe. Teaching rivers is not merely an academic exercise; it is a transformative approach to educating professionals who will lead sustainable riverscape management efforts. By integrating ecological resilience, cultural heritage, and community values into their work, PlaCES ensures that future generations can appreciate and benefit from the rich legacy of European rivers.

Oral presentation

Living River Shorelines: Processes for Co-Design of Climate-Adaptive Urban Shorelines

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Urban river shorelines are integral to the character of a city, yet integrating waterfronts with inclusive access and climate adaptation is a ubiquitous challenge to local municipalities. Public access to the water's edge can provide benefits such as improved public health and well-being, local identity, and economic amenities. However, this social and recreational use must be balanced with the maintenance of continuous ecological networks, biodiversity initiatives, and coherence with environmental policies. In order to harmonize interests and contribute to the development of sustainable, co-creative landscape architecture practices that integrate local knowledge, this work highlights new participatory design methods for living shorelines. In this case, "living" shorelines refers to designs that support life – both people and nature – where land meets water.

This study tests an integrated socio-ecological approach to climate adaptation in landscape architecture that combines methodological frameworks in Research by Design with Co-Creation.

Original co-design methods and activities were created to illustrate landscape architecture work with tangible materials, sound, and games to aid knowledge exchange and the creation of spatial solutions through interactive modes of participation. The methods and workshop were developed to guide collaborative design thinking, discussion, and collective creativity to identify new opportunities and limitations for the development of a local urban shoreline. These methods were then tested in a local workshop hosted in Freising with participants who live and/or study in the area. Results from the Co-Design Workshop were then analyzed to reveal local ideas and desires for the development of Freising's urban shoreline. Data gained in the workshops and in site analysis then contributed to the development of an initial design concept to integrate local desires and ecological restoration. Several new concepts have emerged through this study, including (1) a new utilization of methodologies that combines processes in Research by Design and Co-Design, or "Research by Co-Design", (2) creation and testing of original methods in co-design for use in local Living Labs, and (3) a design concept for Freising's Isar River shoreline that applies the research findings. This study shows both a process for new approaches in design in landscape architecture, and an early outcome of the process.

Preliminary survey results show a positive response to the modes of interaction and show support for further development of co-design methods to be used in an inclusive design process. After participating, workshop attendees showed an increase in interest in co-design, and stated they would like to be a part of similar processes in the future.

While the methods developed in this study were aimed at a workshop on the Isar River, the methods are transferable and adaptable to suit the needs of diverse locations, age groups, and design priorities to support a co-creative process. Democratic landscape transformations require sustained effort and imagination; this work adds to the palette of tools and techniques that can be used to enable sustainable, collaborative planning.

Oral presentation

The Piedmont Po River Park: Advancing Nature Restoration through its Ongoing Park Plan

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Environmental issues are central to contemporary debates, with the international scientific community advocating for updated policies and targets. The continuous loss of biodiversity and ecosystem degradation have prompted institutions to establish legally binding regulations, such as the Nature Restoration Law. In Europe, Protected and Conserved Areas play a crucial role in spatial planning, environmental governance, and landscape policies, emphasizing the need to safeguard both biological and cultural diversity while integrating conservation with innovative approaches. Their planning extends beyond resource management; it must legitimize conservation within broader redevelopment strategies, addressing risks, and shifting from restrictive to proactive measures across physical, economic, and socio-cultural dimensions.

Park planning remains essential in addressing contemporary challenges through a comprehensive and strategic approach. However, fragmented protection measures continue to hinder coherent territorial planning. Since the 1970s, the Piedmont Region in Italy has played a guiding role in protected areas legislation. The Piedmont Po River ecological corridor, spanning 230 km, is a vital component of the regional ecological network, including the Natura 2000 Network and the MAB UNESCO Collina Po Biosphere Reserve.

The Piedmont Po Park Plan, originally developed as a pioneering initiative in the 1990s, is currently being revised. The revision must address contemporary objectives concerning sustainable development, climate adaptation, ecological transition, and ecosystem services. It represents an opportunity to align with EU biodiversity and nature restoration targets, as well as recent regional legislative changes that promote more flexible and integrated strategies. Additionally, the process must mitigate the risk of fragmented management by addressing concerns related to the restoration and protection of areas excluded due to legislative changes and overcoming rigid institutional boundaries that hinder ecological connectivity.

Currently, a new proposal for the spatial reorganization of the Piedmont Po Park is being developed, focusing on harmonizing zoning classifications and using integrated assessments of Landscape-Environmental Units, emphasizing their resilience and the ecosystem services they provide. To ensure an inclusive and participatory process, dedicated working groups are engaging local communities and stakeholders in addressing concrete issues such as hydraulic risks.

In the coming months the planning office of the Piedmont Po Park will collaborate on co-designing the strategic vision that will guide the park's territorial development and update its policy framework.

Oral presentation

Practicing River Restoration in the "Trading Zone" of Large-Scale Projects

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River restoration is one of the key challenges for the rehabilitation of urban and rural landscapes, as outlined in the recently approved Nature Restoration Law by the European Community. But river restoration out of the Natura 2000 areas can be hindered by the many issues involved in river management, from flood protection to minimum runoff compatible with settlement needs. Recent studies point to the need to integrate cultural and/or social aspects into river restoration processes over long time horizons, developing forms of interactive governance capable of including and addressing conflicting conditions between stakeholders.

When these new objectives are not prioritized on the political agenda or are still distant from the sensitivities of local communities, river restoration may be achieved, not as the primary objective of land-use transformations, but as a result of compromise between conflicting economic, environmental, and social interests within overall landscape project. From this perspective, territorial conflicts arising from large-scale settlement transformations (e.g., infrastructure and facilities, quarries, waste treatment, industrial activities) can create an interactive governance space for engaging the "opposed public," in a win-win framework, by bringing new value-driven approaches that prioritize landscape and environmental protection.

Using the "trading zone" approach, applied to spatial planning, this contribution aims to explore how conflicts can influence the quality of transformation in a proactive rather than obstructive manner, steering them towards new socio-ecological equilibria between restored river landscape and urban development.

We analyse and compare three well-known cases, carried out over a span of thirty years: expansion of the port and airport in the Llobregat Delta Valley (Barcellona), the Expo 2008 site on the banks of Ebro River (Zaragoza), construction of the 'Grand Paris' metro line and new neighbourhoods on the Saclay plateau (Ile de France). As they are largely concluded, they let to verify the environmental and social effectiveness of the process arising from territorial conflict.

The comparison of 3 case studies, developed at different scales, makes it possible to identify some key metrics that identify different types of processes for the creation of new river restoration waterscapes: homogeneity/heterogeneity of the objectives underlying the territorial conflicts; outcomes of the transformations and type and location of ecologically restored areas; type of trading zones (interlanguage, fractionated, enforced); tools for implementing trading zones (environmental compensation, design competitions, public debate).

These key metrics can provide a useful reference for the implementation of current strategic river restoration scenarios developed through governance tools.

Oral presentation

Reconnecting the Latorica river floodplain landscape in a transboundary context

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Before its confluence with the Ondava river, the Latorica historically meandered through vast lowland floodplains with soft and hardwood floodplain forests, old river meanders, grasslands and meadows. In the 20th century, large scale drainage and reclamation works drastically changed the landscape and biodiversity. The Latorica was straightened and squeezed between dikes and the former floodplain areas were turned into agricultural lands with a dense network of canals, ditches and pumping stations to control water.

Much of the landscape's character from centuries ago is preserved with rare and threatened and rare fish and birds species, along with rare riverine forests. It is also an inhabited landscape of villages and farms, with livelihoods, economy and culture historically supported and shaped by the river. On both sides of the border vast tracts are designated as protected area but a coordinated management approach is lacking.

The river system that is essential to the landscape's health is disconnected and unable to provide natural resilience. Floods are currently restricted to a small floodplain area between the narrow dikes, while climate change is leading to lower spring floods and higher temperatures in summer.

This leads to drying out of wetland habitats and declining biodiversity, along with lowering groundwater levels and drying out of wells in villages. Extreme summer precipitation events increase the likelihood of floods, without sufficient floodplains to absorb and reduce peak flows downstream.

Through a planning grant of the Endangered Landscapes and Seascapes Programme, partner organisations in Slovakia and Ukraine are working to establish the knowledge, partnerships and stakeholder enabling conditions for a transborder landscape-scale restoration vision of the Latorica river and floodplains. This could provide a foundation as part of Slovakia's Nature Restoration Plan for resilience to floods and droughts, groundwater recharge, carbon storage and the return and increase of key biodiversity.

The landscape has high potential for an innovative "Room for the River" restoration approach, through a combination of reconnecting and seasonal rewetting of former floodplains, the introduction of extensive and viable agriculture and the promotion of eco-tourism encompassing a transboundary wetland landscape of European importance of more than 30,000 ha.

A participative process with stakeholders from agriculture, water management and nature protection is underway to co-create knowledge and understand the issues, which will lead to the co-development of a vision for a healthier local landscape to support the local economy, interests and culture. The results of this process and vision will be presented.

Oral presentation

Stormwater management in Rome: the role of sustainable drainage areas in river landscape restoration processes from an strategic-structural planning perspective.

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Preserving the circular metabolism of the river basins in which our contemporary cities are located must be the primary objective when it comes to water sustainability.

This implies, first of all, the study of mechanisms for the use of water resources and the management of urban soil permeability that allow for its sustainability, working on the basis of prevention for its long-term supply.

With this premise, the city of Rome, where as a palimpsest, past and present coexist in a constant pursuit of balance and where the survival of its natural capital is at risk in the face of climate change, is the subject of study of this contribution, in which, the Components of the city's Ecological Network (Rete Ecologica), one of the three Structuring Systems (Sistemi Strutturanti) of the current city's Master Plan, are described and analysed as the prescriptive regulation that aims to consolidate the Roman natural capital, connecting it with the other urban Structuring Systems defined by the Plan.

Definitions of the Plan as the Categories of Environmental Interventions (Categorie di Intervento Ambientale), the Ambits of Transformation of the Settlement System (Ambiti di Trasformazione del Sistema Insediativo), another Structuring System and the Ambit of Strategic Planning of the Tiber River (Ambito di Programmazione Strategica del Fiume Tevere) are analysed in relation to the Ecological Network in order to highlight the urban areas and ambits and the planning resources that the Plan proposes in direct relation to stormwater management and soil permeability regeneration.

Identifying possible physical networks, systematically integrable, to reinforce regenerative interventions that may have direct implications in the construction of restoration processes of surface water absorption areas in the city, this contribution will shape a conceptual and a physical map that could serve as a reference (strategic-regulatory as well as operational) for social actors involved in river landscape restoration processes, in the aim of bridging the gap between public institutions, civil society and stakeholders involved.

Oral presentation

Sustainability of the Balkhash Lake

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Kazakhstan is planning to build a nuclear power plant (NPP) near the Balkhash Lake area. Four companies including CNNC (China), KHNP (South Korea), Rosatom (Russia), and EDF (France), could be potential technology suppliers for the construction of the nuclear plant. Rosatom (Russia) looks like a favorite potential supplier, based on the original initiatives and extensive promotion of this project. Kazakhstan does not have nuclear capacity yet. The 52 MW Aktau nuclear facility opened in 1973 was closed in 1999 after, following the Kazakh government decision to sign the global non-proliferation agreement. At the same time, Kazakhstan is the world's biggest uranium producer and has the world's second largest proved reserves of uranium. Most local Kazakh citizens are concerned about the NPP safety. Additionally, to many technological expertise factors related to the NPP safety, the basic very simple needs such as the permanent stable water supply are critical for the NPP safety. Balkhash Lake is dramatically shrinking, and it may have a similar fate as the almost dead Aral Lake. Intensive upstream Ili River water consumption by China, Almaty city and planned new Alatau-“Singapore” copy city with additional approximately 2 million people water consumption, will practically destroy the water supply system to the Balkhash Lake. Balkhash Lake eventually could be in a similarly shrinking position as the Aral Lake. What permanent stable water supply strategy should be investigated for the NPP safety? May small internal Kazakh rivers such as Ayaguz, Karatal, Kok-Su, Lepsi supply enough water for the NPP safety, in case of the Ili River disappearance? These small rivers are also under intensive distractions by the Kazakh governments with contractions dozens of the small dams, small hydropower stations, mining in-situ rare metals exploration activities, agrarian and domestic consumption needs. All these small Kazakh rivers are also dying. What and how should the current practice be changed in water supply for the NPP safety? How can the ecosystem services be updated to improve the Balkhash Lake sustainability? This research project provides a preliminary investigation for the Balkhash Lake sustainability improvement by analyzing the intensive human anthropogenic activities in the Balkhash Lake basin area. The Kazakh Ministry of Science grant # BR27197639 "Development of Innovative Hydrogeological Methods for Water Resource Management in the Zhambyl, Almaty, Zhetysu, Abay, and East Kazakhstan Regions" supports this project. The current status of the project activities will be presented.

Oral presentation

Balancing Nature and Urban Life: Insights from Public Perceptions of Cheonggye Stream Restoration in Seoul

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This study investigates how urban river park restorations are perceived in Korea, where at the beginning of this century urban development shifted from growth-driven approaches to environmentally-oriented planning emphasizing traditional landscape values and cultural heritage. Within this context, the Seoul Metropolitan Government prioritized restoring urban river systems to strengthen human-nature interactions and local identity. A key example is the restoration of Cheonggye Stream (청계천), once vital to Seoul's urban morphology and social life. Covered by an elevated highway in the 1970s, the stream was reintroduced into the cityscape in 2003 through an ambitious urban river park project. This transformation has attracted academic interest regarding its impact on urban planning, ecology, and economic development. Yet, less attention has been given to understanding how values and meanings surrounding this restoration are formed and negotiated. In Seoul, 'restoration' ranges from historical reconstructions to preserving intangible cultural values. The Korean term 'bogwon'—to return to an original state—adds complexity when applied to dynamic urban landscapes. The Cheonggye Stream restoration has thus become a negotiation site between visions of ideal nature and urban realities, reflecting evolving relationships between nature and urban society.

This provided the foundation for a pilot study by the Research Unit of Landscape Architecture and Landscape Planning at TU Wien in November 2024. Over nine days (November 2–10), an opportunity sample of 100 respondents was surveyed at various locations along Cheonggye Stream, with data collection at different times of day. Weather remained sunny but cold, with morning temperatures around 1°C and afternoon highs of about 15°C. The questionnaire focused on urban river parks (URPs) and included five item groups: (1) abstract preferences for URPs, (2) preferences for nature in URPs, (3) infrastructure preferences, (4) visiting habits, and (5) preferred URP features. The questionnaire items closely followed the socio-cultural framework of the Swiss National Forest Monitoring (WAMOS), adapted to Korean culture and urban river park contexts.

Preliminary results from quantitative analysis indicate that while abstract landscape preferences overlap across cultures, clear differences appear in preferences for nature, infrastructure, and visitation motives. Respondents valued water and greenery but emphasized cleanliness, order, and accessibility—key elements in dense urban areas. Visitation was shaped by convenience and relaxation, with ecological or educational functions secondary. Despite efforts to foster immersive nature experiences, many users saw these parks more as leisure spaces than natural retreats. These findings highlight the need for urban river parks and contribute to theoretical and practical discourse on designing culturally sensitive urban nature spaces, balancing ecological goals with socially informed functions.

Oral presentation

Integrating longitudinal, lateral, and catchment-based connectivity for freshwater and terrestrial ecosystem restoration in the Danube-Carpathian Region

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Connectivity is a fundamental property of river basins, enabling the exchange of water, sediment, nutrients, and organisms across multiple spatial and temporal scales. In the Danube-Carpathian region, freshwater and terrestrial connectivity are increasingly fragmented by hydromorphological alterations, infrastructure development, and land-use change. Disruptions in longitudinal connectivity (river network fragmentation), lateral connectivity (floodplain disconnection), and catchment-wide connectivity (cumulative impacts of multiple stressors) threaten biodiversity and ecosystem functionality. The EU Biodiversity Strategy 2030 and, more recently, the Nature Restoration Regulation mandate the restoration and reconnection of at least 25,000 km of free-flowing rivers and associated floodplains and wetlands to address this issue.

Within the Horizon Europe project NaturaConnect, we develop a multi-dimensional approach integrating graph- and circuitscape theory to assess and enhance ecological connectivity in the Danube-Carpathian Region. The overarching aim is to create a holistic approach to identify priority areas for restoration.

Our longitudinal connectivity assessment focussing on rivers builds on a reach-based scoring approach, evaluating habitat availability and quality, barrier location and passability, and hydromorphological conditions. This methodology allows the quantification of the restoration potential under different passability scenarios, providing targeted insights for improving freshwater continuity.

The assessment of lateral connectivity focuses on the connection to floodplains and applies a resistance-based modelling framework with Omniscape using Copernicus Riparian Zone datasets. This approach quantifies the structural and functional connections between rivers and adjacent floodplains, identifying areas with high restoration and reconnection potential. Additionally, we incorporate land-use resistance layers to evaluate how different landscape types influence riparian connectivity.

At the catchment level, we integrate stressor assessments with ecological prioritization tools. By analysing Functional Elementary Catchments (FECs), we account for multiple spatial scales, identifying sub-catchments where restoration would yield the highest ecological benefits. We also propose an integrated connectivity index that combines longitudinal and lateral dimensions to provide a holistic view of freshwater-terrestrial connectivity.

These methods contribute to developing a transboundary ecological network, supporting evidence-based policy implementation and enhancing resilience in the Danube-Carpathian region.

Oral presentation

The Ticino River Landscape restoration: a challenge for the benefit of people and nature

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The Ticino River Landscape is a transnational area of around 1 million hectares shared between Switzerland and Italy, that comprises all the 248 km of the Ticino River. While being one of the wealthiest and most productive area in Europe, hosting intensive agriculture, dense urban fabric and infrastructure networks, the Landscape still features significant ecosystems and biodiversity and, to some extent, ecological processes and connectivity.

Restoring the Landscape to its full potential is the goal of the Ticino Initiative, established in 2021 after 2 years of intensive participatory processes that involved an extended partnership of over 30 entities, including protected areas, public administration, NGOs, research centers and private companies from both Italy and Switzerland. This partnership has worked around a Theory of Change to deliver a detailed 10-year Restoration Plan for the Landscape with five main goals: 1. Establish and strengthen the transnational governance of the Landscape; 2. Ensure that ecosystem services and human activities in the Landscape positively reinforce each other; 3. Secure ecological connectivity between the Alps and the Apennines and between the Upper Ticino River and the Adriatic Sea; 4. Restore reproductive populations of locally-extinct species and secure good conservation status for threatened ones; 5. Foster the climate resilience of ecosystems and human communities and mitigate the impact of extreme climate events.

Additionally, a Communication Strategy was developed with the ultimate goal of fostering a common identity in the communities living on both sides of the border. The Ticino Initiative is currently committed in implementing the Plan, with actions being carried out both singularly or jointly by the partnership. Two relevant Interreg projects are now underway, focusing on governance, ecological connectivity and species conservation.

The two projects will further enhance the ecological connectivity of the Ticino Landscape, reinforcing its role as the only ecological corridor crossing the Po Valley, connecting the Alps, the Apennines and, through the Po River, the Adriatic Sea. Its restoration is not only feasible, but is a necessary step in ensuring that the area is resilient to global changes and is able to take advantage of mutual benefits between ecosystem services and human activities.

Oral presentation

Restoration assessment of the Ayaguz river basin based on the EU expertise

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Kazakhstan, as other Central Asian countries, has difficulties with water resources. Some referees to these difficulties to the water usage culture, or simply missing in many cases the proper water culture in balance with Nature. The Aral Lake issue is one example of such a problem. Now, other lakes, including the Caspian and Balkhash Lakes, are under similar problems. Balkhash lake basin and its feeding rivers are under intensive regulation, industrial and agro consumption economic activities. As an example, one of the Balkhash lake feeding rivers is Ayaguz river. In recent years 2018-2022 water level of Ayaguz River has dropped from 558 cm to critical 162 cm with reference to the Baltic Height Sea level System. Before the intense industrialization period of time, this Ayaguz river was feeding the Balkhash Lake, however, these days contributions to Lake Balkhash is practically zero. This is primarily due to the irrational use of water resources. This is a big challenge to restore Ayaguz river landscapes. It is complicated to balance with the Nature and change the local water culture. We are learning about Slovakia's initiatives in "water for climate healing - the new water paradigm and public policy" with contour-strip land organization, <https://www.youtube.com/watch?v=NPx-tiTrqNQ>, how we may adapt it for Ayaguz river basin. By integrating historical climate data, satellite-based remote sensing techniques, and hydrological modeling, we are working on the long-term trends and their impacts on downstream water availability analysis. The Kazakh Ministry of Science grant # BR27197639 "Development of Innovative Hydrogeological Methods for Water Resource Management in the Zhambyl, Almaty, Zhetysay, Abay, and East Kazakhstan Regions" supports this project and the current stage of our work will be presented.

Oral presentation

Reviving Urban Rivers: What Happens When Residents Decide?

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This study examines the potential of river restoration in post-industrial cities through the lens of different demographic perspectives on urban river landscapes. Our research is based on participatory urban design and public engagement methods, including stakeholder surveys and an analysis of ongoing discussions on blue infrastructure in Łódź, Poland. The city's Blue-Green Network, adopted in 2010, serves as a basic framework for restoring green and blue spaces as integral elements of sustainable urban redevelopment. With eighteen small rivers - many of which have been channeled or buried - Łódź exemplifies the complex environmental, social, and economic challenges facing post-industrial cities. Addressing these challenges requires strategies that not only enhance biodiversity and water quality but also promote meaningful social and cultural experiences within urban river landscapes.

We explore how different age groups - adults, students, and children - perceive and prioritize river revitalization. The presentation aims to identify the values associated with river landscapes, including their ecological, recreational, and aesthetic significance. Our findings reveal a common demand for clear functional zoning and improved accessibility, while highlighting generational differences in approaches to greenery management, infrastructure, and public space use. While adults prioritize multi-use recreational spaces, students emphasize event-driven spaces, and children seek greater integration of nature with play infrastructure. These different perspectives highlight the need for an inclusive and adaptive planning approach - one that incorporates participatory design while maintaining ecological integrity. However, this study also highlights the risks of over-relying on public preferences in the absence of ecological expertise. Restoration strategies shaped solely by community input, without consideration of ecosystem dynamics, may inadvertently compromise biodiversity or water quality.

Oral presentation

Cultural Ecosystem Service Transformation During COVID-19: A Case Study of Riparian Recreation along the River Lech, Augsburg

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The COVID-19 pandemic induced significant disruptions to urban life, leading to a transformation in cultural activities, particularly in how people engaged with nature for recreation. With restricted access to indoor leisure facilities, riverscapes—characterized by their central location and natural appeal—emerged as essential spaces for outdoor activities. This study examines how the recreational use of riparian areas in major Bavarian cities, focusing on the River Lech in Augsburg, changed during different stages of the pandemic. Three phases—pre-pandemic, strict restrictions, and relaxed restrictions—were analyzed through a combination of social media analysis, online surveys, satellite imagery, and field mapping.

Findings reveal a clear shift in recreational practices, with a marked increase in nature-based recreational activities, such as short walks, as people sought outdoor spaces for well-being and stress relief. While popular locations saw increased visitation, strict restrictions led to a more dispersed use of these areas, as people sought to maintain physical distance. Swimming lakes became more important, while river-based activities diminished during the most restrictive periods. The study explores the role of urban riverscapes in providing cultural ecosystem services during crises, highlighting the need for diverse and expansive recreational spaces and underscoring the need for natural riverscapes in cities. These findings offer valuable insights for future urban planning, emphasizing the importance of enhancing, preserving and restoring rivers.

Oral presentation

Sense of place as a participatory planning tool to develop socioecological resilience in river territories at hydrogeological risk

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In the context of the international debate, there is an increasing focus on river territories in terms of their resilience to the challenges posed by climate change, which is the cause of frequent catastrophic flooding events. This focus is evidenced by the various directives beginning with Directive 2000/60/EC which calls for integrated action to enhance aquatic territories, landscapes and their safety, including communities and their awareness of risk in these fragile environments. These issues are revisited in the discourse on the role of river territories and community engagement for climate change adaptation (SNACC 2015 and associated plan) and for the implementation of the European Biodiversity Strategy 2030. Consequently, there is a need to investigate both the spatial strategies to be adopted in planning to mitigate flooding impacts and the methods by which communities can be engaged into the place-making process of the river restoration projects with the aim of strengthening the territories' resilience. To address these issues, this research analyses the sense of place, as a potentially effective factor in participatory planning of flood-prone territories examining the case study of the province of Valencia which was recently affected by a catastrophic flood on October 29th, 2024. The concept of sense of place has been theorised by numerous studies, primarily in the field of environmental psychology. This is due to the fact that sense of place has been attributed particular relevance because it intervenes in the human-environment relationship, potentially playing a crucial role in land use planning and natural resource management (H See Hidalgo & Hernandez, 2001; Jorgenson & Stedman, 2001; Kyle et al., 2004; Lewicka, 2005; Manzo, 2005; Nanzer, 2004; Williams & Stewart, 1998) although the relationship with the spatial context through collaborative place-making is lacking of evidences (Meetiyyagoda et al., 2023). By using quantitative and qualitative tools addressed to post-flood communities, the research analyses how local actors' sense of place can be a guiding factor to define river restoration scenarios promoting an integrated approach in accordance with the municipalities' vision of requalification of the Valencian province. This place-based approach is intended to facilitate the inclusion of a greater number of stakeholders' perspectives in the planning process for the restoration of river risk zones to identify regeneration scenarios that respond to ecological, social and local needs.

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Session 3H – River landscapes towards restoration: challenges and opportunities between nature and culture

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Poster presentation

Session 3I – Pathways to Quantify the Impact of Governance Instruments on Ecological Restoration

Symposium

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Keywords: ecological restoration, landscape restoration, governance, policy mix, impact assessment

The current UN Decade on Ecosystem Restoration (2021-2030) as well as national and supranational laws, such as the European Nature Restoration Regulation, reveal a political momentum putting ecological restoration into focus. At international level, the Kunming-Montreal Global Biodiversity Framework equally requires to apply to apply restoration measures under target three for 30 percent of degraded land surfaces globally. These governance instruments are primarily examples for dedicated instruments for ecological restoration. However, other policies at European level such as the Habitats Directive, the Common Agricultural Policy or the EU Forestry strategy as well as national or federal legislation also affect the process and the outcome of ecological restoration practices. This session has two major interests: i) the analysis of the added value of novel governance instruments in the existing policy mix affecting landscape-level restoration and ii) the assessment of the impact of dedicated instruments for ecological restoration as well as other governance instruments (in)directly contributing to ecological restoration should be discussed during this session. For the first subtheme, we are inviting studies analyzing how novel governance instruments, e.g., arising from the European Nature Restoration Regulation, complement existing policy instruments. What is the added value of bundling targets on ecological restoration in the European Nature Restoration Regulation compared to individual laws and strategies partially addressing ecological restoration, for example? For the second subtheme, we are inviting different approaches, generally quantifying the impacts of one or multiple governance instruments related to ecological restoration at landscape or larger spatial scales. For example, how can we quantify landscape-level impacts of nodal (e.g., information and education on implementing restoration measures), authoritarian (e.g., binding national or subnational restoration targets), treasure-related (e.g., funded restoration measures such as peatland restoration, forest restoration, or agri-environmental measures), or organizational governance instruments (e.g., land care organizations or market-based restoration instruments)? What would be the ecological effect of different combinations? Interested participants will be encouraged to contribute to a special issue depending on the contributions (e.g., Ecology & Society, Restoration Ecology Journal).

Analysing the potential of Agri-Environmental Schemes for the restoration of agricultural ecosystem

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The intensive management characterizing agricultural landscapes has led to degraded ecosystems, biodiversity and soils, affecting in multiple ways environmental aspects, but also decreasing ecosystem capacity of supporting farming itself. Restoration actions are therefore necessary.

Together with dedicated instruments pushing for ecosystems restoration (e.g., EU Nature Restoration law, EU Life program), other governance tools are also indirectly contributing to it, specifically in the agricultural context. For instance, within the Common Agricultural Policy (CAP), Agri-Environmental Schemes (AES) provide financial incentives for practices that protect or restore ecosystems, such as organic farming or the maintenance of natural habitats and landscape features on agricultural land.

Within our TRANSFORM project (Smart Transformation Labs as virtual companies of the future for the Central German region), we are interested in analysing the impact of selected AES on biodiversity and ecosystems services (e.g., water quality regulation, pest control). For this we are applying a spatially-explicit models-based approach (i.e., species distribution model, InVEST Nutrient Delivery Ratio model). We are building on information on agricultural land use and AES implementation for the state of Saxony-Anhalt coming from the IACS database. The models are integrated in a decision support system, aiming at supporting farmers in the implementation of AES.

The presentation will discuss on the effect of current agricultural management choices, including currently implemented AES, on farmland bird's occurrence and water quality regulation, highlighting their restoration potential. It will also give an overview of the developed decision support tool, showing its functionality in linking implemented AEP also to the impact on agricultural production for a full support of farmers' decision making.

Oral presentation

Governance instruments for ecological restoration

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This presentation will provide background and motivation to the session, briefly introducing governance instruments for ecological restoration and their impact on it. The thematic and methodological focus of the different presentations in the session will be briefly summarized and positioned within the themes of the session.

Oral presentation

Indicator-based assessment on the effectiveness of conservation-based policies in the EU: the Farmland Bird Index

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Although in the past decades there have been a series of policies on the protection of biodiversity in the EU, all of them have failed to reach their goals. The European Green Deal (EGD) was aligned with the United Nations 2030 agenda, as an ambitious plan to create a sustainable environment for all European citizens. Part of the EGD policy targets is Biodiversity for 2030, through which the Nature Restoration Regulation (NRR) was first proposed. The NRR is a continent-wide regulation that aspires to restore degraded ecosystems, re-establish habitats, while reversing the decline in pollinating insects' populations. To achieve these goals, we need to ensure that monitoring efforts are done efficiently allowing us to detect areas of intervention.

The aim of this study is to systematically review literature that evaluates restoration or related policies with the use of indicators, in order to understand how they could be assessed as a blueprint for the NRR. We focus on farmland birds as an indicator, which is usually well monitored, therefore having a high chance to be well documented due to its use in other policies.

The systematic literature search was conducted using Scopus; the search terms were farmland, birds, policy, governance, impact and response. The following information was recorded from the selected papers:

- Policy evaluation: NRR has gathered the goals of previous and relevant policies in one regulation. It is evident that previous policies failed to reach their targets, the important piece of information here is why.
- Farmland Bird Index (FBI): Farmland birds can be a good indicator of change; therefore, they can also be used to evaluate the effectiveness of NRR.
- Model: Models are used for various reasons during the analysis stage, be it to calculate the population abundance of a species, or to assess the impacts of a policy implementation. Depending on the variables included, a model could fit this study's purpose.
- Scenario: Since every EU Member State (MS) has a different starting point regarding the implementation of the regulation, due to the fact that most MS differ on everything, from dominant land uses to the state of the economy, the results of the implementation will probably vary as well. We are looking for implementation scenarios that could be integrated in models that assess policy impacts.
- Spatial extent: Due to data incompatibility and scarcity, it is not often that an assessment is completed at a national level. Since the NRR does not only concern areas that already had a

Session 3I – Pathways to Quantify the Impact of Governance Instruments on Ecological Restoration

protection status (Habitats Directive) but all different habitats and ecosystems, studies that are in comparable extents could provide useful information about data availability and variables that can be included.

The results from this review help shed a light through the evolution of restoration policies. Furthermore, the results are used to determine whether existing models could be adjusted to quantify selected impacts from NRR, at MS level. Each failed strategy has contributed to taking a step further, therefore, even if a suitable model is not found, understanding why previous attempts have not succeeded and the factors that contributed to these shortcomings, will provide useful knowledge that could help improve current and future policies.

Oral presentation

Enhancing Biodiversity in Agricultural Landscapes: The Role of CAP Eco-schemes in Wildlife Conservation

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Slovakia, with the largest average field size in the EU, faces significant ecological challenges in intensively farmed landscapes. In 2023, a voluntary whole-farm eco-scheme under the Common Agricultural Policy introduced buffer strips to enhance habitat diversity. Over 85% of agricultural land enrolled within the scheme's first two years, reflecting high farmer participation despite initial scepticism regarding its ecological benefits. Our field study conducted over 2023 and 2024 sought to quantify the impact of these CAP eco-schemes on abundance and diversity of farmland birds. The study was implemented on 14 farms with 43 paired study sites, where we monitored over 6,800 observations of birds representing 69 species. The results clearly demonstrated that buffer strips significantly enhance bird abundance and species richness, particularly benefiting ground-nesting and threatened species. Complementary insect surveys revealed that buffer strips attracted up to 40 times more insects, including key pollinators and pest predators, compared to conventional fields. These findings not only underscore the role of buffer strips in providing critical habitats for birds but also highlight their broader ecological value in supporting pollinators and other wildlife. The success of the eco-scheme is underpinned by its tailored design to address the unique challenges posed by oversized fields and the limited availability of non-productive land in Slovakia. However, our study also identifies several areas for improvement. Financial incentives and bureaucratic hurdles remain significant barriers to maximizing the scheme's ecological potential. Enhancing these governance instruments—by reducing administrative complexity and diversifying the suite of agri-environmental measures—could further boost biodiversity and strengthen ecosystem resilience. The Slovak eco-scheme has the potential to serve as a model for other countries. However, its reliance on GAEC8—which mandated non-productive areas in Slovakia primarily as fallows—poses challenges, since this requirement has been abolished at the European level. Also, recent modifications to the Slovak CAP strategic plan have introduced a new alternative within the eco-scheme, namely "biodiversity islands", which can be established on field margins or other convenient locations instead of using the central parts of fields as buffer strips. This shift may reduce benefits for open-land species and weaken the scheme's impact on addressing the challenges posed by large, intensively farmed fields—a question that will be the focus of our future research.

Oral presentation

Preparing for the EU-Nature restoration regulation to restore ecosystems

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The EU-Nature Restoration Regulation (adopted in June 2024) requires action to restore at least 20% of degraded ecosystems by 2030, and to improve the conservation status of species and habitats of the Directives. It demands improvement of the spatial cohesion of the nature network, and increasing biodiversity, whether in protected sites, farmland or urban environments. The regulation is legally binding and has large implications for the restoration efforts of EU-Member States, land owners and conservation organisations. There is a huge task for all Member States to develop and submit their national nature restoration plans within the coming year!

We have developed three scenario's for nature restoration, for two transboundary landscapes, straddling the Dutch-German border and Dutch-Flanders border. The scenarios combine restoration measures that are deemed feasible and acceptable to land owners and other stakeholders in the area. The focus is on restoring forests and grassland ecosystem and raising biodiversity in farmland. Restoration measures considered were adaptation of forest composition, creating forest corridors, planting of hedgerows or agroforestry. For grassland restoration opportunities are in diversification of grasslands, extensification of management or grazing and the reintroduction of landscape elements for green-blue veining. The possible restoration measures have been used for discussion with stakeholders, to assess their preferences and adjust them where necessary.

With models like LARCH and QuickSCAN we assess the impact of measures to restore habitats and species and to improve the TEN-N, impact on biodiversity, connectivity, productive functions for farming and forestry.

More important than two regional restoration plans is the resulting methodology, tested in preparation for the implementation of the EU-Nature Restoration law. Countries preparing for the Nature Restoration Law can learn from this project how to develop nature restoration plans, lessons which extend to all countries.

Oral presentation

Session 3J – Towards Landscape Ethics: Fostering Just Sustainability Transition in Social-Ecological Landscape Nature and Culture

Symposium

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Keywords: landscape ethics, social-ecological landscape, just transition, cohabitability, environmental justice

In this session we discuss the opportunities and challenges to develop coherent and practical landscape ethics to respond to landscape changes caused by human activities. Interdisciplinary landscape approaches have for a long time pursued the objective of balancing human activities with multiple values and value-laden objectives such as biodiversity conservation, ecosystem services, or cultural heritage. However, such perspectives are often limited to a human-centered vision which differentiate (divide) human needs from non-human needs. Landscape approaches often elude ethical considerations. No principles are used to define legitimate or just actions, or to articulate the ethical assumptions grounding approaches, except for the presumption that supporting biodiversity is desirable. To incorporate ethical and justice considerations into landscape change responses, both social (such as just transition) and more-than-human (such as cohabitability) perspectives are needed. We welcome contributions from studies exploring for instance: • Environmental justice • Environmental landscape ethics • Co-construction of practices and participatory landscape planning • Landscape and sustainability transformations • Social and ecological dimensions of landscape The moderator will introduce the concept of planetary well-being and the potential contribution of a landscape perspective into it. We will close the session with a round table discussion that wraps up and integrates key insights of the different presentations.

Characterising landscape homogenisation and navigating the ethical landscape

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Landscapes are relational spaces where diverse social-ecological relations unfold. due to intensification of human land-uses, they are losing their diversity of species and functions, languages, and practices, and thereby influencing the ways in which people interact with each other and non-human beings across the globe. Understanding these changes is central to fostering transformative change necessary to address today's sustainability crisis. Using an in-depth, reflexive thematic qualitative approach, this study characterises landscape homogenisation across five case study landscapes in Ethiopia, Finland, Germany, Iran, and Uruguay by (a) identifying the main driving forces underpinning landscape homogenisation within each landscape and (b) exploring and discussing some of the main relations between different driving forces contributing to landscape homogenisation across landscapes. Our analysis reveals four key drivers of landscape homogenisation worldwide: prioritisation of economic growth, industrialised commodity production, rural depopulation, and the abandonment of traditional practices. While present in all studied landscapes, these forces manifest in distinct ways depending on local contexts. Our findings underscore that landscape homogenisation is not driven by isolated factors but by an intricate interplay of co-occurring and mutually reinforcing processes. This complexity presents challenges for transformative change, as efforts to counteract homogenisation must navigate intertwined economic, social, and political forces. Beyond ecological and economic consequences, landscape homogenisation raises important ethical considerations. As landscapes are reshaped, tensions emerge between competing values, priorities, and ways of relating to nature. The erosion of cultural and ecological diversity challenges the ability of multiple knowledge systems and practices to coexist, potentially marginalising certain ways of knowing, doing, and being. Addressing these tensions requires governance approaches that recognise ethical pluralism and the legitimacy of diverse perspectives. By offering a nuanced characterisation of landscape homogenisation, this study contributes insights for action-oriented research and more context-sensitive inclusive sustainability pathways, grounded in the multiple ways landscapes are valued and lived.

Oral presentation

UnWorlding and reWorlding: re-imagining ‘the human’ in a more-than-human world

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In a fast-changing world with multiple crises, taking place at the same time on the planet earth, it is time perhaps to embrace the uncertainties and the unknown, instead of denying or refusing to see it. It is important to be present, in the current situation and as the title of an important book by Donna Haraway says, ‘stay with the trouble’.

Perhaps this is the time and the opportunity to re-think and re-envision what does it mean to be human in a more-than-human world. How can we be part of the world without reproducing binary structures (nature/culture; strong/weak; dominant/dominated; humans/non-humans etc.) or without mainly prioritizing human benefits at the cost of non-humans? How can humans be actors without (or at least with less) anthropocentric goals? Is this type of world even possible?

This call for a paradigm shift, understood as a process of unWorlding and then reWorlding ourselves. In this context, UnWorlding means letting go of our ideas about ourselves (humans) our habits, our perceptions and the way things are working.

This is followed by a reworlding process, which means to reconstruct the world, or attempt to view it differently. In the activity of re-imagining what is to be humans in a world cohabitated by various species, we should first start to pay attention on how the description of natural sciences, landscape ecology or even of the society (descriptive anthropocentrism, meaning explaining what it is) are made. Since descriptions are not neutral and not all the descriptions are made in the same way, they rather carry normative and justice implications which at time are hidden or simply not analyzed sufficiently. Second, it is important to focus on the implications of descriptions.

In this presentation, I try to engage in the unWorlding and reWorlding process, attempting to identify activities, practices, interventions and spaces of knowing and doing that disrupt seemingly hegemonic anthropocentric regimes, binary thinking and prioritization of the economic aspects over all others.

Oral presentation

Linking ethical norms to local empowerment in sustainability transition

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Environmental planning translates goals, such as the SDGs, into spatially and temporally specific objectives and actions. As a normative basis, we use legislative objectives with varying degrees of binding force, alongside quantified, concrete standards like mandatory pollutant thresholds. These legal norms are viewed as democratically legitimized, possessing either obligatory or advisory status depending on their legal enforceability. Within the binding frameworks—such as those for protecting ecosystem services—public participation can contribute to the sustainability transition. However, these avenues for participation may be restricted by national politics, potentially infringing upon participation as an ethical norm in itself. Additionally, the complexity of planning might overwhelm people, leaving them feeling excluded by expert-driven decisions about their environment. Moreover, ethical norms widely shared, such as “Justice and Equity,” may not be adequately represented within legislative frameworks across different political systems. How should such additional normative aspects be addressed in environmental planning, and what approaches exist to integrate them into a constructive participation process that promotes local-scale sustainability? By applying theories and methodologies from environmental ethics, philosophy, and behavioral science, we show how it is possible to transparently break down legally defined and other ethical norms from the international to the local level and empower people in local participation to interactively and constructively participate in the decision-making process on change in their local landscape. Our findings are based on research involving modeling of pathways in the German energy transition, as well as adapting these findings to the local level and engaging communities in the transition process through a new participation tool using behavioral interventions.

Oral presentation

Morphologies of land use reform: Rethinking power in cultural landscapes

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Politics and other interactions involving power relationships are integral to the way humans organise themselves, establish societies and engage in common and individual pursuits. It is therefore also a central theme in landscape research, where power to decide on land use, rights and duties pertaining to land and resources is a key research theme. Based on a review of power concepts used in landscape research, we provide an overview of conceptual formations currently used to investigate land use reform. We define land use reform as processes manifesting intentional breaks with inherited path dependency and vested interests, characterised by actions that shift landscapes into a qualitatively different state of social-ecological functioning. Reform processes informed by internationally agreed political targets typically take place through processes where politics at federal, national, regional and local levels come into contact with global targets, and translate them into land use options and practices on the ground. This takes place through exploration and testing of real-world solutions and measures addressing targets reaching local contexts mediated through power relationships and information transfer. It is therefore critical to understand how reform policy is transmitted, implemented, opposed, reacted to, reinvented and interpreted as it travels across social hierarchies. We discuss how conceptual models of reform processes addressing targeted transformation of cultural landscapes may be redefined and further elaborated.

Oral presentation

Characterizing Life Frames of nature value in protected areas: Insights from participatory mapping in multifunctional landscapes

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The Life Framework of Values, developed by the Intergovernmental Platform on Biodiversity and Ecosystem Services, provides an integrative typology of human-nature relationships (Living in, Living as, Living for, and Living with nature). Despite its potential for informing environmental decision-making, empirical research on Life Frames remains limited. This study applies the Life Framework in combination with spatial analyses to explore links between people's relationship with nature, and the values they associate with places in a given landscape. Using public participatory GIS (PPGIS) survey data from case studies in France and Germany, we empirically characterize Life Frames and examine their relationships with key parameters. Specifically, we investigate: (1) how Life Frames relate to socio-demographic and cultural factors, (2) how they connect to nature values, and (3) their spatial distribution and degrees of overlap across the landscapes in the two case studies. Our findings advance the empirical operationalization of the Life Framework, offering insights into its application for protected area governance, stakeholder engagement, and value negotiation in multifunctional landscape planning.

Oral presentation

Farmers' visions for a landscape of human-wildlife coexistence in the Western Carpathians

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As wildlife populations expand or reappear in landscapes across Europe, conflicts between farmers and wildlife are becoming more frequent. In order to successfully navigate Europe's wildlife comeback, we must learn how to coexist with wildlife. One step towards this goal is understanding how communities that actively share a landscape with wild animals perceive and experience the interactions. Integrating their perspectives into the scientific discourse can inform more effective coexistence strategies that are adapted to distinct landscapes and engage local communities directly, reducing human-human conflict over wildlife management.

Our study explores how farmers across the Czech-Slovak border envision the future of their landscapes and their interactions with wildlife. Through a participatory approach, we collaborated with local farmers to co-create future scenarios, imagining what their landscape might look like in 15 years. These included a scenario of a desirable future, a business-as-usual scenario and two undesirable scenarios illustrating farmers' hopes and anxieties around potential future developments. By translating farmers' perspectives into plausible future scenarios, we provide insights into how those most directly affected view the shared landscape. We further visualize potential futures from farmers' normative point of view, and describe in what way communities can work towards a future of positive coexistence between farmers and wildlife. We identified the following key areas for action: Building a mindset of coexistence, strengthening local communities, maintaining the landscape, improving wildlife management, and improving the economic situation of farmers.

Sharing these local perspectives deepens our understanding of human-wildlife interactions and strengthens the voices of those on the frontline of coexistence. By integrating farmer knowledge into future planning, we can develop more inclusive and adaptive approaches to landscape development and wildlife management—ensuring that coexistence strategies are both effective and locally supported.

Oral presentation

Landscapes as socioecological-ethical constructs: The integration of ethics into ecosystem services selection for land use planning

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The perception and management of landscapes as socioecological constructs are deeply influenced by the structural-functional paradigm that dominates current scientific approaches in this field. This means land use categories as the building blocks of the landscape are not only perceived by their physical structure, but also by their functions and processes that are the emergent properties of a landscape as a whole. An important implication of the structural-functional paradigm is that planners and decision makers can assign an infinite number of functions and processes to a landscape as these are inherently abstract concepts with no physical embodiment. Therefore, not only their definition but also their selection for land use planning inherits a significant and immeasurable level of subjectivity and uncertainty with important ethical implications. In this context, the choice of which functions, i.e. ecosystem services, to be prioritized for optimization during a land use planning process is deeply a moral decision and reflects the ethics and values of the decision makers.

This paper investigates different environmental ethics perspectives and studies how different value systems can affect the definition and selection of landscape functions and ecosystem services. A spectrum of ethical frameworks including deep ecology, consequentialist, deontological and virtue ethics are analyzed. Such insights can help to better understand the feedback loops between landscape research and morality and how different ethical frameworks can trigger different trajectories in the analysis, description, and thus also societal responses to landscape dynamics. Understanding landscapes evolution and its description via research through an ethical lens can help align moral considerations with ecological principles and foster resilient and functioning landscapes.

Oral presentation

Cohabitability: a novel concept for thinking environmental landscape ethics

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In this presentation, we introduce ‘cohabitability’ as a novel conceptual framework for approaching the ethics of land use across different landscapes. Humans actively utilise approximately 50 % of the habitable land on Earth, which highlights the central importance of land use in environmental ethics, particularly concerning nonhuman flourishing and human-nature relations and valuation. Unfortunately, most approaches in environmental ethics are grounded on wilderness-focused assumptions that make them ill-equipped to deal with land use in a theoretically plausible and empirically informed manner. Despite the broadening scope of environmental ethics, the focus has mainly remained on areas outside direct, intentional human modification or on ‘nature generally’, inheriting assumptions and conceptualizations grounded in wilderness ideals. Thus, environmental ethics needs new perspectives and concepts to overcome this theoretical lock-in and to meaningfully address the questions of human land use ethics, both within environmental ethics and with/in other disciplines. We first briefly elaborate on the need for a new ethical perspective and theorizing for environmental landscape ethics. We bring forward the key questions for future landscape ethics and discuss how the demands for plausible ethical theorizing in this respect also link landscape ecology to environmental philosophy. Then, we introduce the conceptual framework of cohabitability and its different constituents. We exemplify the perspectival shift implied by the cohabitability framework concerning concrete cases drawn on landscape-oriented research in, but also beyond, ecology. Finally, we reflect upon the implications that the cohabitability framework can have both in research, especially with regards to philosophy and landscape research, and in the practical realm of ethically assessing various landscape-related practices (land use planning, policies, and cohabitation practices between humans and other species).

Oral presentation

Beavers and the ethics of landscape: rethinking control in social-ecological systems

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Beavers (*Castor fiber*) in Latvia have undergone a governance shift. Reintroduced in the 1920s and later recognized in the 1970s as an important ecological asset, they were initially managed as a resource for fur, meat, and castoreum production. By the 1980s, their populations expanded, leading to conflicts with farmers, water managers, and foresters. Today, even conservation agencies actively advocate removing beavers from small rivers, drainage canals, and ditches, citing their impact on river flow and habitats. This shift – from a harvested species to a managed problem – raises critical questions about how governance frameworks focused on species management, habitat protection, and water regulation intersect with broader landscape change.

Beaver presence challenges dominant landscape management paradigms, which continue to prioritize control and intervention rather than coexistence. While their activities alter hydrological regimes and reshape habitats, they also create conditions for ecological diversity. Despite this, removal remains the primary response, often justified as landscape management. This governance logic reveals a deeper ethical and political question: should social-ecological landscapes be managed as fixed systems based on human-defined stability, or can they accommodate non-human agents as active participants?

Using examples from recent conflicts over water and land use, we explore how beavers disrupt dominant visions of landscape order. Drawing on landscape ethics, just transitions, and more-than-human governance, we examine how beavers expose the limits of human-centered landscape management, what governance alternatives exist beyond their removal, and what a just transition in beaver-inhabited landscapes could look like. By moving beyond a managerial approach, we argue for a governance perspective that recognizes beavers not just as disturbances but as co-creators of dynamic social-ecological landscapes. Their presence forces us to reconsider not only how landscapes function but also the multiple and competing claims to their use and transformation.

Oral presentation

Session 3K – Enabling Co-Governance of Urban Landscapes Amid and for a Rapidly Changing World

Symposium

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Keywords: urban landscapes, urban nature-based solutions, urban green spaces, collaborative governance, reflectivity, flexibility, accountability, inclusion

A successful response to the rapid changes and uncertainties caused by accelerated population growth, unsustainable environments, increasing extreme events, and significant inequalities in cities' landscapes requires a shift in how urban landscapes are governed. Top-down, hierarchical, and monocentric governance approaches—dominated by siloed sectors and responding to political and financial agendas often disconnected from local circumstances—are no longer sufficient to address the complex and multifaceted challenges urban landscapes face. The wicked problems threatening and influencing them require an integrative and transdisciplinary actor collaboration specific to local contexts that foster i) the inclusion of multiple perspectives, needs, and knowledge; ii) flexibility to adapt to unforeseen changes; iii) reflectivity to guide and re-shape the way forward; iv) and accountability on the short- and long- term to recognize socio-environmental circumstances and ensure long-lasting benefits. The importance of more alternative and collaborative governance approaches has grown over the past decade with increasing calls to broaden perspectives to include all processes encompassing co-creation, co-design, co-implementation, co-management, and co-monitoring. However, collaborative governance of urban landscapes remains a challenge in practice. Knowledge and experiences on how to enable such processes influencing or supporting urban transformations are still limited and often clash with governance practices in place, hindering their implementation. We invite conceptual and case study presentations that bring forward methodologies and experiences (good or bad) spanning the broad range of governance applications from co-creation to co-monitoring. Contributions can take an integrative perspective encompassing whole governance systems or in-depth insights on enabling or hindering factors to promote inclusion, flexibility, reflectivity, and accountability in urban landscape governance. Moreover, we welcome contributions from practitioners and researchers involved in the governance of urban landscapes, nature-based solutions, urban forests, and green spaces from different environmental, economic, and socio-cultural contexts. Through a co-learning roundtable setting with speakers and participants, the key messages and recommendations for collaborative governance will be synthesized.

Towards Inclusive Nature-based Solutions: Criteria for Equitable Implementation of Nature Based-Solution in cities

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Widely integrated into global research and policy agreements, nature-based solutions (NbS) offer approaches to address both environmental and societal needs. While NbS have been gaining in popularity, some challenges remain in their development and implementation, including the need for greater inclusivity and justice, particularly in the context of urban greening initiatives.

Our study presents a systematic literature review on NbS at the European level to define the intersecting parameters for inclusive NbS. We searched the relevant literature in the Scopus and Web of Science databases, acknowledging that the topic spans both ecological and social domains, to capture the full scope of equity and inclusiveness. A content analysis of the final sample was employed to gain deeper insights into the concepts of equitable and inclusive NbS.

A total of 13,027 publications were retrieved. After several screening sessions, a total of 280 publications were retained for the final analysis. We have therefore extracted the relevant criteria that support equitable and inclusive NbS across Europe. According to our analysis, hybrid or multi-actor governance and the involvement of all relevant stakeholders, from the early planning phases to implementation, monitoring, and learning stages represent one of the most important criteria. Additionally, considering vulnerable groups is emphasized as crucial to mitigate existing inequalities and inequities in urban areas. We have further examined the characteristics of the vulnerable groups and found that the distribution, access, and use of NbS vary mainly across age, followed by ethnic identity and socio-economic status.

Our findings contribute to the ongoing discourse on just and accessible NbS, providing insights for policymakers, urban planners, and researchers striving for more inclusive and sustainable cities. We outline key lessons learned from case studies where equitable and inclusive NbS have been successfully implemented.

Oral presentation

Land resources and knowledge as key resources for future resilience of the city food system in Oslo, Norway

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The degree of self-sufficiency in food in Norway is just above 40 percent. Currently, 83 percent of Norwegians live in urban areas, and most arable soil is situated close to the major cities. During the First World War, Oslo's allotment gardens were important for food supply, and potatoes were grown in the Royal Palace Park. In a future crisis, areas within or near the city might again become more important for cultivation of vegetables such as potatoes and carrots. In addition, some livestock farming might be done, for meat, milk, eggs, and manure. On behalf of the Regional Office of Agriculture and the Agency for Urban Environment, we have examined the potential for food production in the City of Oslo. Our focus was on 1) agricultural land registered in the Land resource map 'AR5' of 2023, 2) land that was registered as fully cultivated on an early version of the Economic Map series in the early 1980s and that is registered as covered by vegetation in the Green Structure map of 2024, and 3) land registered as potentially arable. The total area belonging to one or more of these categories is 1,669 hectares; however, the register of agricultural production subsidies and the municipal master plan indicate that much potential is currently unused. Increased intraurban food production might thus make a significant contribution to the city's food security over shorter periods, such as in situations when transport options are limited, whereas the potential production volume over time relative to the population size is limited. Therefore, increased production, especially in urban agriculture, can primarily contribute to building and maintaining awareness and knowledge about food production and about the importance of preserving arable land resources in the population. Such knowledge can be challenging to maintain unless measures are implemented. An option could be to establish networks of experts in agricultural production, particularly in urban agriculture. Also, broad participation among the population in the city's food system can foster and sustain essential knowledge about cultivation. This applies regardless of whether participants are active growers, shareholders in community supported agriculture, or simply customers. Greater knowledge of cultivation means a city could become more self-sufficient in the event of a crisis, and this knowledge can also be applied beyond the city borders. At the same time, participation in the food system fosters social connections, which can have a reinforcing, positive effect on resilience in society. From this perspective, it is crucial to preserve the capacity of food production in Oslo as part of preparedness planning.

Oral presentation

Co-governing urban nature – between policy ambitions and local realities in German cities

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Co-governance – or similar collaborative approaches such as co-design, co-creation or co-production are widely promoted in urban policy including the “New Leipzig Agenda” or “Urban Nature Plans” to implement the EU-Biodiversity Strategy 2030. Based on findings from two German research and development projects, we will present conceptual approaches and results from case studies.

The first project focused on a dialogue about Urban Nature Plans, which led to recommendations for German municipalities in the development of these plans (Hansen et al., in prep.). According to the European Commission (EC), Urban Nature Plans are to be developed in a co-creative process (EC, 2024). During the dialogue with national stakeholders from urban greening and nature conservation as well as in workshops with municipalities and through the evaluation of planning documents it was evident, that most German municipalities are familiar with the lower levels of participation such as consultation in relation to urban nature, but that co-creation presents a novelty and a challenge, also in terms of competences and resources. Nevertheless, the call for co-creation was seen as an opportunity to promote innovative participation and co-creation processes.

The second project developed the German digital “Toolbox Urban Nature” (www.bfn.de/werkzeugkasten-stadtnatur), designed to support German municipalities in promoting urban green infrastructure. Innovative process design is a core component of the toolbox building on five components: internal co-operation, new forms of co-operation, participation, communication, and use of resources. These components are supposed to make green infrastructure planning, implementation and maintenance more effective. “New forms of co-operation” represent co-governance approaches and were categorized into three types: (1) “new co-operations” in which municipalities, civil society, local economy or academic institutions undertake activities together but in a temporary or less formalized format (e.g. during the design of green spaces or during a research project). (2) “Co-production” can be described as the equal development, decision-making and implementation of green infrastructure by partners from different areas of urban society. In contrast to the first form, there is not just partial cooperation, but comprehensive joint design and decision-making. The stakeholders actively plan and implement the green infrastructure together. Co-production requires new structures for assuming responsibility. (3) “Self-organization” describes urban nature initiatives started by citizens, companies or other stakeholder groups, which might operate independent from the local administration and take over roles and responsibilities for the common good. The “Toolbox Urban Nature” data base presents 69 good practice cases, 39 of which include co-governance approaches. We will present selected cases and their specific approaches of co-governance.

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Concluding, we will discuss the potentials and challenges of co-governance in a country with a high degree of state responsibility and complex established administrative procedures for urban greening such as Germany.

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Oral presentation

Shaping the future with the neighborhood: The JUSTNature Project Experience in Leuven

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As urban environments increasingly face the effects of climate change, such as heat islands and flooding, nature-based solutions (NbS) provide an essential strategy for building more resilient cities. The JUSTNature project aims to support the transition to low-carbon cities through NbS, while ensuring a just approach to urban development, emphasizing the right to ecological space and voice for all. In collaboration with seven cities, the project is implementing diverse NbS across Europe while striving to foster a more collaborative governance approach.

Leuven, as a pilot city within the project, is using the Constantin Meunierstraat street as a testbed for integrating NbS into urban street design and planning. Prior to major infrastructure renovations, a temporary green installation was set up to demonstrate the potential benefits of greening, such as reducing heat, and enhancing public space. This installation also serves as a tool to engage the local community in the design process, showcasing the potential impact of green interventions on the neighborhood and the benefits and challenges of experimenting with more collaborative approaches toward NbS governance.

Through participatory workshops, surveys, and presentations, Leuven has involved local residents and stakeholders in shaping the future of the street—gathering diverse voices before, during, and after the process. Feedback from these workshops led to adjustments in the design, including increasing green spaces and testing one-way traffic to create room for the implementation of nature based solutions and public gathering spots. These temporary changes provided real-time insights into the feasibility of NbS and fostered community ownership and recognition during the transformation process. The project also fostered cross-departmental collaboration to bridge gaps in siloed administration and enhance communication.

The Leuven pilot offers a valuable case study on the challenges and opportunities of co-governing NbS, highlighting not only the importance of community participation in the design and implementation of climate adaptation strategies but also of the involvement of multiple departments and actors. This presentation will reflect on the lessons learned, including the successes and difficulties encountered, to inspire and guide other cities and practitioners to embrace similar co-governance approaches in their NbS projects.

Oral presentation

Governance of Nature-based Solutions: Insights from a global survey.

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To support the development of healthy, climate-responsive, and just cities, Nature-based Solutions (NbS) are being increasingly promoted. Successful planning, implementation, and management of NbS are inextricably linked to a transition toward adaptive collaborative urban governance. However, this transition is hampered by entrenched practices, such as siloed thinking, risk aversion, and path dependency, limited knowledge about the processes of planning, designing, and managing urban NbS in which aspects of governance come into play. Despite the proliferation of assessment frameworks for NbS, these frameworks address governance processes only to a limited extent. This narrow scope can also be seen in studies on NbS governance, which often focus on collaborative approaches with non-governmental approaches, overlooking the role government continues to play in NbS governance. A more systematic understanding of NbS governance is needed, grounded in comparative multinational studies across different cultural contexts and governance regimes. To address this knowledge gap, van der Jagt et al. (2023) developed a survey with open and closed questions regarding nine governance dimensions derived from a systematic review. This contribution advances this survey by adding three additional indicators, acceptance and uptake, strategic and incremental planning process, and community-based knowledge, to build a better picture of possible bottlenecks and enablers for NbS co-governance. Focusing on cities across Europe, Latin America, and beyond, this revised survey was conducted with key actors in urban NBS governance and planning across diverse countries and continents. The survey was made available in four languages: English, Spanish, Portuguese, and Italian—from March 17 to June 20, 2023—and received 100 valid responses. The results, with 58% of the entrees from Latin America, 31% from Europe, 6% from Asia, and 4% from Africa, show that the Acceptance and Uptake of NbS are well on their way. However, the governance of NbS, as addressed in the other dimensions, needs substantial improvement. The dimensions of Advocacy, Stakeholder Networks & Partnerships, and Active Community Engagement are well-acknowledged in all regions, although not always well implemented. Differences between regions show that the main challenges are more context-dependent, with Europe rating Financing Mechanisms the lowest and Latin America Community-based Knowledge. Latin American respondents rated overall NbS governance lower than their European counterparts. In all regions, local governments were seen as key actors, often supported by

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the third sector and civil society, but not the private sector. Projects are seen as an important enabler as they bring people and knowledge together and allow us to test new approaches and, in such a way, form a starting point for longer-lasting change.

Oral presentation

Session 3L – Condatis Connectivity Analysis to Plan Resilient Habitat Networks

Training Workshop – not open for abstract submission

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Keywords: connectivity, conservation, planning, climate change, restoration, population dynamics, network structure

Condatis is decision support software to identify the best locations for habitat restoration to increase connectivity across landscapes. It can help planners to find multiple-win solutions for land management, so that biodiversity can recover and natural ecosystems can co-exist with human activities. Condatis's metric of long-distance connectivity is particularly relevant under climate change, ensuring that networks of habitat facilitate range shifts. Condatis: • Highlights pathways across a landscape that allow both dispersal and reproduction of species; • Pinpoints bottlenecks in the habitat network, where there are restricted opportunities for colonisation, and where restoration would be most impactful; • Ranks the feasible sites for habitat restoration, to efficiently enhance the existing habitat network. Condatis has been developed since 2015 and has been used by conservation practitioners around the world, via its web application (see Condatis.org.uk). Through collaboration with users, we have designed it to be fast and user-friendly, and to work with the kind of data that organisations typically have. This workshop for IALE delegates will provide a series of graded exercises, showcasing the different functions of Condatis. There will be examples using the web app as well as the R environment. Attendees will need some familiarity with GIS, e.g. reading, writing and querying raster data. After the exercises, there will be a Q&A session, and attendees may request to look at certain outputs in more detail. Our examples will include a recent project of relevance to policy in England, UK, where a series of 'Local Nature Recovery Strategies' are published for the first time in 2025. Mapping of connectivity bottlenecks across England's broad seminatural habitat networks was conducted to inform these strategies (<https://doi.org/10.7910/DVN/VI7HXP>). 'Search zones' based on bottlenecks are convenient for time-pressed practitioners to use and combine with other spatial data.

Session 3M – River Restoration Strengthening Green Infrastructure

Symposium

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Keywords: renaturation, streams, ecosystem services, stakeholder analysis

This session shall focus on the restoration of streams in urban or suburban areas as backbone for strengthening green infrastructure. Together with a valorization of watercourses as ecological connectors and habitats, designing their banks and environment as greenways and experience area for people help to enhance the ecosystem services and live quality. Such measures that enhance ecosystem services and biodiversity are called as nature-based solutions. The session aims to collect innovative ideas, frameworks to assess them and to adjust with stakeholders in order to make them appreciated and sustainable. The session will address several examples in European cities, the need for action, problems of implementation and transdisciplinary methods to co-design the according nature-based solutions with residents and stakeholders.

Enhancing Landscape Resilience through Flood Discharge Water Collection and use for Agriculture

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Effective flood-drought mitigation programs are essential for the sustainable land use and agricultural development in many regions worldwide, including Kazakhstan, which is prone to big fluctuations of flood and droughts. We are developing the landscape resilience, improvement of the farmer's land use with comprehensive land categorization in the Panfilov District, south east of Kazakhstan, near the border with China. We have categorized the local lands into seven types of land categories, including 1) agricultural land, 2) settlement lands (cities, towns, and rural settlements), 3) industrial lands, such as transportation network roads and other non-agricultural purpose lands, 4) protected lands, as well as recreational land facility regions, 5) forest lands, 6) water covered lands, 7) reserve lands. Next, from these categorizations, we selected areas, which could be used for the agricultural needs with the proper soil quality from the selection 1) agricultural land, and 7) reserve land. Within these two groups 1) agricultural land, and 7) reserve land, the next level categorizations were provided by the division into eight categories, based on land user types: A) backyard gardening lands; B) small farming lands with animal husbandry; C) joint partnership farm land use; D) agricultural cooperative lands; E) Big agrarian corporation lands; F) Research and education training lands, connected to the agricultural Technical and Vocational Education and Training (TVET) programs; G) Agricultural crops processing lands used for storing, processing, and maintaining agricultural products; H) Other agricultural land - land belonging to various agricultural organizations that is not included in the above categories. These farming groups have been having good quality soils, but most of them require water for their farming lands. We have worked on development of the integrated flood drainage water retention program, which should work on the potential areas where water could be located and could be delivered to these farming groups of water users. From the seven types of land categories, the two of them 4) and 5) were with excessive water from the glacier snow melting, emergency, dangerous level water collection areas. It was necessary to plan properly the flood mitigation activities, without harming the Nature, flora and fauna. A gravity-driven irrigation system with a water pipe supply system from the elevated areas to lower-lying agricultural zones is under investigation. A case study focuses on Aidarli village, where 1,000 hectares of fertile land can be optimized, changed from the crops into apples and peaches growing with the drip irrigation network setup. The proposed approach aligns with nature-based solutions by integrating flood water management with green infrastructure, promoting sustainable land use and water conservation. Slovakia's initiatives in "water for climate healing - the new water paradigm and public policy" <https://www.youtube.com/watch?v=NPx-tiTrqNQ> with contour-strip land organization under our investigation also for the adaptation. Carbon farming also could be a

connected support mechanism for Kazakh farmers to adapt with economic incentives, which we need to learn from the EU experts. These findings highlight the need for state investment to implement advanced irrigation systems and adapt crop selection strategies for long-term agricultural viability. The Kazakh Ministry of Science grant # BR27197639 "Development of Innovative Hydrogeological Methods for Water Resource Management in the Zhambyl, Almaty, Zhetysay, Abay, and East Kazakhstan Regions" supports this project. The current status of the project activities will be presented.

Oral presentation

Ecological restoration goals for urban streams

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Urban streams are degraded due to multiple stressors and anthropogenic pressures. Ecological or historical restoration is often not possible due to chemical contamination, a strongly fluctuating hydrography, a lack of space for natural dynamics, a limited species pool for recolonization and many instream migration barriers. Defining less ambiguous goals, but going beyond instream channel enhancement and human aesthetic standards is an opportunity to target ecosystem functionality and increased biodiversity in urban streams. Within the international research project ReBioClim we will identify and analyze the current urban challenges and opportunities for river restoration from different perspectives in four different countries and extract the trade-offs between social and ecological requirements in the context of urban planning and institutional settings.

To set realistic restoration goals in terms of feasibility, achievability and measurability we develop a comprehensive method based on chemical, geomorphological and biological data collection and stressor analysis. In a next step, we establish an urban reference systems based on numerous biological datasets from Water Framework Directive (WFD) monitoring data. These will allow us to prioritize urban stressors and set restoration targets. We consider spatial and administrative constraints to formulate ecological targets that are understandable, measurable and achievable. These criteria are particularly important as ecological restoration targets are combined with urban-spatial analysis and socio-economic objectives as the basis for stakeholder co-design workshops and are made available to communities as projects are implemented in our project sites.

Oral presentation

How to identify and engage stakeholders in urban stream restoration?

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Streams in cities have often been heavily anthropogenically modified, straightened and often forced into an artificial bed. As a result, they can hardly function as green infrastructure today and only provide very limited ecosystem services. However, these would be particularly important for adapting cities to climate change, increasing biodiversity and improving the quality of life in cities. The restoration of streams could therefore offer cities a number of benefits.

However, the planning and implementation of stream restoration projects can face many obstacles and challenges, including lack of space, ownership rights to neighbouring properties, differing interests among stakeholders, low levels of acceptance and flood protection issues.

A participatory approach from the very beginning of the planning process is essential to overcome obstacles and meet challenges at an early stage. It should involve many different stakeholders, including the local residents, to raise awareness of the importance of biodiversity and ecosystem services and to increase the acceptance of restoration measures. This means that restoration goals should be defined jointly, nature-based solutions should be developed in co-design and the implementation of restoration measures should be organised collaboratively.

This raises two questions i) How do I identify the stakeholders that are relevant for a specific stream restoration project? and ii) How can I reach and engage them?

The presentation will show the lessons learnt from the first year of the Interreg Central Europe project ReBioClim 'Restoring urban streams to promote biodiversity, climate adaptation and to improve quality of life in cities' and illustrate them with examples from the four case study cities Dresden (Germany), Senica (Slovakia), Poznan (Poland) and Jablonec nad Nisou (Czech Republic).

Oral presentation

The concrete riverbed is no longer favoured: How to take residents' preferences into account when restoring streams in urban areas

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Urban streams have undergone significant changes over time. Natural watercourses have been progressively regulated, often transformed into concrete channels or diverted into underground pipes. As urban development has advanced, these streams have lost their natural character and, with it, many of the ecosystem services they once provided. In light of biodiversity decline, impacts of climate change, and the growing emphasis on adaptation measures—particularly nature-based solutions—there is increasing interest in reversing these past interventions and restoring urban streams to their natural state. Although recent years have seen a rise in stream restoration efforts in both urban and open landscapes, successful implementation requires interdisciplinary cooperation. This involves addressing multiple constraints, not only those arising from natural, technical, and spatial conditions. In addition to securing financial resources, it is crucial to reconcile the interests of diverse stakeholders, engage with private landowners, integrate nature-based elements with technical or hybrid solutions, and consider the needs and preferences of local residents.

This paper presents a methodology for using a questionnaire survey based on a choice experiment to capture residents' preferences and needs in an inclusive stream restoration design. This approach, applied in four Central European cities as part of the ReBioClim project in 2024 and 2025, reveals not only preferences for individual restoration elements but also combinations of elements that represent different approaches to river restoration.

The case study of Jablonec nad Nisou (Czech Republic) illustrates that only 12% of respondents prefer the current form of the Bílá Nisa stream, which flows through a concrete channel and completely lacks nature-based features. In contrast, results from the choice experiment indicate that over 87% of respondents favour a nature-based form with meanders and accessible riverbanks featuring stairs and piers.

These findings support the co-design process of stream restoration by incorporating residents' preferences. Moreover, by identifying the characteristics of the group that prefers the existing form, it becomes possible to tailor communication strategies more effectively to address their concerns.

This contribution will also present additional results, including preferences for specific restoration measures and a comparative analysis of choice experiment outcomes across the participating cities.

Oral presentation

Assessment of the condition of watercourses in the Poznań Metropolitan Area as a starting point for planning restoration activities

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Metropolitan areas are characterized by the greatest dynamics of spatial and socio-economic processes. In the context of climate change and the need to protect biodiversity, one of the key challenges for the main development centers in the country is the integrated water resources management, including through the implementation of the restoration of heavily modified water bodies, which currently dominate both in the metropolitan centers themselves and their suburban areas.

The condition or potential of surface water bodies is largely dependent on the management of the catchment. The state of water is affected by all pressures caused by human activity, such as pollutant emissions or intensive fertilization. These factors cause the condition of water to deteriorate, and thus their quality decreases, which significantly affects ecosystems dependent on water, as well as for people.

In this work the Poznań Metropolitan Area, which consists of 45 communities, was selected as a case study. Analyses were carried out to group municipalities using the Ward method on the basis of selected factors, such as the share of agricultural crops, built-up area, use of fertilizers on agricultural land, percentage of population using the sewage system and livestock for agricultural land. Analyses were carried out to differentiate the assessment of ecological status or potential, chemical status and overall status for the designated groups. Publicly available monitoring data from the monitoring network of the Polish institution, the Chief Inspectorate for Environmental Protection, were used for the calculations and analyses. Furthermore, based on the analyses carried out, it was determined how the assessment of status or potential changed in selected years of the first and second water management planning cycles. For the identified groups of municipalities, it was determined which factors determine the reported quality classes of surface water levels in the analysed area.

Oral presentation

Blaues Band Geberbach – Starting point and pilot area ReBioClim

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Dealing with increasingly frequent and intense periods of heat poses a major challenge for urban planning. The creation of a multifunctional blue-green infrastructure offers a practicable and sensible solution for climate adaptation to improve the urban climate and quality of life and to reduce damage during extreme weather events, as it combines hydrological functions with urban greenery.

In order to provide people with walkable access to climatic recreational areas, especially in hot and dry weather, the large-scale renaturation project Blaues Band Geberbach has been running since 2017 under the direction of Katja Schumann, Environmental Agency of the City of Dresden. The Geberbach is to be restored in two sections over a length of around four kilometres and made accessible to people. In the first section, the Geberbach is currently disappearing into a pipe and is to be opened up along a new route. The pipework in the road will remain in place and will be used as a relief channel to divert rainwater and floodwater in the future. In the second section, the Geberbach is located in a concreted embankment and runs along gravel lakes in the Niedersedlitzer Flutgraben to the Elbe. The project aims to meet the challenges of climate change by improving the ecological condition of the stream, flood protection and the recreational and connecting function for people, as well as connecting green spaces and biotopes.

Upstream of the Blaues Band project area, two further sections of the Geberbach are to be restored and made accessible as part of the Interreg project ReBioClim, which was launched in 2024. The first section is located in an urban district, while the second section is located in a suburban district. This results in different challenges for stream renaturation in the two sections. The ReBioClim project pursues similar goals to those of the Blaues Band: the quality of life in cities and biodiversity are to be improved and the stream habitat adapted to climate change. In order to achieve these goals, it is very important for the project to involve local residents, stakeholders and interested parties in the redesign process. The experience gained will ultimately be made available in a best-practice guide and a handbook for other cities.

In this presentation, you will gain valuable insights into the ongoing implementation of renaturation projects from the perspective of the Dresden city administration.

Oral presentation

Edible plants along urban streams as ecosystem service and feature of nature-based solutions

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Modern cities are faced with a high density of urban fabric and an estrangement of people from nature. Urban streams and their green surroundings could be the backbone of a valuable urban green infrastructure, but they have often been restricted to small stripes and forced into concrete embankments. Issues of flood control, nature conservation and climate adaptation require to restore urban streams as nature-based solution. The benefits people can obtain from the restored stream and the surrounding green space are ecosystem services. The success of stream restoration should be measured by an enhancement of ecosystem services.

To design nature-based solutions, sound assessment methods are needed. While streams in the urban context provide a high range of regulating and cultural ecosystem services, there are only very few provisioning services that can be provided by urban streams and their green spaces. The provision of edible plants by riverside green spaces for healthy food and a re-connection of people with nature is among them. Since there are hardly applicable methods available, the authors developed an assessment scheme. This scheme uses on the one hand citizens' voting about plants they appreciate. On the other hand, seasonal availability and the current presence and frequency of edible plants are taken into account.

The method allows to assess, select and justify solutions that make the stream area more valuable by planting shrubs and trees with edible fruits or develop areas with useful appreciated herbs. The contribution shows prepared voting material, the collection of appreciated plants and first assessment results in a study region of Dresden, Germany.

Oral presentation

Participatory processes of urban river restoration - experiences from Slovakia.

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A traditional example of urban river regulation, typical of the 20th century, is a strictly technical monotonous solution which, in addition to the degradation of river ecosystems, also led to total isolation of people from the river. Coordinating different restoration interests and ideas about the shape of a river in a city tends to be a challenging and long-term process, requiring the participation of experts from various fields. Search for appropriate forms of public involvement is a hot topic for research. The study presents two different examples of participatory processes in Slovakia.

The Danube River is a large river flowing through Bratislava, the capital of Slovakia. Its channel has been heavily regulated for international inland navigation, significant urbanisation, but also for hydropower (Gabčíkovo Dam). The restoration measures have been proposed to improve the hydromorphology of the 15.6 km long reach by restoring three side arms and restoring the natural riverbanks. These works will also enable public recreation, relaxation and education in a natural environment right in the city, in newly established area “Bratislava Danube Park” (BDP). Proposals of measures were preceded by participatory processes on a large scale. The group of experts from different fields drew up a strategy document for the sustainable use, protection and restoration of the Danube. The municipalities and other stakeholders were consulted in detail on the BDP studies. The public expressed its opinion by petition, with the opportunity to participate the guided tours and public discussions. The complex and long process led to the unification of the idea confirmed by the Memorandum signed by the municipalities, state institutions, civic conservation associations and interest groups.

In the small Teplica River in Senica, a 1.2 km long reach is being restored. The straight trapezoidal channel and concrete banks will be altered to increase the level of flood protection and to improve the hydromorphology. The plan was technically designed by river engineers in collaboration with architects and river manager. On the adjacent reach within the urban park, local nature-based solutions, improvement of the flood protection and the creation of access to the river are planned. The next phase will involve the public using scientific methods in the consultation ("choice experiment" using illustrative images) and in the design itself (co-design workshop).

Based on the experience of the above projects, it seems to be an advantage when the river restoration is advocated by experts with a technical water management background. River restoration schemes typically raise concerns or resistance from river managers and water engineers with the traditional single-purpose approach that was most often applied in the 20th century. It is experts with the same, but extended education who can effectively dispel their concerns with professional arguments and a common language.

Oral presentation

Designing co-design workshops in socio-ecological integration projects: challenges and opportunities in the ReBioClim project

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This research elaborates on a co-design workshop methodology that was developed during the Interreg Central Europe project ReBioClim (Restoring urban streams to promote biodiversity, climate adaptation, and improve quality of life in cities). The methodology was implemented in four case cities – Dresden, Germany; Jablonec nad Nisou, Czechia; Senica, Slovakia; and Poznań, Poland – each with different environmental and social conditions, and capacities. The workshops aimed (1) to achieve inclusive participation of diverse stakeholders and viewpoints and (2) to facilitate social-ecological integration through open dialogues. Experts, from ecological, technical, social, or economic fields, as well as citizens could participate equally in co-designing solutions that blend ecological goals, community priorities and situated knowledge. A key challenge during the process was creating tailor-made workshops that adapt to the specific needs, capacities, and starting points of each case city. In response to these challenges and previous experiences in design workshops, we devised a modular methodology that can be effectively adapted to local conditions, as well as different formats and target groups. The proposed methodology was used as a tool for integrating situated knowledge into urban stream restoration projects, and to highlight the role of communities in creating inclusive, place-based designs that relate to the local challenges and needs and maintain momentum after the project's completion.

Oral presentation

Identifying spatial synergies and conflicts for urban stream restoration in the ReBioClim project

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Urban stream corridors are critical elements of green and blue infrastructure, contributing to climate adaptation, biodiversity, and the quality of urban life. However, many urban streams worldwide have been altered, buried, or degraded due to urbanisation, channelisation, and infrastructure expansion. These modifications have not only diminished ecological functions but have also intensified urban flooding, increased heat retention, and weakened social connections to natural water bodies. Developing effective restoration strategies requires an integrated understanding of geomorphological, ecological, and socio-spatial factors within these corridors. However, the extent to which these factors interact positively or lead to conflicts in restoration planning remains insufficiently studied.

To address these challenges and opportunities, we put forward a methodology for identifying spatial synergies and conflicts in urban stream restoration. Focusing on the four urban streams of the ReBioClim project located in Germany, Czechia, Poland, and Slovakia, we applied geospatial analyses to assess key factors that influence restoration potential. These factors include stream morphology, land use, landscape connectivity, and socio-spatial characteristics such as urban density and accessibility to key locations. By analysing the relationships between these variables, we identified typologies of areas where ecological, hydrological, and socio-economic interests either support or compete with each other.

The findings of this study provide a basis for urban design strategies and participatory planning in Central Europe, and potentially beyond. The identified synergies and conflicts are used as a foundation for co-design workshops, where citizens, urban planners, and policymakers engage in the decision-making process. By visualising the effects of different restoration approaches, these workshops support the development of strategies that integrate ecological improvements with urban requirements. This research offers a structured approach to guiding urban stream restoration efforts, ensuring they contribute to more resilient, inclusive, and adaptable cities in response to climate change.

Oral presentation

Fostering Participatory Urban River Restoration through an Ecologically-Integrated 3D Visualisation Tool

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The ecological health of rivers is directly linked to the availability of appropriate levels of daylight, which sustains aquatic and riparian communities and ensures the sustainable delivery of ecosystem services. However, many urban rivers have been culverted, significantly reducing daylight exposure and impacting ecological functions, such as disrupting natural water filtration, altering aquatic habitats, reducing biodiversity, and impeding nutrient cycling. In response, daylighting—the process of restoring buried rivers to the surface—is increasingly integrated into urban blue-green infrastructure planning.

Urban river restoration is a complex multi-stakeholder process, as rivers flow through multiple land parcels managed by different owners and utilized by diverse residential groups with conflicting interests. Effective stakeholder engagement is essential for raising awareness of existing conflicts while fostering collaborative solutions. Yet, stakeholders often struggle to make meaningful contributions due to limited ecological knowledge and planning experience, making it challenging to evaluate alternatives and anticipate outcomes.

The City of Zurich in Switzerland is a global pioneer in daylighting urban rivers (particularly streams). However, 31.4% of its waterways remain culverted, with 49.3 km out of a total 157.1 km still enclosed. While some stream sections are buried solely at road crossings, making daylighting infeasible, most culverted segments are longer and remain enclosed due to, either, overhead infrastructure, such as railways and roads, or their passage through densely populated residential areas, posing significant challenges to restoration. Notably, 12 culverted sections exceed 1 km in length, with two stretching over 3 km, significantly fragmenting ecological connectivity, weakening hydrological resilience, and degrading aquatic habitats, making their restoration particularly urgent.

With Zurich as a case study, we aim to develop an ecologically-integrated 3D visualisation tool leveraging video game engine technologies to support stakeholders in co-designing urban stream restoration scenarios. By integrating environmental data, ecological models, planning regulations, and interactive 3D visualisations, the tool automates the generation of landscape elements procedurally, including daylighted rivers and riparian vegetation communities. It enables users to explore and combine land-use and restoration alternatives dynamically. We present the tool's development workflow, encompassing landscape modelling, automated landscape element generation, and integration with a user-friendly graphical interface for interactive co-design. The study concludes by discussing the tool's potential to enhance participatory river restoration while outlining future research directions.

Oral presentation

Integrating of the Downtown section of Bükkös stream (Szentendre) in the Blue and Green Infrastructure Network

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Streams play or would play outstanding role in the blue and green infrastructure networks. In urban environments, they often function like treeless, mowed, even grassless, paved beds. They have a low BGI and ESS function, very low naturalness and hardly any ecological role. However, the society, right in the urban areas, needs a living stream, which accompanied by a diverse, wooded lane, to mitigate the heat islands and help recreation. Streams have prominent ecological and conservation role. Their regenerative capacity is relevant and should be taken into account in planning processes. My study, which started in 2022, focuses on regeneration of an urban stream section and its integration into the GBI network.

The 18 km long Bükkös stream is located in Hungary, North from Budapest. It originates in Visegrád Mountains, flows into the Danube at Szentendre Downtown. Szentendre is a town of 30.000 inhabitants, and an important administrative, educational, health and turistical centre. Changes of streamside vegetation lane were studied by archival maps, orthophotos, satellite pictures and descriptions. A botanical survey of the 4 km long urban section was carried out between 2022 and 2025, based on the ÁNÉR 2011 methodology. A habitat map and a list of botanical species for each stream section were carried out. A fish faunistical survey was made in 2023, on ten sections, with electric fishing device. Seven sections of them located in urban and suburban areas.

By the end 18th century, almost the entire wooded vegetation along the stream was cut out to create pastures and reapers. The stream bed was later regulated, which changed the morphology of the valleyfloor and thus the water regime and the local conditions. The valley floor spontaneously reforested in the 19th és 20th century, except the 700 m section of the Downtown, but in new habitat conditions. There, mowing and dredging impede natural processes. In the 1970's, a 1,2 km long stream section was concreted, but the trees of the 500 m long wooded section were spared.

The woody vegetation type typical of the landscape (streamside alder grove) is present in sections, or its dominant tree species is common in several places, along with other native species and invasive species. The streamside woody vegetation could not develop due to maintenance work on the downtown stream section. However, the regeneration potential is high, therefore, it is worth taking into consideration by planning. Experiences of reforested urban sections can eliminate the difficulties of spontaneous reforestation natural and human effects, e.g. shading by mature trees, trampling, maintenance works, invasive species, concret lining, artificial bedmorphology.

Poster presentation

ReBioClim – Restoring urban streams to promote Biodiversity, Climate adaptation and to improve quality of life in cities

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In times of global warming, declining biodiversity and continued pressures of urbanisation, it is the moment to reconsider the role and quality of urban streams. Creating green and blue corridors not only significantly contributes to building climate-resilient cities by improving microclimatic conditions in overheated cities or providing fresh air corridors, it also connects stream reaches, provides floral and faunal habitats, as well as recreational spaces that improve human wellbeing. Unfortunately, urban streams have become increasingly invisible: over-built, channelised and degraded by anthropogenic use. Restorations in urban areas with nature-based solutions (NBS) face many barriers and challenges: lack of space in intensively built-up areas, property rights of surrounding land, funding, different stakeholder interests, acceptance, and flood protection. Biodiversity in these stream areas is often perceived as a problem of limited importance. To face these challenges, it is necessary to perform an integrated analysis of ecology, stakeholder interests, institutional frameworks, social perspectives and urban space requirements. In ReBioClim, researchers, local public authorities and practitioners work together to strengthen the sustainable provision of biodiversity and ecosystem services provided by (peri-)urban streams to foster climate adaptation, citizens well-being and quality of urban environment by improving the planning, the application and the management of NBS solutions in urban stream restoration. The focus in ReBioClim is on four study stream areas located in Dresden (DE), Jablonec nad Nisou (CZ), Poznan (PL) and Senica (SK). We will identify and analyse the current urban challenges and opportunities together with stakeholder groups with different perspectives and extract the trade-offs between the social and ecological requirements in the context of urban planning and institutional settings.

To integrate, test and refine the results from our analyses and modelling activities, we place a series of stakeholder Co-design workshops, restoration plans and initial restoration activities as pilot actions at the core of our project. With a multiperspective, transdisciplinary, participatory and integrated approach we will produce best-practice guidance for widespread applications of NBS in urban areas, raise awareness for biodiversity and involve multiple stakeholder groups in the decision process. This will enable practitioners and decision makers in urban planning to utilise socialecological integrated NBS for urban multifunctional areas that promote biodiversity and provide ecosystem services.

Poster presentation

Session 3N – Ecological Aspects in Agricultural Landscapes

Symposium

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Keywords: Agricultural Production; Rural Landscapes; Ecological Sustainability; Food Security; Integrative Approaches

Agricultural landscapes are rapidly becoming dominant worldwide, underpinned by the still prevailing paradigm of the green revolution, and occupying land that was previously characterized by natural and semi-natural values. These landscapes are undergoing rapid processes of intensification, financialization and homogenization. All of these processes contribute to deteriorate the capacity of agricultural landscapes to deliver multiple ecosystem services, and therefore to tackle key sustainable development goals, as committed by most countries and regions. A discussion is in place around alternative management strategies that may help shift agricultural landscapes towards more ecologically sustainable and resilient status, including sustainable intensification, regenerative, organic and other forms of nature-friendly agriculture, landscape approaches and agro-ecosystem services. In this session, papers will be presented and further discussion fostered that examines ecological solutions to address the reconciling agricultural (food and fibre) production with ecological integrity from a landscape perspective. Focusing on issues related to agriculture, forestry and livestock production, the session will cover all pertinent scales through empirical examples that expand the farm to bioregional levels. Theoretical discussions will also be promoted based on these examples to help advance scientific discussions towards more robust and critical knowledge.

Flower-bee networks along land use and climatic gradients: a large-scale study for Central Europe

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Bees are the most important pollinators in both natural ecosystems and agricultural settings. Their pollination service enhances seed and fruit set in wild flowers and many economically important crops. Since bees, with very few exceptions, rely solely on floral rewards such as nectar and pollen for food and larval provision, the landscape must provide sufficient flowers to suit the preferences of different bee species. In Europe, as in other regions of the world, a large portion of the land cover is intensively used for agriculture, although the type and intensity of land use varies between climatic regions. For example, in Austria, the country with the highest number of bee species in Central Europe (ca 700 spp.), the Pannonian lowlands and hills are dominated by intensively managed arable land, whereas the inner alpine region is mainly used for (extensive) grazing. Both type and intensity of land use affect the floral resources and thus the composition of flower-bee networks. Although floral preferences and habitat requirements of the European bee species are well known, flower-bee networks along climatic and land-use gradients are still poorly understood. This information is essential for predicting the resilience of plant-pollinator interactions in a changing environment. To investigate how flower-bee networks are changing across Austria, we sampled 229 sites, which included farmland, grassland and conservation areas, using a standardized transect approach. We analyse how flower-bee networks change in relation to land use type and conservation status, and across the prominent climatic gradients (longitude, latitude, altitude, ecoregion) regarding network complexity, generalisation and specialisation. Our results will provide valuable implications for agricultural management and conservation measures.

Oral presentation

What matters for the future of Mountain Hay Meadows? Applying Q-Methodology to identify viewpoints among stakeholders in Armenia, Austria, Germany, and Sweden

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Mountain hay meadows (MHM) are valuable elements of alpine multifunctional landscapes that provide many different ecosystem services. They represent biodiversity rich habitats, play an important role for cultural heritage and tourism and produce high quality fodder for agricultural production. In order to fulfill these multiple functions, they need a particular moderate management and use. For several decades MHM disappeared, or their ecological status degraded because of either intensification of management or underuse and abandonment. Although the MHM are protected under EU nature conservation legislation and are listed in Annex I of the Habitats, recent assessments show that the current conservation status of MHM in Europe is poor. The reasons for that are complex and range from economic constraints to agricultural structural change, to land use pressures or ineffective governance frameworks. Insights into the perspectives of key stakeholders on what factors determine the use and conservation of MHM can provide crucial information on how these habitats can be also successfully managed, preserved and possibly restored in the future.

To provide these insights a Q-study was conducted with participants from different actor groups relevant to MHM in four countries (Armenia, Austria, Germany, and Sweden) to identify particular viewpoints on the question "what matters for the future of mountain hay meadows". The Q-method is an established semi-quantitative approach in which participants rank a number of statements that comprehensively represent a discourse on a particular topic. An inverted factor analysis of the statements allows the identification of viewpoints. The sample of participants was based on stakeholder mapping and included participants from different sectors (agriculture, nature conservation, tourism, decision makers, etc.) from the local to the national level. A total of 70 people participated.

The results of the analysis suggest that there are four heterogeneous viewpoints on "what matters for the future of MHM" among stakeholder groups, each emphasizing different influencing factors that affect MHM management. One viewpoint the economic aspects of agricultural production, one the policy frameworks that compensate managers for maintaining the multiple functions of MHM, one the role of cultural heritage, and one the concrete farming practices of MHM management. In addition to these different foci, a number of statements were identified that are similar across all viewpoints. The findings contribute to

a better understanding of the factors that hinder and promote the conservation of MHM, as well as the conflicts and debates between different stakeholder groups in this regard, and can also help to identify possible future actor coalitions. Consequently, they can be used to develop appropriate strategies and policies that meet the different stakeholder needs and help to improve the conservation status of MHM in Europe.

Acknowledgment: Dr. Volker Mauerhofer is acknowledged for his efforts for the project proposal and as project coordinator of ALPMEMA (2023–2024).

Oral presentation

The role of forested landscapes in promoting bird and bat-mediated pest control in vineyards

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Agricultural intensification poses a major threat to farmland communities and associated ecosystem services. More specifically, the intensive use of pesticides and landscape simplification can drastically alter the abundance and activity of natural enemies resulting in hindered pest suppression and increased yield loss. However, the effects of these factors on vertebrate predators and their contribution to pest control are relatively understudied.

In our study, we examined the effects of birds and bats on grapevine pests and their pest control service using experimental field enclosures in Hungarian vineyards, considering management (i.e., organic vs. integrated [IPM]) and landscape heterogeneity (i.e., proportion and proximity of deciduous forests) of the plantations. We also measured fruit and leaf damage and sentinel prey predation associated with canopy-dwelling herbivorous and predatory arthropods and the European grapevine moth (*Lobesia botrana*).

We found that forested landscapes increased insectivorous bird abundance and bat activity in spring and reduced fruit damage caused by insects. The abundance of canopy-dwelling arthropods was higher in organic than in IPM vineyards, which resulted in higher leaf herbivory and a higher occurrence of sentinel prey predation there. Grape plant exclusion increased leaf herbivory and fruit damage and reduced the yield, showing the biocontrol service of birds and bats. In addition, increased bat activity significantly decreased the abundance of the major grape pest, *L. botrana*, in spring.

Our findings demonstrate the importance of connected landscapes incorporating deciduous forest patches in promoting vertebrate predators and, therefore, increasing economic benefit to farmers. Organic vineyards can further enhance pest control services by supporting predatory arthropods.

Oral presentation

Understanding Farmers' and Public Perceptions of Ecosystem Services to Foster Sustainable Agriculture

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Long-term pressures on agricultural efficiency, driven by synthetic fertilisers, pesticides, intensive technologies, population growth, and land-use changes, contribute to biodiversity loss and reduce the capacity of landscapes to provide essential ecosystem services (ES). Simultaneously, increasing natural hazards due to climate change pose significant risks to farmers and rural communities. Adopting sustainable agricultural practices—such as organic fertilisers, crop rotation, supporting local production, and nature-based solutions (NBS)—can mitigate these effects and restore landscape multifunctionality. However, these changes often increase costs for farmers and require broader social acceptance. Understanding how farmers and the public perceive ecosystem services is crucial for fostering the adoption of sustainable practices and innovative policy instruments.

Our research examines how farmers and residents perceive ecosystem services, focusing on factors influencing farmers' willingness to implement NBS and the public's readiness to support such transitions. We conducted semi-structured interviews with farmers to assess their awareness, prioritisation of ecosystem services, and barriers to NBS implementation. Farmers ranked selected ES based on their importance to agricultural practices. The findings indicate that farmers prioritise provisioning services (e.g., food production, soil formation, and protection) over regulating services (e.g., flood risk mitigation and climate regulation). Key barriers to adopting NBS include administrative burdens, complex land ownership, and economic concerns.

We also investigated public preferences for sustainable agricultural practices through a choice experiment, assessing how much residents value specific ecosystem services and their willingness to accept higher costs for sustainable agricultural products. Our findings suggest a mixed response: while there is public support for sustainable practices, willingness to bear additional costs varies with socio-economic factors and personal values.

By synthesising results from three methodological approaches—semi-structured interviews, ES ranking, and public choice experiments—we provide a comprehensive analysis of socio-economic and perceptual factors shaping NBS implementation in agroecology. This holistic perspective highlights the need for policies that reduce administrative and financial barriers while engaging the public in supporting sustainable agricultural transitions. Our presentation will outline policy recommendations to align stakeholder interests and promote the adoption of ecosystem-based approaches in agricultural management.

Oral presentation

A geospatial approach to assess multiple benefits of an alternative beef system

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A geospatial approach to assess multiple benefits of an alternative beef system

The ongoing intensification of agricultural production increase pressures on biodiversity, environment, and climate, and calls for re-thinking of agricultural production systems and landscapes. Often, research studies are dominated by a focus on single factor impacts on e.g. climate or nitrogen mitigation, while approaches embracing multiple aspects of agricultural impacts are neglected.

This study shows a new method to assess multiple benefits in the landscape of an alternative beef production system, with a mixed structure (combination of grassing, agroforestry with energy crop production, and harvest of green biomass harvest for biorefinery fiber and fodder production). A geo-spatial method to select best-suited cereal fields to replace with the defined alternative beef-steer production system was used to assess multiple benefits based on five spatial-varying indicators, representing benefits for biodiversity, environment (reduced N loads), climate (reduced greenhouse gas emissions), for the farmer, and policy-implementation

The effects from the inclusion of one or multiple indicators in the assessment were in each case evaluated, by appointing the best suitable fields until the resulting area to get the present Danish consumption of beef from current intensive steer production was achieved. Results showed, that when aiming at multiple benefits (indicator factors >3) the selected land area decreases, and thereby also the related benefits at a national scale. However, significant benefits on a local scale still occurs. As a result, the method can be used as a decision support tool, exploring benefits and tradeoffs within specific societal areas of interest.

Poster presentation

Theme 4: Advancing with new data, tools and methods in landscape ecology

This theme highlights the importance of integrated, data-driven approaches to address the challenges faced by landscapes and societies in a changing world. Advances in landscape ecology research demand and integration of new data, tools, methods, and knowledge sources. For example, many types of Earth observations in different spatial, spectral, and temporal resolutions can be analysed using new digital technologies such as artificial intelligence. Advances in environmental-DNA allow us to study the impact human activities have on landscape processes and even detect endangered species that were otherwise unseen. The rise in big data facilitated a better understanding of human-nature interactions. Newly developed policy and management tools have helped translate scientific findings into practical actions, supporting evidence-based policies that promote environmental sustainability and social well-being. Finally, the integration of artificial intelligence, including machine learning techniques, into landscape ecology research presents itself with both opportunities and challenges. This theme highlights the importance of engagement within the landscape ecology community with forward-looking data, tools and methods to better understand and manage landscapes in the face of rapid environmental change.

Session 4A – Assessing Landscape Structure: Spatial Data Challenges, Metrics, and Solutions in Landscape Ecology

Symposium

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Keywords: landscape structure, spatial pattern, metrics, databases, GIS tools

Rapid environmental changes in all EU countries are often associated with various aspects of landscape structure. The complexity of the landscape pattern, with its variety of scales and the need for analysis at different geographical regions, such as a watershed, a mountain range, or a natural community, presents an intellectual challenge. Scientific expertise is crucial in navigating this complexity, especially in cases where the initiative is part of government policy or planning, and the region may be delineated by a sub-national administrative unit or an entire country. Notably, in most cases, there are no universal solutions and no single correct or optimal methods for describing and assessing landscape structure. However, since landscape patterns are scale-dependent, using different scales in the analysis may result in different outcomes, affecting landscape management options. Over the last thirty years, many landscape indices have been developed for different purposes. Landscape metrics, widely recognized as practical tools for analyzing and evaluating environmental impacts and landscape changes, can quantify patterns. Therefore, we should unanimously aim to review and adopt a wide range of good practices for analyzing and evaluating landscape structure and landscape changes, the latest research methods (source and quality of data as well as GIS tools), and possibly universal recommendations for landscape management at the local, regional, national, and international scales.

Countrywide Mapping of Goldenrod Invasion and Assessing Its Impact on Ecosystems and Human Well-Being: Project Assumptions, Objectives, and Methods

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Here we introduce the assumptions, objectives, and proposed methods of an ongoing research project investigating the invasion of North American goldenrod species (*Solidago canadensis* and *S. gigantea*) across Poland. These species, introduced centuries ago for ornamental and nectar benefits, now pose ecological challenges by outcompeting native flora, yet offer advantages like honey production and aesthetic value. Our project aims to map the spatial extent and cover of goldenrod patches nationwide, characterize invaded areas by environmental and socioeconomic factors, and assess their impact on ecosystem services (ES) and human well-being. We hypothesize that goldenrod's effects on ES vary by location and patch traits, producing both gains and losses.

While local studies exist, no high-resolution, countrywide analysis has been conducted. This project addresses this gap by using Sentinel-2 satellite imagery for cost-effective mapping over Poland's 300,000 km². Our approach integrates remote sensing at two levels of acquisition (drone and satellites) with fieldwork to validate data and evaluate ecosystem conditions via bioindicators. This is complemented by biophysical and preference-based ES assessments comparing invaded and non-invaded sites. Key deliverables include a distribution map, a goldenrod invasion model, and a balance of ES impacts, informing sustainable management. This pioneering, spatially explicit national mapping of an invasive plant offers scalable insights for global application. As an ongoing effort, final results are pending; this presentation outlines our framework and methods, with partial results to be detailed elsewhere at the IALE Congress.

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Oral presentation

Multispectral cameras applications for landscape ecology

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The integration of multispectral camera technology with flexible wheeled robotic tools represents a significant advancement in the study of landscape ecology and disaster mitigation. This work examines the synergistic use of these technologies to monitor and assess landscape changes, support ecological research, and aid in disaster response efforts. Small-scale multispectral cameras, deployed on flexible robotic platforms, enable high-resolution data capture across diverse terrains. The multispectral imagery provides critical information on vegetation health, land cover change, and habitat fragmentation, essential for understanding ecosystem dynamics and monitoring environmental shifts. When combined with Digital Surface Models (DSM), Digital Terrain Models (DTM), and Digital Elevation Models (DEM), the robotic system can generate highly accurate topographic and vegetation maps that facilitate more precise ecological analysis and decision-making. These models support landscape ecology by offering insights into elevation changes, slope analysis, and surface features, which are crucial for assessing the impact of environmental changes and natural disasters. The robotic platform's flexibility and mobility allow for deployment in remote or disaster-affected areas, where traditional methods may struggle. This makes it particularly valuable for post-disaster assessments, such as flood, wildfire, or landslide recovery, by providing real-time, detailed data on affected landscapes. The ability to quickly collect multispectral and elevation data in hard-to-reach locations ensures that decision-makers have the necessary tools for effective disaster response and mitigation strategies. Additionally, this integrated system can be used for ongoing landscape monitoring, restoration efforts, and ecosystem management, offering a proactive approach to mitigating the impacts of climate change and other environmental stresses. Overall, the combination of multispectral cameras, robotic tools for different applications, including quality improvement, calibration and verification of the DEM-DSM-DTM models can be a useful support solution to the challenges of landscape ecology and disaster management, enhancing our capacity to monitor, assess, and respond to environmental changes. The Kazakh Ministry of Science grant # BR27197639 "Development of Innovative Hydrogeological Methods for Water Resource Management in the Zhambyl, Almaty, Zhetysay, Abay, and East Kazakhstan Regions" supports this project. The current status of the project activities will be presented.

Oral presentation

Using functional ecology tools to assess landscape habitat heterogeneity

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The growth of large-scale spatial images allows to assess landscape composition and configuration at high resolution. Such data can be used to better understand the relationships between landscape heterogeneity and biodiversity. However, landscape heterogeneity is still mostly measured with indices using land-use categories (e.g. Shannon index of land covers). We present a method derived from the tools of functional ecology to measure landscape heterogeneity from continuous data (i.e. rasters). We looked at how these metrics relate to biodiversity in comparison with “classical” land cover-based metrics. As a case study, we looked at bird diversity in Finnish forest-dominated landscapes. As landscapes, we used the 6-km long transects of the annual Finnish bird monitoring program and calculated metrics of bird taxonomic and functional diversity and landscape heterogeneity over several buffer sizes. We used the forest Multi-Source National Forest Inventory, a set of nation-wide raster layers describing forest structure such as tree species composition, mean canopy cover or mean tree age in 16x16m pixels. We inferred the heterogeneity of non-forest lands based on additional conventional land cover data sources. For each pixel, we aggregated data to identify “habitat species” characterized by their own “traits”, i.e. the structural information. Therefore, each landscape was considered as a sampling unit with data on the abundance of each habitat species from which we calculated functional richness, dispersion, evenness, divergence, and Rao’s Q. We also calculated the weighted mean of each trait and their dispersion for the semi-natural habitats. In addition, we calculated an index of configurational heterogeneity by averaging the mean functional distance of each pixel in the landscape with its eight and 24 closest pixels. We found several positive effects from functional composition heterogeneity. We also found complementary positive effects of functional composition heterogeneity and Shannon land cover index on overall bird species richness. Functional configuration heterogeneity was correlated with composition and further research are needed to disentangle effects of each of them, e.g. by selecting landscape where both are uncorrelated. Nonetheless, in our case study, functional composition heterogeneity showed promising capabilities in detecting the landscape heterogeneity-biodiversity relationship in addition to or replacing land cover heterogeneity. It has also made it possible to describe heterogeneity within land cover categories, such as forests.

Oral presentation

Vulnerability and resilience of selected ecosystem functions and services in highlands/mountains in Central Europe

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The assessment of the vulnerability and resilience of habitats and selected ecosystem functions (EF) and services (ES) to land degradation, caused by climate and land use change in the landscape, is becoming increasingly important under current conditions. We present a method for assessing the vulnerability of habitats and provision of ecosystem services under climate change and increasing human impact at a 1:10,000 scale in the Novohradské hory mountains, situated in the South Bohemia. The first step consists in the assessment of the Environmental Sensitive Area Index (ESAI), defining sensitivity level to land degradation, based on combinations of 15 drivers, grouped into four thematic groups related to climate, soil, vegetation, and human pressure/land management. In addition, the GLOBIO 3-CZ model was used to evaluate the degree of influence of anthropogenic pressure on habitats and their biodiversity, caused by intensity of land use, infrastructure, landscape fragmentation, N deposition and climate change. During the second step, selected EF were quantified using specific indicators and associated with habitat types using look-up-table method, indicating their ability to provide ES (local environmental cooling through evapotranspiration, climate change mitigation through carbon storage, regulation of extreme runoff through water retention and habitat provision through species and habitat diversity). The third step involves evaluating the resilience of ES under climate change conditions by assessing climate change risk and key resilience preconditions: biodiversity, habitat connectivity and heterogeneity, and estimation of resistance to projected land use intensification by the level of landscape protection. Based on the method used, the most vulnerable habitats were identified in the northern and western parts of the territory with intensively used forest-agricultural landscapes in the lowland compared to the southern part of the territory, where mountain forest landscape predominates. This approach is applied for the whole Czech Republic and can serve as a useful tool to identify areas with high vulnerability of habitats and ES provided.

Oral presentation

A new approach to assessing the degree of landscape fragmentation by transport infrastructure

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Standard approaches for calculating the level of fragmentation by transport infrastructure suffer from one major shortcoming from the perspective of landscape connectivity for the wildlife: all barriers are considered equally as completely impermeable. Therefore, the calculation cannot take into account the positive impact of the implementation of migration objects (underpasses and overpasses) on motorways and class I roads, nor the different degree of migration permeability of two-lane roads depending on the traffic volume. In the real world, most traffic migration barriers are at least marginally permeable, which is not assumed by existing indicators. This was the motivation to develop an algorithm for calculating a new indicator called IDFK (Indicator of Landscape Fragmentation Dynamics), which would overcome the shortcomings mentioned above. The innovation is to take into account the integration of individual working polygons defined by fragmentation geometry into larger spatial units where there is at least a partial probability of migratory connectivity between fragmented subspaces. However, the higher explanatory power of the new indicator is outweighed by the complexity of the workflow itself and the requirement for a higher amount of input data than the existing indicators. To simplify the process of indicator application, a calculation toolbox for the ArcGIS Pro environment was created for the entire algorithm, which allows the evaluation to be processed in five sequential steps. The computational model is primarily intended for the assessment of larger areas - the presentation will describe the application on the territory of the entire Czech Republic (however IDFK can be used also as a basis for the calculation of the regional disparities in the degree of fragmentation) but at the same time, as an auxiliary output it allows to describe individual road routes with a detailed visualization of their wildlife permeability, whether based on traffic intensity or with migration objects. This also broadens the potential use of the indicator from the strategic planning phase (SEA to policies and spatial planning documents) to the investment preparation of individual roads and motorways.

Oral presentation

The value of PPGIS in assessing landscape perception in the Swiss Landscape Monitoring Program LABES – exploring new tools for future monitoring

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The Swiss Landscape Monitoring Program (LABES) presents one of the first large-scale landscape observatories to systematically integrate both physical data and public perceptions of landscapes, providing high-quality landscape assessments. To evaluate the Swiss public's landscape perception, LABES builds on a set of social indicators comprising landscape quality perception, recreational quality, perceived landscape change, as well as place identity and attachment. These indicators are newly collected for each monitoring cycle at both national and cantonal levels through representative online panel surveys conducted in Swiss municipalities. Hence, the spatial resolution of public landscape perception is currently restricted on municipality level.

Yet, improved spatial resolution of social indicators is highly relevant for assessing landscape perception in less densely populated areas such as mountainous regions. Whereas social indicators collected through nationwide surveys on a municipality level provide limited knowledge on the perception of remote landscapes by residents, these landscapes are nonetheless perceived through touristic activities, assigning importance and value to respective regions. An on-site survey to gain location-specific information on public landscape perception was already tested as an approach to address these challenges. While results highlighted the added value of spatially nuanced, site-specific landscape perception, performing nationwide on-site surveys is too extensive. Thus, we aim to present and discuss Public Participation Geographic Information Systems (PPGIS) as a new methodological tool in LABES.

The integration of PPGIS in LABES broadens the possibilities of gathering concrete, site-specific landscape perception and people's evaluation of particular landscape features. PPGIS allows for the mapping of specific locations and the collection of detailed, selective perceptions and assessments related to them, thus improving the spatial resolution of public perceptions of landscapes significantly. Punctual, spatial localisations of specific public landscape perceptions using PPGIS further facilitate the alignment of socially perceived landscape elements with spatially concrete biophysical landscape features. These new technical capabilities will be further evaluated, tested, and developed through pilot studies in several Swiss regions to enhance LABES as a long-term monitoring program. Ensuring the scalability of social and physical indicators across different administrative levels is crucial for maintaining consistency and applicability in landscape assessments. Through its comprehensive approach, LABES offers a robust framework for monitoring landscape changes and perceptions in Switzerland, supporting informed decision-making at various governmental levels and ensuring sustainable landscape management.

Oral presentation

Development of an indicator to assess wetland degradation based on soil, water drainage, and human-related landscape

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Wetlands are rich ecosystems that provide goods and services to communities. They are home to abundant biodiversity, and their role in climate mitigation is well-established. These ecosystems lie at the interface between terrestrial and aquatic systems. However, they have rapidly declined over the past decades due to environmental stresses and human activities. In sub-Saharan Africa (SSA), particularly in the eastern Democratic Republic of Congo (DRC), anthropogenic practices related to agriculture and brick production have significantly degraded these wetlands. Various indicators have been developed to assess soil quality, but there is limited documentation on the relationship between these indicators and the anthropogenic factors influencing them. This study elaborated a Wetland Soil Degradation Index (WSDI) by combining data on soil quality, human-related landscape factors, hydrological regimes, and land use types. The index was experimented in two wetlands in eastern DRC. An indicator was developed and adjusted using a combination of GIS and remote sensing approaches alongside soil profile analyses. The overall WSDI score averaged 0.52 across the two study sites. However, it varied significantly based on land use type, with the highest values in areas where bricks are produced (0.62), followed by agricultural zones (0.52), while intact zones had a lower score of 0.28. The index was also higher in completely drained areas (0.72) compared to partially drained (0.48) and intact or not drained zones (0.28). Significant correlations were found between the WSDI and human-related landscape factors, notably the proximity of villages, rural settlements, and roads. The increase in wetland degradation is strongly linked to road accessibility and the distance to other human landscapes. The monitoring of this indicator confirms a gradual degradation pattern, starting from the wetland edges and progressing toward the center. Therefore, it is essential to question the future of these wetlands and explore possible management scenarios.

Oral presentation

Mapping local food landscape: challenges and solutions

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The concept of local food is deeply embedded in the landscape, shaped by the interplay of environmental conditions, cultural practices, and historical land use. As a reflection of the relationship between people and place, local food heritage emerges where ecological characteristics and cultural traditions intersect. In this context, the landscape and food heritage are intertwined across multiple levels.

This presentation addresses the spatial data challenges encountered during the mapping of local food heritage in Poland. The identification and mapping process aimed to explore how local food products relate to the landscape and whether their spatial distribution can be explained by ecological, economic, or social variables. To achieve this, we utilized the List of Traditional Products, maintained by the Polish Ministry of Agriculture and Rural Development. The list comprises over 2,100 products and dishes across various categories, including meat, dairy, bakery and confectionery products, honey, fruits and vegetables, as well as dish recipes. We then identified local food clusters in Poland and analyzed their spatial patterns using different GIS approaches. While working with this dataset, we encountered multiple challenges related to data harmonization, particularly concerning scale issues and the use of diverse spatial descriptors in product documentation, which ranged from natural and administrative descriptors to geographical, ethnographic, and historical units. This presentation specifically focuses on the spatial data challenges that arose from this process, and the solutions we developed to address them.

Through the lens of local food heritage, this study reflects upon multi-scalar environmental processes unfolding within socio-ecological systems, highlighting how landscapes of local food are shaped by both natural conditions and cultural practices.

The research is conducted within the project: “Linking people and nature in local heritage food. A social-ecological system approach” (Localinary), funded by the National Science Centre of Poland (UMO-2023/49/B/HS4/00769).

Oral presentation

The development of landscape quality over time in the entirety of Switzerland and its nature parks: the potential of the Swiss landscape monitoring program LABES as a policy-evaluation tool

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The Swiss Landscape Monitoring Program (LABES) is a pioneering large-scale landscape observatory, where physical/spatial data and landscape perception have been systematically monitored with representative surveys from the inception of the program. The comprehensive monitoring program encompassed approximately 30 indicators, with about 25% of these indicators addressing landscape quality perception, encompassing aspects such as landscape structure, land cover, land use, perceived landscape change, landscape services like recreational quality, place identity and attachment. Respondents were invited to provide a rating of the quality of the landscape within the boundaries of their respective home municipalities. In addition, the LABES approach was employed to evaluate the landscape and its development in the Regional Nature Parks of National Importance in Switzerland. Again, both physically measurable landscape indicators and the residents' assessment of landscape quality were investigated. The values of the individual parks, all parks, those of reference communities and all Swiss communities outside the parks were compared over the two time periods of LABES1&2 (2011 & 2020). The results demonstrate that, across Switzerland, indicators for the physical landscape show lower values in 2020 than in 2011, whereas residents rated the landscape quality of their municipalities positively and without significant changes from LABES1 to LABES2. Nevertheless, there are remarkable differences between geographic regions and municipality types, in LABES1&2 as well as in the developments over time. Park communities achieve significantly higher landscape quality values than Switzerland as a whole, indicating that they are located in areas where high nature and landscape values are present and perceived. The landscape quality of the entire park perimeter has improved over time for the park population compared to the whole of Switzerland, while the physical qualities of the landscape remained largely constant. In comparison to the reference communities, no systematic change in landscape quality could be identified in the park communities. While differences were observed between individual parks, these could not be interpreted conclusively. It is therefore recommended that, in the evaluation of policy instruments such as Regional Nature Parks, park-specific indicators be developed that better correspond to the park instrument, and that the temporal course between individual parks be compared in future. This approach would facilitate a comprehensive evaluation of the policy instrument in its entirety, as well as the individual park's performance. Additionally, the evaluation of other landscape-related policy instruments through landscape monitoring programs is both desirable and important but is feasible and promising.

Oral presentation

Factors Influencing Trade-offs and Co-benefits Between Carbon Sequestration and Ecological Connectivity in Restoration

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Restoration plays a crucial role in mitigating climate change by enhancing carbon sequestration while promoting biodiversity conservation. However, achieving a balance between these benefits often involves trade-offs influenced by spatial and locational factors. This study aims to investigate the factors affecting trade-offs and co-benefits between carbon sequestration and ecological connectivity in restoration planning. Specifically, we explore how spatial structural characteristics and locational variables influence the relative effectiveness of carbon sequestration and ecological connectivity.

To evaluate carbon sequestration, an artificial neural network (ANN)-based Net Primary Productivity prediction model was employed. The delta Probability of Connectivity was utilized to assess ecological connectivity. Trade-offs and co-benefits were quantified by normalizing both values and calculating the relative distance from the Y=X line. Correlation analysis was then conducted to identify significant drivers influencing the trade-offs and co-benefits between carbon sequestration and ecological connectivity.

The results will provide insights into how potential green spaces contribute to both carbon sequestration and ecological connectivity. By examining trade-offs and co-benefits, we aim to identify key spatial patterns that influence these ecosystem functions. Both spatial structural characteristics and locational variables will be analyzed to determine their relative influence on the observed trade-offs, allowing for a more nuanced understanding of their roles in shaping restoration outcomes.

Our findings will underscore the importance of integrating multiple spatial factors in restoration planning to optimize the co-benefits of carbon sequestration and ecological connectivity. By identifying potential drivers and their interactions, this study aims to provide actionable insights for designing resilient landscapes that maximize ecosystem services. A comprehensive understanding of spatial influences can support more effective trade-off management, ultimately contributing to climate change mitigation and biodiversity conservation.

Oral presentation

Spatio-temporal patterns of land use and land cover changes in the different structural elements of an ecological network - new insights from Poland

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An ecological network is a system of three key elements: core areas, ecological corridors, and buffer zones. Understanding the spatio-temporal patterns and changes in each of these three elements is key for understanding their effectiveness in protecting biodiversity and maintaining ecosystem services. We used structural landscape metrics to assess the spatiotemporal changes in LULC in each element of the ecological network (core areas, ecological corridors, and buffer zones), as well as at different scales (supra-local, regional, national, and international), and at various buffer distances surrounding the core area and corridor elements: 250, 500, 750 and 1000 m. We used different statistical methods to identify which metrics provide unique information on the spatial patterns in each network element. The Pearson correlation matrix showed a very strong correlation in the following metrics: ai, pladj, division, and lpi. Through clustering analysis, it is possible to distinguish four natural groups of metrics that are consistent across the ecological network elements for characterizing spatial patterns and changes. Furthermore, pairing the metric lpi with share_mn also effectively differentiates LULC patterns in the three key elements of the ecological network, and a single metric, such as lsi, can differentiate the analyzed ranks. In conclusion, our results indicate consistent groups of metrics that describe the key elements of the ecological network and differentiate them in terms of time and space.

Oral presentation

Geoinformatics-Based Foundations for Landscape Character Assessment in Falasarna, Crete, Greece

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Landscape Character Assessment (LCA) is a systematic approach to the description and mapping of landscape diversity as a crucial tool for sustainable landscape planning and management. In this research study, a geoinformatic-based approach is used to develop an LCA framework for the Falasarna area, Crete, Greece. An ecologically, agriculturally and culturally rich landscape of high historical and archaeological as well as economic value. The initial phase of this study focuses on the development of multiple geospatial basemaps, which serve as the foundation for the subsequent analytic steps of the LCA process.

Falasarna is a region of high environmental, cultural and economic significance, with a great diversity of coastal, agricultural, tourism-related and archaeological features. The region supplies important ecosystem services (ES), including food provision through its olive groves and greenhouse cultivations, as well as cultural ES through its archaeological heritage as an ancient city-port, and recreational benefits related to tourism and outdoor activities. The integration of geoinformatics in LCA makes landscape change, human influence, and natural dynamics assessment more objective and data-intensive contributing to sustainable management of such ES in the long run. The study is aimed at providing valuable information regarding landscape character dynamics for support in conservation strategies, heritage management, agricultural expansion and sustainable land-use planning for the region.

For this purpose, high-resolution spatial datasets have been generated using Geographic Information Systems (GIS) and remote sensing techniques. The basemaps integrate a variety of thematic layers, including topography, geology, land cover, vegetation, viewshed analysis, pattern analysis, ecological quality, historical and archaeological landscape features. Spatial analysis techniques such as landform classification and object-based supervised classification of satellite imagery, but also combinatory analysis of basemaps' various thematic layers have been employed to contribute to the reliability and accuracy of the data. These basemaps facilitated the systematic classification of Landscape Description Units (LDUs) of the study area, allowing for a spatially explicit evaluation of landscape heterogeneity. Subsequently, fieldwork was conducted to refine and validate the desktop-based results, leading to the delineation of Landscape Character Types (LCTs).

Future work will focus on refining the classification of landscape units and engaging stakeholders to ensure the applicability of the assessment results. The outcomes of this study will contribute to the overall discussion on geospatially-informed landscape management, offering a replicable geospatial approach to LCA, applicable to Mediterranean landscapes and other regions.

Oral presentation

Using social media data and eye tracking in landscape preference analysis

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Human interactions with the landscape documented through photography can be used as a source of landscape preference analysis data. Social media, such as Instagram, provides photographic data indicating these interactions. Geotagged photographs can complement traditional research methods by providing information about activities performed in landscapes, further indicating aesthetic preferences and perceptions of the landscape. The research combined an analysis of Instagram data with visual attention measurement (eye tracking) and surveys, giving a broader view of landscape perception. The key aspect in this case is to obtain data on real landscape use, rather than solely declared use, which traditional survey data offers.

The research focuses on the urbanized landscapes of two Polish cities with suburban zones, where metropolitan, urban, and suburban units are analyzed. Within the boundaries of the landscape units, locations were assigned to Instagram photos, and then based on these locations, photographs posted in 2023 and 2020 were downloaded. While excluding locations that were too general, e.g., covering the entire city, and locations pertaining to objects where activities are undertaken inside buildings. By analyzing the content of the photograph, labels were assigned to each individual photograph taken outdoors, providing information about the content of the photograph and the activities recorded. This provided information on human-landscape interactions. The resulting data made it possible to compare the results for photographs taken in two separate years, conduct an analysis of the density of activities in the units, and possibly identify the dominant activities by landscape type. Subsequently, the selected photographs were used for an eye-tracking study to verify whether the locations of fixations and their duration are indicative of landscape users' preferences and sense of aesthetics. In addition to recording the path of vision, participants in the study filled out a questionnaire about the emotions and feelings accompanying the observation of the photographs. This made it possible to determine whether elements that hold the gaze longer are more important to people and account for their personal preferences.

Oral presentation

Assessment of Wrocław's Landscape Structure Using Modern Spatial Data and GIS Tools

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Assessing the landscape structure of Wrocław is a crucial issue in the context of dynamic urbanization and environmental protection. Landscape ecology enables the analysis of the spatial organization of ecosystems and their impact on urban functioning, while modern GIS and remote sensing technologies facilitate more effective monitoring of these processes. The primary objective of this study was to assess the landscape structure of Wrocław by analyzing spatial data, applying landscape metrics, and identifying challenges and solutions in this field.

The study area encompassed Wrocław, including highly urbanized areas as well as green spaces, parks, and ecological corridors along the Oder River. The analysis utilized satellite imagery from Sentinel-2 and Landsat 8, LIDAR point cloud data, high-resolution orthophotos from drones, and GIS layers from OpenStreetMap and Geoportal. To conduct a comprehensive analysis, land cover classification methods were applied, landscape metrics were calculated, and ecological modeling was performed. Classification algorithms such as Random Forest and K-means were employed, along with Fragstats tools and R packages for analyzing landscape fragmentation and heterogeneity. Furthermore, a comparative analysis of land use changes from the years 2000, 2010, and 2024 was conducted to assess the dynamics of urbanization processes.

The results indicate an increasing fragmentation of green spaces, particularly in the city center, leading to a reduction in the average size of natural areas. Concurrently, landscape heterogeneity has increased due to intensified construction and land use transformations. Although ecological connectivity remains relatively well-preserved along the Oder River, barriers associated with transport infrastructure limit species movement. The applied methods proved effective in identifying key landscape changes; however, integrating multi-source spatial data remains a challenge. The use of machine learning techniques and advanced spatial analysis algorithms enables more precise modeling and prediction of future changes.

In conclusion, this study confirms the dynamic changes in Wrocław's landscape structure and underscores the significance of modern spatial analysis methods in landscape ecology. The implementation of advanced GIS tools and predictive models can support urban planning and environmental conservation, which are essential for sustainable urban development.

Oral presentation

Optimizing crop diversity across multiple spatial scales

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The agricultural sector is the biggest driver of biodiversity loss worldwide. An important reason of this decline is the homogenization of agricultural landscapes through increased field sizes and a focus on fewer crops. Increasing the diversity of crop species in agricultural landscapes can promote biodiversity and provide crucial ecosystem services such as pest control and pollination. Farms can contribute to more diverse landscapes by increasing the temporal diversity of their crop rotation by cultivating new crops over time and/or by increasing the spatial diversity of their rotation by e.g. cultivating current crops in strips. However, scaling up such farm practices requires thorough evaluation of their economic, environmental, and ecological impacts on different farming systems and the landscape as a whole. To capture the spatial and temporal aspects of crop diversification, assessments at different spatial scales are required. Because these assessments must also consider farm-specific constraints such as available resources, crop rotation restrictions, and policies, advanced decision support tools are essential

We developed and used a Mixed Integer Linear Programming Landscape planning model to optimize crop diversity (Shannon Diversity Index) at multiple spatial scales of an agricultural landscape in the Netherlands. We used the current crop rotations of 83 arable farms in the province of Flevoland. We assessed potential crop diversity under three strategies: 1) coordinating the cultivation of current crop rotations between farmers, 2) increasing the spatial diversity of current crop rotations, 3) increasing the temporal diversity of current crop rotations. With the model we calculated optimal levels of crop diversity at different spatial scales (0.25, 0.5, 1km).

We revealed that coordination of the current crop rotations among farmers has little effect on crop diversity at the landscape level. We found that increasing the spatial diversity of crop rotations resulted in the largest increase in crop diversity, especially at lower spatial scales (0.5 – 0.25km). We also demonstrated that including different spatial scales has a direct effect on optimal land use planning decisions. Our optimization model quantified trade-offs between optimal levels of crop diversity and preferred diversification strategies at different spatial scales. We conclude that increasing the spatial diversity of rotations through technologies like strip cropping and pixel farming have the potential to increase crop diversity at landscape level. However, for effective land-use planning, their impact on crop diversity across multiple scales must be considered.

Oral presentation

Landscape Dynamic Typology – A method to assess landscape dynamics

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Landscapes are shaped by a dynamic balance of anthropogenic activity and ecological processes. Landscapes are shaped by a dynamic balance of anthropogenic activity and ecological processes. Substantial or fast changes may disrupt the natural balance of ecosystems, jeopardizing their capacity to provide essential services. Landscape changes are often measured via land use / land cover variations, and encompass phenomena such as habitat loss and fragmentation, that have been pointed out as a major cause of biodiversity loss. This work represents an effort to prevent misuse and misinterpretation of the underlying concepts while at the same time offers a conceptual framework, compatible with existing ones, as well as a concrete analytic method and associated tools to implement it.

Landscape Dynamics Typology (LDT) can be generally described as a classification system in which landscape changes are organized and labelled according to the spatial land transformation processes that originate them. More concretely, LDT is a method for assessing landscape composition and configuration changes, allowing to identify and geolocate the processes of amount (loss/gain) and geometric (fragmentation/aggregation) variation. Types of dynamics (ToD) are defined by considering how changes are depicted by specific metrics (area and number of patches), follow a nomenclature that integrates landscape composition and configuration aspects, and is versatile enough to relate to and wide enough to accommodate existing paradigms of spatial patterns of land transformation. The operational elements of the LDT ecosystem are the tools intentionally designed and developed to implement the LDT method and associated functions: LDTtool - a python-based add-on ArcGIS toolbox; LDT4QGIS – a set of python scripts for QGIS; and LDTR – an R package. LDT-based approaches can add analytical value in a wide range of topics related to natural resources management, regional planning, urban expansion, biodiversity conservation, ecosystem services assessment, or other topics in which land cover patterns and dynamics are relevant. LDT has been used to study urban dynamics in Romania, Indonesia and Ethiopia, afforestation in Spain, invasive alien plants in Portugal, grasslands in Slovenia, and fragmentation/connectivity in South American dry forests, which shows acceptance by the community and attests its utility and usability. LDT is a work in progress that can benefit from further engagement of users and developers by modifying it to fulfil their research needs, to enhance the tools' performance or simply to add new functionalities in order to expand the analytical capabilities.

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Oral presentation

Assessment of landscape ecological problems of the Poľana Biosphere Reserve

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Biosphere reserves (BRs) are integral to UNESCO's intergovernmental scientific program "Man and the Biosphere" (MaB). This program integrates knowledge from natural and social sciences, providing a foundation for the rational and sustainable use of biosphere resources while simultaneously protecting natural ecosystems and human-altered landscapes. Most BRs encompass both natural-like areas and regions affected by human activities. This duality enables the study of conflicts between human activities and the natural environment. This paper is focused on presenting assessing landscape–ecological problems resulting from conflicts of interests of the landscape utilisation in the Poľana Biosphere Reserve. The present paper focuses on a comprehensive assessment of impacts on the landscape and its components resulting from land use conflicts.

Landscape conflicts are those that arise from different interpretations, evaluations, and demands on the landscape; from the relationships between individuals and social target groups or stakeholders, and their demands on physical space and natural resources. The approach is grounded in the concept of the landscape as a geosystem as the integration of natural resources at every point on the earth's surface. Such approaches require not only comprehensive knowledge of all landscape-forming components but also an understanding of the interactions and relationships between these components. It examines natural and socio-economic phenomena, classifying them as either threatened or threatening. By intersecting these phenomena, spatial delineation of the conflicts of interest has been achieved. In the study area, three groups of problems resulting from spatial conflicts of interest were identified: threats to biodiversity and ecological stability; threats to natural resources; and threats to the environment of human society. A total of 121 specific threats were identified in the study area. This approach is applicable to other BRs for identifying areas with conflicts of interest as the identification of spatial conflicts is crucial for the effective and targeted design of measures aimed at their mitigation or elimination, aligning with the overarching objective of BRs — sustainable development.

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Oral presentation

Ecolandscapes: A Conceptual and Practical Framework for Assessing Landscape Structure and Change Over Time

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All landscapes serve as habitats for a variety of animal and plant species. For example, bocage landscapes provide habitats notably for woodland species, while arable farming areas support species adapted to open environments. However, defining landscapes as spatial units that are both ecologically relevant and operational for land-use planning remains a challenge. We introduce the concept of ecolandscapes, a novel framework for delineating landscape units based on their internal heterogeneity (composition and configuration) at relevant ecological scales.

Using a moving window approach to capture landscape gradients, landscape metrics to characterize landscape structure, and unsupervised classification, ecolandscape units are identified as clusters of pixels with similar landscape characteristics. This flexible, multi-scale, methodology can be applied to widely available land-use/land-cover (LULC) data, making it accessible and practical for ecological assessments.

We tested this framework to the Lannion Trégor Communauté (LTC, France), generating ecolandscape maps at different spatial scales, and comparing them to an expert-based delineation map. We also assessed their ecological relevance using biodiversity data from citizen science surveys (356 species of various taxa, 21,301 occurrences). Our results show that ecolandscapes defined at scales of 3-5 km correlate more strongly with biodiversity patterns than traditional expert-based delineations, confirming their ecological validity. Practitioners from LTC found the ecolandscape maps insightful, stating that "you quickly understand what's behind them" and that the framework helps in "objectifying a vision".

As part as the MOTIVER project, we further explore the temporal dynamics of ecolandscapes, applying this framework to sequential LULC data. This approach provides a valuable tool for detecting landscape changes over time, supporting long-term ecological monitoring and adaptative land managment.

The ecolandscape framework is implemented in the open-source R package "Chloe - landscape metrics" (chloe.inrae.fr), ensuring accessibility and reproducibility for end-users. By offering an operational method for mapping landscape structure and change, ecolandscapes contribute to the integration of ecological principles into land-use planning and biodiversity conservation policies.

Oral presentation

Mapping of patterns of geo-ecological landscape structure: The case of Eastern Denmark

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Conditions for plant growth are unevenly distributed in most landscapes and vegetation must adapt to ensure survival and competitiveness. Therefore, geo-ecological landscape structure forms an important driver of vegetation development and differentiation alongside human land use and management practices. In the short term, plant community distributions generally adapt to site suitability and the presence of other organisms (i.e. through colonization, succession mechanisms and land use informed by site conditions), while on the long term they co-determine site conditions (i.e. through soil formation processes, erosion control, modulation of hydrological flows and influence on micro-climates). This means that modelling of geo-ecological site suitability is critical to understanding vegetation development in both managed and unmanaged ecosystems across landscapes. We here report on an analysis of patterns of geo-ecological landscape structure in Eastern Denmark. Based on an existing high-resolution model of the East Danish Land mass we regionalized and mapped patterns of geo-ecological variation known to affect potential vegetation development and associated site suitability parameters for land use, contributing to landscape structure. We used a holistic mapping method subdividing the total surface into functional geo-ecological landscapes based on supervised pattern recognition and expert judgement. The map reveals significant variation and patterning, featuring 94 distinct landscapes classified into 18 landscape types, reflecting a wide range of environmental conditions. For each of the types, we propose a description and categorization. By classifying landscape types in Eastern Denmark, it becomes clear how different areas are defined by distinct environmental conditions. We discuss how this may be used to formulate tailored land use policy informed by each landscape's specific features.

Oral presentation

Importance of the High-Resolution Digital Elevation Models preparation for proper Landscape ecology support programs

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Most of the engineering organizations, researchers, disaster management agencies, meteorology and hydrology, agricultural organizations in Kazakhstan currently use low-resolution Digital Surface Models (DSM) for modeling and forecast analysis (the Shuttle Radar Topography Mission (SRTM) based on DSM pixel resolutions of 30-90 meters). Very often, the estimates of different events, and modeling related to water volume forecasts are of poor quality, because the input data is poor for modeling, water volume calculations, and forecast analysis. Inaccurate input data will potentially produce poor modeling output data (GIGO rule: Garbage In - Garbage Out). Also the complexity of the landscape pattern, with its variety of scales and the need for analysis at different geographical regions, such as a watershed, a mountain range, or a natural community, presents an intellectual challenge. Therefore, we should unanimously aim to review and adopt a wide range of good practices for analyzing and evaluating landscape structure and landscape changes, the latest research methods (source and quality of data as well as GIS tools), and possibly universal recommendations for landscape management at the local, regional, national, and international scales. Kazakhstan has begun the transition to a new digital coordinate system QazTRF-23, which should allow integration into the international geospatial community and improve the quality and clarity of local maps. A stable telecommunications infrastructure is essential for proper work. The Continuously Operating Reference Stations (CORS) is highly dependent on modern telecommunication networks. Without stable communication channels, real-time data collection and processing for QazTRF-23 will be difficult, reducing the effectiveness of geospatial analysis and water resources management. We are also working on the expansion of this current Kazakhstan strategy to use the QazTRF-23 in development the high-resolution digital elevation models (DEM) with a step of up to 10 cm in areas of potential flooding, with the processing of DSM and the preparation of high-resolution digital terrain models (DTM) up to 10 cm. Such DTM could be useful for the contour strip organization of land landscapes design preparation, based on the Slovak expertise, Slovakia's initiatives with contour-strip land organization in "water for climate healing - the new water paradigm and public policy" <https://www.youtube.com/watch?v=NPx-tiTrqNQ> are under our investigation for potential adaptation in Kazakhstan. The high-resolution DTM is in the development of a combination of drones and geodetic surveys by using Hexagon Leica Viva GS-16 GNSS rover and bathymetric tools. These systems provide real-time data transmission from remote areas, enabling accurate modeling and forecasting of flood risks and other landscape changes. The integration of these technologies, combined with a new coordinate system and improved telecommunication infrastructure, will enable Kazakhstan to improve landscape management, water forecasting, and disaster prevention at local, regional, and national levels. The Kazakh Ministry of Science grant # BR27197639 "Development of Innovative Hydrogeological Methods for Water Resource Management in the Zhambyl, Almaty, Zhetysu,

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Abay, and East Kazakhstan Regions" supports this project. The current status of the project activities will be presented.

Oral presentation

Reevaluating LULC data in spatial structure analysis: Why field surveys and own data collection still matter in the times of online remote sensing data

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In the era of publicly accessible spatial data, field expeditions may seem unnecessary, and many researchers rely exclusively on predefined datasets without paying much attention to the issues this practice may introduce. While the pool of online remote sensing data provides complete coverage of our planet, including numerous time series, these datasets are often described as high-resolution, accurate, and precise. However, our research reveals that standard spatial data on land cover and land use (LULC) have limitations in capturing the character of landscape structure to a degree sufficient for reliably determining its fragmentation level. Despite this, such data continue to be used, often uncritically, in many scientific studies.

Among other aspects, we examined how the values of specific landscape metrics can vary within a given year, depending on the chosen spatial dataset. We also developed a custom spatial data rasterization method, the "custom priority", which preserves critical landscape details. This innovative approach is crucial when transitioning from vector to raster data, a frequent step in calculating landscape metrics.

The problem of spatial data generalization and the omission of significant landscape features was previously identified in relation to widely used pan-European data such as Corine Land Cover (CLC). CLC is often criticized for its excessive generalization at the 100 m resolution, which is unsuitable for local-scale research like ours. On the other hand, increasing the resolution to 50 m by using highly detailed national data, such as Poland's Topographic Objects Database (BDOT10k), leads to significant computational challenges in large-scale studies. Our "custom priority" rasterization method addresses these issues and offers an alternative to commonly used rasterization approaches (cell center, maximum area, and maximum combined area), which are available in software like ESRI ArcGIS Pro and QGIS.

Generalization problems also affect the newest LULC datasets, including the globally available ESRI Land Cover at a resolution of about 10 m, published annually since 2017. While these datasets offer high resolution and use Sentinel-2 satellite imagery along with advanced AI-based modeling, they still omit many important landscape features. Such omissions stem not only from technological constraints, such as sensor specifications but also from the characteristics of the adopted spatial data model.

Oral presentation

Utilizing landscape metrics for rangeland degradation assessment and historical ecosystem health estimation

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Arid and semi-arid regions are increasingly threatened by land use/land cover conversions under extreme climate events. This degradation disrupts critical functional processes such as energy flow, nutrient cycling, and water retention, compromising soil integrity and overall ecosystem health. Addressing these challenges requires integrating field-based assessments, such as the Interpreting Indicators of Rangeland Health (IIRH), with advanced remote sensing technologies to monitor and restore ecosystem functions. This study was conducted in central Iran, spanning 2,238 km² in the Mediterranean climate zone. This area has traditionally sustained local livelihoods by providing multiple ecosystem services including livestock forage and water resources. However, overgrazing, droughts, and the dieback of oak tree forests (*Quercus persica* Jaub. & Spach), along with the decline of valuable rangeland species such as *Astragalus verus* (Olivier) and *Astragalus adscendens* (Boiss. & Hausskn. ex Boiss), have led to significant land use and land cover changes. Using the IIRH protocol at the catchment scale, we classified 40 sites as healthy, at-risk, and unhealthy. Unhealthy and at-risk sites exhibited significant deviations from healthy sites in key attributes such as soil stability, hydrological function, and biotic integrity, often driven by human activities and land use changes. Remotely sensed indices such as landscape metrics, the Leakiness Index (LI), and the Moving Standard Deviation Index (MSDI) reveal variations in landscape structure and patterns, including fragmentation and resource leakage, offering valuable insights for sustainable land management in semi-arid regions. Using multivariate statistics and landscape metrics, we were able to estimate historical ecosystem health conditions. This study illustrates how satellite-based rangeland health assessments complement traditional field methods, demonstrating the value of integrating in situ data with remote sensing to monitor and manage land degradation across space and time effectively. This approach enables large-scale monitoring of land health, establishes benchmarks for degradation, and provides early warnings of ecological shifts, contributing to global efforts toward land degradation neutrality.

Oral presentation

Changes in a transboundary landscape: lessons from the border between Spain and Portugal

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The border between Spain and Portugal, which fits a general N-S direction, separates territories with similar geophysical characteristics. It can be considered as one of the oldest in Europe and has hardly been modified for eight centuries. This work studies the changes in the landscape on both sides of the border, interpreting them as the response to historical and socio-economic aspects. We analysed the effect of the distance from the border on land use/cover by means of landscape metrics. Nine transects crossing this border were established at zones with broadly a similar topography, lithology, and climate. In every transect, three 5-km diameter circles were randomly located at three distances from the border to extract the CORINE land cover classes (2018). Fragstats was used to calculate several landscape metrics regarding area/edge metrics, shape, aggregation, and diversity. Among the results, in the Spanish side, the number of patches, the patch richness, and the Shannon's diversity index generally decrease from north to south with distance from the border indicating an increase in landscape homogenization. Similar trends can be found in the Portuguese side of the border but they are less marked and metric values are higher. This suggests the presence of more specific patterns that reflect local characteristics. In Spain, the Euclidean nearest neighbour distance does not show a clear pattern at 5km and slightly increases at 20km in a north-south direction while it increases in Portugal at both distances from the border. The largest patch index increases within the distance from the border in the north-south direction in Portugal while there is not clear trend in Spain. The results also suggest a conspicuous difference among the transects to the northern and southern parts of Spain. The analysis of landscape patterns of these types of borders (persistent and over similar geophysical conditions) can provide information on the suitability of land uses and guidelines for advancing towards sustainability.

Oral presentation

Improving Riverine Land Cover Classification Using Spectral Indices and GLCM Features in LISS-4 Imagery

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Precise land cover classification in riverine environments is vital for effective hydrological studies and resource management. This study evaluates the influence of feature set design and machine learning classifiers on land cover classification accuracy in the confluence of the Mahanadi and Shivenath Rivers using high-resolution LISS-4 imagery from the IRS-R2 satellite. Two feature sets were developed. Feature Set 1 includes the original three spectral bands and twelve derived spectral indices, making a total of fifteen features. Feature Set 2 incorporates the original bands along with twenty-one Gray-Level Co-occurrence Matrix features computed from the original three LISS-4 bands, resulting in a total of twenty-four features. The GLCM features were derived from the original bands and include metrics such as Angular Second Moment, Contrast, Correlation, Entropy, and Variance. Four machine learning classifiers were applied to each feature set, namely Random Forest, Support Vector Machine, Gradient Tree Boosting, and Classification and Regression Tree, generating eight classified images. The best performance was observed with Feature Set 2 using the Support Vector Machine classifier, achieving an overall accuracy of 86.2 percent and a Cohen's Kappa coefficient of 0.827. Feature Set 1 with Random Forest also performed well, with an overall accuracy of 84.5 percent and a Kappa coefficient of 0.806, and was particularly effective in delineating narrow water channels. Feature Set 2 consistently improved class separability for challenging classes such as wet sand, dry sand, and sparse vegetation, highlighting the potential of texture-based features in enhancing classification accuracy. The findings demonstrate the value of integrating spectral indices and GLCM texture features with high-resolution imagery for detailed land cover classification in complex riverine systems. This approach provides valuable insights for ecological monitoring, flood risk assessment, and sustainable management of riverine resources.

Oral presentation

Multifunctional Ecological Networks: what they are and how they can be implemented

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How natural and semi-natural environments are interconnected within a landscape, along with the diversity of ecological functions and services that they provide is critical to how ecosystems work and interact. Yet, the underlying concepts of ecological networks (EN) and ecosystem multifunctionality (EM) are rarely integrated quantitatively to inform sustainable landscape management, mainly due to scale limitations. In this work, we build on the concept of Multifunctional Ecological Networks (MEN) to expand existing multifunctionality approaches and operationalize EM and EN at the local and regional scales. At the local scale, we introduce intra-ecosystem multifunctionality to describe the variability of EM within ecosystems and juxtapose it to inter-ecosystem multifunctionality, describing the variability of EM across ecosystem types in a broader region. We complement these two dimensions with local and regional EN analysis based on land use composition and configuration. By testing the framework in a case study in the Alps, we demonstrate how our approach support land managers and decision-makers in the operationalization of MEN by identifying areas where either synergies or trade-offs between multifunctionality and conservation exists to guide specific policy-driven intervention.

Oral presentation

Relevance of disturbance spatio-temporal scale domain for landscape pattern analysis

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Wildfires are one of the main disturbances in Mediterranean environment associated to landscape structural and functional changes. Mapping burned areas (BAs) over time is the base to investigate fire generated patterns and fire impacts on landscape dynamics. However, scale-dependency of landscape spatial patterns is contingent on the scale-dependency of disturbance regime (encompassing both the spatial and the temporal dimensions). To illustrate this concept, the case study is presented of the Natura 2000 Network (N2K) Special Area of Conservation (SAC) IT9130006, comprised of nine *Pinus halepensis* Mill. forests (sites) mostly ascribed to the 2270 priority Habitat type. Non-spatial records for this area indicated a longer fire history than the one documented by the BAs official vector maps publicly available (2000-2021 time interval). Thus a BAs map was obtained and a fire severity assessment carried out by reconstructing a 40-year (1981-2021) fire history by means of the Landsat imagery in the Google Earth Engine (GEE) environment. For the scope of the analyses, landscape was defined at two different scales by changing the extent in both the spatial (the 'SAC scale' and the 'site scale') and the temporal dimensions (long vs short observation periods: 1981-2021, 1981-1999 and 2000-2021). Two regime parameters were computed (ratio of fire size to landscape extent and ratio of return interval to vegetation recovery time) to assess landscapes' relative equilibrium conditions. At the SAC scale, a regime shift was observed between the 1981-1999 time interval and the 2000-2021 interval considered by the official BA maps. At both spatial scales, changing the extent of the temporal dimension affected the position of the system along the equilibrium/non-equilibrium continuum. In particular, across the long-temporal extent (1981-2021) the landscape moved from stability to instability conditions. The same was observed for the short-temporal extent over the 1981-1999 period, whereas, the system appeared relatively more stable over the 2000-2021 period. Consistently, differences in the values of simple landscape metrics over the different spatial and time scales were observed. These findings indicate that overlooking the effect of fire history and regime (i.e. relying on too short term BA maps) might mislead the perception of landscape dynamics, representing a crucial issue within the framework of fire/habitat management planning.

Oral presentation

Towards a comprehensive landscape character typology: Method development and prototype for a novel Swiss landscape characterisation

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Landscape characterisation and mapping is essential for the conservation of landscape diversity and their region-specific characteristics. To strengthen landscape character and preserve site-specific landscape qualities as an integral part of Switzerland's landscape policy, a spatially explicit, comprehensive, and widely accepted definition of Switzerland's characteristic landscapes is needed. Existing landscape typologies in Switzerland are either not spatially explicit or too coarse to capture regional characteristics. In particular, there is a lack of holistic approaches that take into account people's perception of landscape character as well as existing expert knowledge.

To bridge this gap, we propose a methodology for a comprehensive landscape character typology for Switzerland that integrates both the biophysical and social dimensions at a high level of spatial detail. Following a holistic landscape character assessment approach, our typology builds on four pillars consisting of 1) nationwide geodata on landform, land cover, land use, and other physical landscape elements, 2) the perception of landscape character by the Swiss population based on nationwide survey data, 3) existing expert descriptions of characteristic cultural landscapes in Switzerland, and 4) local knowledge of representatives in landscape research for validation. We investigated different classification approaches and, in an interactive process, developed a prototype map of our typology for the Swiss canton of Zug.

Based on our results, we suggest unsupervised classification as a valuable 'bottom-up' and data-driven approach to identify reasonable landscape patterns for establishing more reliable criteria in rule-based classification. However, landscape characterisation through unsupervised classification lacked in adequately addressing landscape typology hierarchies and the (social) prioritisation of specific landscape elements amongst others. The strength of rule-based classification thus lay in the inclusion of expert knowledge and the social perception of landscape elements as an additional weighting in the classification process of what constitutes 'characteristic' landscapes. By applying a rule-based classification, we ensured high traceability while enhancing the interpretability and transferability of the identified landscape character typologies. Through this methodological approach to landscape characterization, we aim to enrich tools for monitoring changes in landscapes and their qualities — both in Switzerland and beyond.

Poster presentation

Mapping Agricultural Landscape Structure Over Six Decades: Automatic Field Segmentation Using Historic and Modern Remote Sensing Data

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The structure of agricultural landscapes plays a fundamental role for multitrophic biodiversity, influencing ecological processes and species interactions across multiple scales. Especially the change in landscape heterogeneity in the form of field size change, along with crop diversity, has notable impacts on habitat complementation and connectivity, ultimately affecting species diversity. Accurate delineation of farmland parcels is therefore needed in order to keep track of the evolution of agricultural landscapes and to support and evaluate ecological policies. High-resolution remote sensing data offers great potential for this task but an adaptive and robust algorithm is needed for an effective large-scale analysis.

Here we exploit the strengths of the Segment Anything Model (SAM) for the automatic segmentation of farmland parcels using two distinct sources of remote sensing imagery: historic panchromatic CORONA data from the year 1965 and modern digital orthophotos from 2021/2022. Our study focuses on the German state of Saxony, which experienced severe transitions in agricultural landscape structure during and after the 1960s due to substantial policy changes implemented, such as collectivization. We selected several study areas throughout the state reflecting a wide range of soil, terrain and meteorological conditions. For these areas, scenes from both data sources were pre-processed and harmonised, ensuring comparability. Administrative data from regional authorities was employed to mask non-farmland before a two-step SAM algorithm was applied. The first SAM iteration addressed the segmentation of the full image while the second iteration focused on filling gaps. Post-processing included the removal of falsely detected segments based on a compactness score and morphological operations. For the majority of test regions, the results show a high accuracy with mean Intersection over Union (IoU) values of up to 0.8 for historic and over 0.9 for modern images. Limitations of the approach are revealed in mountainous areas and such with low image quality.

The developed approach holds considerable potential for applications in landscape ecology, particularly in cases supported by historic imagery. The resulting products can be used for the calculation and evaluation of landscape metrics and for subsequent assessments of biodiversity implications and the planning of conservation efforts. In our case, preliminary comparisons reveal a significant increase in mean agricultural field size from 1965 to the 2020s and further long-term evaluations of a multitude of landscape metrics are planned. We also plan to apply the method to a larger area and more time steps in the future, enabling a more detailed examination of agricultural landscape change in the state of Saxony over the past six decades. This will ultimately contribute to a better understanding of the relationship between agricultural policy and its implications for biodiversity in this region.

Poster presentation

Comparison of detailed and less detailed mapping of landscape fragmentation. Case study Skalica district, Slovakia

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Construction of artificial surfaces, such as buildings and roads, causes fragmentation of landscape. This process results into decrease in resilience of ecosystems, creation of barriers for movement of organisms and matter, and loss of biodiversity. This study focuses on landscape fragmentation caused by urbanisation and construction of transportation network (roads and railways). For calculation of landscape fragmentation metrics was used FragScape plugin in QGIS. As study area, we chose Skalica district divided into 28 cadastres. We calculated fragmentation metrics separately for each cadastre. Results of our study suggest, that linear vegetation, such as habitats related to transport infrastructure (HTI), or lines of grass and trees within agricultural land, can have positive effect on mitigation of effects of landscape fragmentation in urbanised landscape. However, these habitats are often overlooked in mapping and assessment due to their small size. Therefore, we compared landscape fragmentation metrics using less detailed mapping with those using more detailed mapping. In this comparison, we focused on the values of effective mesh size (m_{eff}). Although detailed mapping detected more fragmentation elements than less detailed mapping, it also recorded more green areas. In most cases, using the detailed mapping resulted in higher values of the effective mesh size in intensively used agricultural landscape.

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Poster presentation

Assessing Ecological Dynamics and its Association with Socio-Economic Factors Utilizing the Remote Sensing Ecological Index (RSEI) and the Geographical Detector Method: A Case Study of Crete, Greece

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Understanding the ecological variability of a region is essential for sustainable management and planning. This study evaluates the ecological conditions of Crete Island, Greece, a Mediterranean region characterized by diverse landscapes, biodiversity, and human activity. By integrating the Remote Sensing Ecological Index (RSEI) with the Geographical Detector (GeoDetector) method—a robust spatial statistical approach—this study quantifies the influence of environmental and anthropogenic factors on ecological dynamics at the municipality level. The analysis considers both natural and human-induced factors, including slope, Global Digital Elevation Model (GDEM), proximity to the primary national road network and major cities, number of settlements, legal units, population density, tourism-related establishments (accommodations and restaurants), cultivated land, wind farms, and new building constructions. Statistical data from the 2011 and 2021 censuses were incorporated to ensure data accuracy, allowing for a temporal perspective on demographic and economic influences. GeoDetector enables the assessment of Spatially Stratified Heterogeneity (SSH), identifying how ecological variations are structured and influenced by different explanatory variables without assuming linearity.

The results indicate that ecological quality varies across Crete's municipalities, with different factors having a stronger influence each census year. In 2011, legal units and tourism-related establishments had the strongest association with ecological conditions, while in 2021, legal units and cultivated areas were the most influential. Other factors had a lower impact on ecological variation. GeoDetector's interaction detection feature further highlights how multiple factors contribute to ecological dynamics, though no single variable was found to dominate across all municipalities.

These findings provide insights for policymakers and stakeholders as Crete faces environmental pressures due to tourism and land-use changes. Understanding how these factors influence ecological conditions over time can support more effective land-use planning strategies that balance economic activities with environmental sustainability in Mediterranean island ecosystems.

Poster presentation

Assessment of landscape vulnerability in the Czech-Slovak border region using national approaches

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The effects of climate change are being felt all over the world and have different impacts - environmental, social and economic. The basic principle for mitigating these impacts is to understand the causes, identify the hotspots and design appropriate adaptation and mitigation measures. Natural processes and other drivers of landscape change operate in a wider context and need to be analysed within logical, functional and natural boundaries. Therefore, analyses and adaptation measures implemented within the borders of administrative units are insufficient and do not bring the expected benefits for the landscape and human society, also due to the interaction of various measures implemented in neighbouring localities.

Currently, there are important methodological procedures (applications) for landscape vulnerability assessment on both sides of the border Czech-Slovak Republic border. In Slovakia it is the application "Horia obce" and in the Czech ESAI+. However, both approaches focus only on their territories, taking into account administrative borders and the availability of national datasets. However, the European Commission aims to coordinate and link data, especially on the living environment. In line with this objective, it is therefore desirable to prepare analyses (data, knowledge base) that take into account the manifestations and connections of entire natural units on the Czech-Slovak border, regardless of national borders.

In our study (carried out in the framework of the Interreg project JIZKES), the two methodologies were first compared at the level of the concept of the evaluation. This was followed by an analysis of the data used and the possibility of equivalent data sets on the other side of the border. Both methods were then applied, first on the home side and then on the opposite side, at the extent of the selected adjacent counties, to produce seamless maps of the whole study area. The main differences were identified in the climate data used (value, resolution) and the detail of the habitat map. The resulting maps were published on the project's public map portal. Finally, the applicability of the methodologies was evaluated using the SWOT method to create a (new) unified landscape vulnerability methodology applicable in both countries.

Poster presentation

Landscape mosaic typologies as nature-based solutions for fire risk mitigation under Atlantic conditions

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In southern Europe, drastic shifts in fire regimes (i.e. increase in the size and severity of the events) have been detected in the last decades, due to interactions between land use transitions and anthropogenic climate change, with unprecedented consequences for biodiversity and society. In the Ibero-Atlantic region, where forest fires have been historically frequent but small and moderately severe, large areas are expected to be affected by extreme fires in the coming decades due to increased fuel connectedness and dryness. The objective of this study was to characterize the landscape mosaics present in the northwesternmost corner of Spain, identifying the typologies less susceptible to suffer large forest fires. First, landscape composition (proportion of land cover types) and spatial configuration (heterogeneity and connectedness) were characterized at a regional scale based on passive multispectral remote sensing data. Then, landscape mosaics were typified into different categories by means of classification and ordination techniques, using watershed boundaries as spatial units of analysis. Finally, relationships between these landscape mosaic typologies and fire regime parameters (estimated across the last three decades) were assessed using machine learning models to identify the most resistant and resilient landscapes to large fires. Land management actions based on nature-based solutions such as the preservation of landscape heterogeneity or the conservation of native forest patches could help to reduce landscape susceptibility to large wildfires, providing environmental, economic and social benefits while fostering the development of wildfire resilient landscapes under Atlantic conditions.

Poster presentation

Historical and Contemporary Analysis of Landscape Heterogeneity: Methods and Challenges

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Studying landscape heterogeneity (LH) and its changes over time is crucial for understanding ecosystem dynamics and developing effective strategies for biodiversity conservation and climate change adaptation. Landscape heterogeneity consists of two components: compositional LH, which describes the diversity and abundance of land-cover types, and configurational LH, which accounts for their spatial arrangement. While analyzing contemporary LH is relatively straightforward due to the availability of land-cover datasets such as CORINE or satellite imagery that can be classified using remote sensing methods, assessing temporal changes of LH based on historical data presents a significant challenge.

Classification and segmentation of historical cartographic sources is difficult due to the lack of spectral information, making remote sensing methods unsuitable. Researchers must rely on manual vectorization or computationally demanding semi-/automated classification methods. Our study examines LH changes since the mid-19th century in selected localities on the Czech-Austrian border and demonstrates that no single classification approach is universally suitable for all historical maps. For the earliest maps from the 19th century, we utilized manual on-screen vectorization to capture compositional LH, as our attempts to use semi-automated technique for this component did not lead to satisfactory results due to the poorer quality of available data sources. To capture configurational LH, we considered aerial photographs from the 1950s onwards, which offer better quality and allowed us to apply semi-automated techniques using the Orfeo Toolbox in QGIS leading to satisfactory results.

Our results, showing both compositional and configurational heterogeneity and their changes over time, contribute to the investigation of their potential impact on grassland communities in the Czech-Austrian borderland. This research is a part of the ongoing bilateral project GRACE: GRASSland Communities Experiment: 300 years of insight from a large-scale natural experiment (24-14299L).

Poster presentation

Session 4B – Intelligent for Nature

Symposium

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Keywords: artificial intelligence, big data, biodiversity loss, disaster risks

In recent years, numerous reports have shown humanity's inability to tackle two of the major global crises: climate change and biodiversity loss (IPBES, 2019; WWF, 2020; IPCC, 2021). As the worldwide climate crisis intensifies, and requests more complex analysis of increasing datasets new tools are required to assist scientists. Technologies like Artificial Intelligence (AI) is increasingly critical in environmental sciences. It offers transformative opportunities in environmental sciences, particularly in disaster risk management and biodiversity conservation. By enhancing data processing, modeling, and translation in robust recommendation, AI can support a rational decision-making process and provide timely solutions to the urgent challenge faced by humanity. This session will explore how AI-driven innovations are transforming environmental science, focusing on disaster risk management and biodiversity conservation. Leading and junior scientists will present case studies and research on how AI can enhance predictive analytics for natural hazards and biodiversity loss, improve early warning systems, and optimize emergency response efforts. Additionally, the session will delve into AI's role in monitoring ecosystems, human activities, climate change, and environmental process changes.

Landscape climate changes emergency mitigation with expansion of IT Applications

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The limited water resources in Kazakhstan, Central Asian (CA) region dictate the need to implement a targeted water management policy to maintain the potential of water sources, a comprehensive solution to social, water management and environmental problems, based on the proper integrated surface-groundwater modeling prediction analysis, which require the substantial support in IT expertise. Efficient use of water resources is becoming an important demand for sustainable development. Water sustainability with long-term planning is vital for regional economic development. The predicted long-term water deficit in the region creates potential risks in the region. The proper solutions of water resources management, including its institutional aspects, issues of studying the permissible degree of water withdrawal and their quality, the optimal combination of beneficial effects associated with the development of water resources and the transformation of river ecosystems, are of urgent importance for the CA region. Proper prediction analysis requires good quality input data for modeling, which is a complicated issue in Central Asia (CA), connected to historical archive digital databases with the high speed processing system with IT experts support, especially for the advanced disaster emergency preparation activities. Meteorological, hydrological and hydrogeological data are often fragmented and controlled by separate ministries and departments without sharing by the open access platforms in Kazakhstan, CA. Integrated surface-groundwater resources studies are poorly developed in CA, mostly surface water resources are under investigations in CA. In Kazakhstan, surface water resources are mainly studied, while groundwater resources are used inefficiently. At the same time, groundwater is a vital component of the river basin ecosystem and should be studied simultaneously with surface water to obtain a more complete analysis of the sustainability of the integrated surface-groundwater system. For sustainable use of water resources, it is important to study the full water balance of surface-groundwater with the related IT support. This IT support should include the water engineering and technology perspective, focusing on technological aspects, including: 1) monitoring climate measurements, including the impacts of water-based healing methods; 2) forecasting the impacts of climate change in Kazakhstan. Moreover, it is necessary to be connected to the Nature, flora and fauna. Human activities should less distract Nature without the big engineering distractions, such as big dams, and artificial reservoirs. Slovakia's initiatives in "water for climate healing - the new water paradigm and public policy" <https://www.youtube.com/watch?v=NPx-tiTrqNQ> with contour-strip land organization under investigation by our Kazakh-Kyrgyz group of researchers for the Central Asia (CA) adaptation. We are currently trying to optimize the cross-border solution between Kazakhstan and Kyrgyzstan in the proper data sharing with IT support. Both countries lack sufficient

information, education, methods, and IT systems to efficiently manage the water resources. Adapting technical planning and forecasting would be helpful by learning and collaboration with expansion with Slovakian experts. The proper financial management connected to the IT-supported programs, using tools such as ArcGIS Hazus, artificial intelligence, machine learning, integrated to powerful platforms as SAP, as our targeted activities. IT applications, data analysis and visualization, as well as strategic forecasting are important needs to be applied in our project “Development of innovative hydrogeological methods for water resources management in the Zhambyl, Almaty, Zhetysay, Abay and East Kazakhstan regions,” funded by the Kazakh Ministry of Science, grant # BR27197639, the current results of our findings would be presented.

Oral presentation

Digital Tools for Citizen Participation in Urban Landscape Planning: Opportunities and Challenges

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The development of digital technologies is transforming urban governance, especially in how citizens participate in landscape planning and decision-making. Participatory Geographic Information Systems (P-GIS) and Digital Twins (DT) are powerful tools that facilitate more inclusive, transparent, and data-driven planning. P-GIS enables communities to map their concerns and spatial needs, while DT offer real-time simulations of urban environments to evaluate policy impacts before implementation. Despite their potential, challenges such as digital literacy, data accessibility, and administrative constraints limit their widespread use. This study explores the role of these tools in participatory urban governance through two case studies: Barcelona's Decidim platform, an open-source participatory democracy tool that incorporates P-GIS for urban planning, and Tallinn's DT initiative, which fosters citizen engagement through real-time spatial simulations. By examining these cases, the study assesses the effectiveness of digital participation in shaping sustainable urban landscapes and identifies the key factors influencing success. The findings contribute to ongoing discussions on digital inclusion, governance innovation, and the ethical implications of data-driven planning. Research questions include: How do P-GIS and DT improve public participation in urban planning? Which governance models successfully integrate these tools into decision-making processes? What challenges and limitations arise in their implementation, particularly regarding inclusivity and transparency? The study uses case studies of Barcelona, with the Decidim platform, which allows citizens to propose and vote on urban interventions while integrating participatory mapping for spatial planning, and Tallinn, with the Digital Twin Initiative, which allows real-time modeling of urban projects to simulate social and environmental impacts before implementation. Data collection includes Policy Analysis, Expert Interviews (with urban planners, technologists, and civil society representatives), Online Citizen Surveys (gathering feedback on user engagement and influence), and Comparative Analysis (evaluating usability, inclusivity, and effectiveness of both tools). The results offer insights into how P-GIS and DT promote democratic urban planning, identify governance strategies that integrate digital tools into decision-making, and provide recommendations for overcoming digital barriers to ensure equitable and inclusive participation. This study emphasizes the need for an ethical, transparent, and accessible digital governance framework.

Oral presentation

Monitoring Peat Bog Revitalization with UAS and Machine Learning: A Case Study from Krkonoše National Park

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Peat bogs are a vital global ecosystem playing a crucial role in water and carbon cycles, making their monitoring an essential prerequisite for their conservation. Although remote sensing technologies can significantly enhance this process, they are used in only a limited number of studies. A major advancement in this field is the application of Unmanned Aerial Systems (UAS), which reduces costs and increases the flexibility of image data collection.

The aim of our research was to assess changes in the vegetation cover of a peat bog before and three years after revitalization using remote sensing methods. The changes were evaluated by comparing two vegetation cover maps of the peat bog at the species level, created using UAS data and machine learning techniques. The study area was the Hraniční Louka peat bog in the Krkonoše National Park (KRNAP) in northern Czech Republic, a Ramsar-protected site. This peat bog underwent revitalization in 2021 by blocking human-made drainage channels that had significantly altered the ecosystem's water regime.

For vegetation cover mapping, we used UAS imagery captured in 2021 (DJI Phantom 4 Multispectral, 5 bands with a spatial resolution of 5 cm) and in 2024 (DJI Mavic 3M RTK, 4 bands with a spatial resolution of 2.5 cm). Field data for 11 plant species and 2 other classes (water and dry vegetation) were collected with the help of botanists from KRNAP, using GNSS measurements with an accuracy of up to 3 cm. Additional input features for the model included vegetation height and texture features derived from GLCM (Gray Level Co-occurrence Matrix) and GLSZM (Gray Level Size Zone Matrix).

Several pixel-based classification methods were compared in the analysis, including Random Forest, Support Vector Machine, Gradient Boosted Decision Trees (GBDT), XGBoost, and Multi-Layer Perceptron. Their hyperparameters were optimized using k-fold cross-validation to prevent overfitting and tested on a separate dataset. The overall accuracy and weighted-average F1-score was used to evaluate classification accuracy.

The peat bog was in both years classified with an accuracy exceeding 90%. The highest accuracy was achieved for common classes, whereas rarer classes showed lower accuracy due to insufficient field data. A comparison of the most accurate results indicated that no significant vegetation changes occurred but the water level increased noticeably. The results suggest no significant changes in species composition yet, but the water regime was affected, and monitoring of the peat bog is ongoing. KRNAP plans to systematically use remote sensing tools for monitoring the ecological state of peat bogs and assessing changes after revitalization in the future. The methods and results of this research will serve as a foundation for these efforts.

Oral presentation

Intelligent AI-based management system for optimizing rainwater and snowmelt runoff utilization

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Global freshwater scarcity is significantly exacerbated by climate variability, irregular precipitation patterns, and ineffective management of both rainwater and snowmelt runoff. Traditional methods of freshwater resource management are increasingly proving insufficient in adapting to these climatic challenges, necessitating innovative, intelligent solutions for sustainable water collection, storage, and utilization. For the research and training purpose the demo simulations tools were set up with the artificial intelligence (AI)-based system that autonomously manages both rainwater and snowmelt runoff, optimizing their capture, storage, and distribution for various practical applications in the small replicas. The developed system integrates sensor technologies and intelligent control mechanisms using microcontroller platforms, combined with real-time IoT (Internet of Things) connectivity. The system employs sensors for precise, continuous monitoring of water levels in the demo storage reservoirs, and incorporates real-time environmental sensors that distinguish between rainfall events and snowmelt processes. Utilizing meteorological data AI-driven predictive analytics, including machine learning algorithms and deep neural networks, the system can simulate runoff events, predict reservoir inflow, and dynamically manage storage capacities to prevent overflow and optimize resource availability. The simulation package includes integration of predictive modeling for snowmelt runoff, which presents additional complexity compared to rainfall due to variable melting rates influenced by temperature fluctuations, solar radiation, and surface characteristics. By training AI models on extensive datasets encompassing weather parameters and snowpack dynamics, the system attains the capability to forecast snowmelt periods and intensity reliably, thereby enabling proactive and efficient management of storage resources. The developed system is an intelligent device designed for real-time rainwater and meltwater monitoring and management and predictive modeling. The hardware platform integrates a Raspberry platform based architecture, combined with precise digital sensors and actuators. For water level detection, a configuration with ultrasonic sensors capable of continuous measurement with centimeter accuracy is used real-time telemetry data collection, storage and analysis functions are integrated in a cloud-based platform on a central server, allowing for remote monitoring, logging and system diagnostics. Prediction algorithms based on artificial intelligence analyze the accumulated sensor data in real time, which allows taking proactive management measures and optimizing decision-making processes. Currently, the developed system is undergoing field tests in Almaty region. The Kazakh Ministry of Science grant # BR27197639 "Development of Innovative Hydrogeological Methods for Water Resource Management in the Zhambyl, Almaty, Zhetysay, Abay, and East Kazakhstan Regions" supports this project. The current status of the project activities will be presented.

Oral presentation

Applying machine learning to anticipate crisis management of marine submersion events.

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As climate change intensifies, natural hazards pose a growing threat, making early warning systems essential for effective crisis management. Our research models marine submersion risks while integrating human behaviors, which significantly influence crisis dynamics. Using multi-agent simulations, we aim for realistic representations through an interdisciplinary approach involving geography, psychology, computer science, and sociology.

These simulations, based on previous geographical work, enable the physical modeling of marine submersions by analyzing past events (such as the Xynthia storm in 2010) and future scenarios derived from the most pessimistic projections of the IPCC for the Pays de la Loire region in France. The impact on infrastructure (buildings, roads, etc.) has been evaluated in parallel in the French municipalities of Batz-sur-Mer and L'Aiguillon-La-Présqu'île. Mapping the environment provides a foundation for using multiagent simulations to model residents' behaviors. Each agent is equipped with driving capabilities, enabling them to move from point A to point B via road networks, while reacting to various alert scenarios. Agents are also assigned specific behaviors, modeled using the BEN (Behavior with Emotions and Norms) architecture. This allows us to integrate emotional responses, particularly panic behaviors, which are extensively studied in social psychology. A survey has been developed to accurately represent the behaviors and lifestyles of residents of coastal communities. Using the GAMA software for multi-agent modeling enables us to integrate insights from these disciplines into our simulations. This methodology allows us to identify various profiles that may be more or less vulnerable during a crisis. Each profile is informed by behaviors derived from the literature and survey responses, which is then modeled to ensure high reliability in our simulations. Five profiles were identified based on six different parameters: knowledge, exposure, fear level, stress level, type of housing, and estimated behavior. Each profile is determined based on survey responses, which are then modeled to ensure high reliability in our simulations.

For Profile 1, characterized by average knowledge, high exposure, a fear and stress level above 60%, and ground-level housing, participants indicated an immediate departure by car. This first profile represents 16.1% of the studied population. Once these behaviors are integrated into the architecture, we will be able to identify problematic areas (e.g., below sea level, potential breaches in dikes) and behavioral patterns during crises (e.g., panic, denial, fear of death). The models will also incorporate agent interactions, such as mutual support and the arrival of emergency services.

The ultimate goal is to develop an application to alert populations before and during crises while providing valuable information to emergency response teams.

Oral presentation

Artificial intelligence-based GIS method for creation of invasion risk map of Hungary

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Understanding the relationship between geographical drivers (such as climate change) of biological invasion, and based on its results to predict the potential habitat of invasive species, is the most important issue of a successful invasion control strategy. In order to understand the geographical causes, we need up-to-date, well-structured spatial data covering all geographical factors (independent variables) and occurrence data of invasive plants (dependent variables). Based on visual interpretation of more than 120,000 European Environmental Agency Land Use and Coverage Area frame Survey (LUCAS) geotagged field photos we created a National GIS Database of Invasive Plant Species of Hungary web-map: http://earth.geo.u-szeged.hu/invasive/index_en.html. This database contains spatially homogenous geotagged point data of the occurrence of four investigated common Eurasian alien plants (1) the Russian olive (*Elaeagnus angustifolia*), (2) the goldenrods (*Solidago* spp. *Solidago gigantea* or/and *Solidago canadensis*) (3) the tree of heaven (*Ailanthus altissima*), (4) and the common milkweed (*Asclepias syriaca*). This 3 km cell size digital occurrence map represents the current status (2009-2022) of plant invasion in Hungary and provides a very realistic country scale spatial distribution of the infected and non-invaded LUCAS points.

For mapping the country scale invasion risk of Hungary (potential habitats of the four common invasive plants mentioned above), we need to take into account many geographical factors (road and hydrological network, land cover change, land use, soil properties, climate, elevation etc.) and the relationships between them (especially climate change related independent variables) and their weights on the occurrences of investigated invasive plant. Based on the maps with the recent (2009-2022) occurrences of the invasive species between and the maps of the above mentioned geographical factors, machine learning algorithms have been trained to determine the relationship between the geographical factors and the distribution of the investigated four invasive species. The method will be present can be easily extended to prepare a continental-scale hazard map of invasive plants, and can be adapted to identify the main driving forces of biological invasions and the geographical factors and pathways influencing the spread of invasive species.

Oral presentation

Flexible wheeled robotic tool to support the landscape changes and disaster mitigation

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Kazakhstan has had devastating floods-droughts issues during the recent years, which distracted much of the landscape environment and farming activities. The proper strategies with tools and methodologies are required to adapt. Some of the targeted efforts are related to the EU expertise adaptation in accumulation of snow, flood water collection in the retention ponds with the local expertise development in Flood-MAR (managed aquifer recharge) programs. The high-resolution digital elevation models (DEM) with a step of up to 10 cm in areas of potential flooding, digital surface models (DSM), high-resolution digital terrain models (DTM) up to 10 cm are target activities in the some regions to set up the contour strip organization of land landscapes. Combination of the geodesy tools with drones are popular applications for such DEM-DSM-DTM preparation. Some regions require remotely control moveable tools, where it is getting dangerous for people to go, such as spring flood, ice melting period of time, and other emergency events. Drones can be used in such cases, at the same time it is required to provide direct contact with the surface in some cases. In order to satisfy the need for contact with the surface, as well as through direct contact to provide high-precision data on the surface and its aspects, a remotely controlled wheeled robot with a certain number of special sensors is in development. The mobile platform is under investigation for more optimal running characteristics. This approach will ensure safety and high accuracy without the direct presence of a human for many emergency activities. These efforts align with the goals set by President Tokayev for 2025 as the "Year of Skilled Professions". The Kazakh Ministry of Science grant # BR27197639 "Development of Innovative Hydrogeological Methods for Water Resource Management in the Zhambyl, Almaty, Zhetysu, Abay, and East Kazakhstan Regions" supports this project. The current status of the project activities will be presented.

Oral presentation

The role of AI in spatial energy planning - to tackle both the climate and biodiversity crisis

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Multiple stressors lead to steady decline in biodiversity across various dimensions. While land conversion remains a primary threat, climate change is also accelerating biodiversity loss worldwide, with effects expected to intensify in the coming decades. Therefore, climate change mitigation efforts can support biodiversity conservation. The rapid transition toward climate-neutrality can also counteract these conservation efforts, however. In practice, planners face increasing intensity of competing societal demands and strong pressure on land as a resource. At the same time, they are confronted with a lack of sound knowledge on biodiversity metrics based on reliable data and updated predictions and preferences to base their decisions upon.

Our contribution presents stakeholder perspectives (authorities, consultants, NGOs,...) on the role of AI application in environmental planning with a focus on spatial energy planning to tackle both the biodiversity and the climate crisis. Through case study analyses and three workshops with serious game approaches we discussed the role of novel (digital & AI supported) data and knowledge to reflect the complex dynamics in ecosystems in interrelationship with rapid land use changes.

The poster explores the role of data deriving from innovative approaches such as passive acoustic monitoring, UAV or digital processing of camera traps data, supported by artificial intelligence, to improve the wicked data problem occurring at several planning levels and impacting largely the planning quality so far. Austrian stakeholders discussed a way out of existing data deficiencies to enable a net-gain planning and ameliorate both the identification of suitable locations, measures to compensate negative environmental impacts as well as their management plus monitoring for solar and wind energy planning.

Poster presentation

Detection of Asbestos-Cement Roofing Materials Using Image and Laboratory Spectroscopy in the Krkonoše Mts.

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Asbestos-cement roofing materials, extensively utilized in construction until the 1980s due to their notable durability, strength, fire resistance, and affordability, continue to present significant public health concerns in urban environments. These concerns primarily stem from the potential exposure to asbestos fibers released during the deterioration of materials, a process significantly accelerated under harsh mountainous environmental conditions. This study specifically examines and identifies the prevalence of asbestos-cement roofing materials in the town of Pec pod Sněžkou and its surrounding areas within the Krkonoše Mountains National Park. Given the labor-intensive nature of data collection, the challenging terrain, and the financial burden of manual inventories, accurately estimating the proportion of buildings that may require future reconstruction—whether due to public health risks, environmental concerns, sustainable development goals, or climate change impacts—is crucial.

The case study demonstrates the application of satellite data (Sentinel-2, PlanetScope), airborne hyperspectral data (400–2500 nm), and thermal data, complemented by ground-based spectral measurements acquired with an ASD FieldSpec 4 spectrometer. Advanced laboratory and imaging spectroscopy methods were employed and compared, specifically Spectral Linear Unmixing, along with machine learning algorithms such as Support Vector Machines (SVM) and Object-Based Image Analysis (OBIA). SVM is used for classification and regression analysis, identifying the optimal decision boundary between classes in a feature space. Spectral Unmixing decomposes the spectral signature of a pixel into the fractional abundances of its constituent materials (endmembers). While SVM is designed for class discrimination and predictive modeling, Spectral Unmixing enables the estimation of material composition within mixed pixels in hyperspectral data.

The existing literature suggests that these methods generally achieve an overall accuracy exceeding 80% in detecting asbestos-cement roofs. The results of the study may prove to be of interest to organisations involved in the fields of settlement improvement, urban planning, and environmental protection.

Poster presentation

Session 4C – LiDAR in Landscape Research

Symposium

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Keywords: LiDAR visualisation, DEM, modelling, remote sensing

Light Detection and Ranging (LiDAR) technology enables precise, high-resolution 3D mapping of terrains, buildings, and vegetative structures. This session explores the growing use of LiDAR across various landscape research disciplines, including landscape archaeology, environmental science, remote sensing, and landscape planning. Key focus areas include its ability to detect subtle landscape features hidden beneath vegetation, assess ecological variables such as forest biomass and canopy structure, and the use of detailed Digital Elevation Models (DEMs) for modeling various landscape processes. Presentations covering the application of airborne, terrestrial, and mobile LiDAR systems, from case studies to regional-scale analyses, are welcome. Challenges related to data processing, accuracy, validation and cost-efficiency will also be addressed, alongside discussions on future advancements. This session aims to foster interdisciplinary collaboration by presenting LiDAR as a transformative tool in landscape analysis.

Airborne LiDAR enhances modelling context-dependent changes in ecosystem functioning after plant invasion

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Assessing the impact of invasive plant species is a key goal in invasion ecology. Certain species, known as invasive ecosystem engineers, such as *Acacia* spp., can alter ecosystems so profoundly that a return to their original state becomes unlikely, leading to negative consequences for ecosystem functioning and services. Since the impact of invasive species is context-dependent, spatial data is needed not only on the invader's location and effects but also on the biophysical characteristics of the recipient ecosystem.

Remote sensing, particularly airborne LiDAR, provides powerful tools to capture such data across various spatial and temporal scales. However, the transferability and generalizability of these approaches remain challenging. Comparative, multi-site studies offer a way to elucidate context dependency from both a remote sensing and ecological perspective.

Here, we demonstrate how airborne LiDAR contributes to both mapping and assessing the impacts of invasive plant species. We introduce a conceptual framework for capturing invasion impacts using remote sensing while accounting for context dependency. Additionally, we present a case study in a heterogeneous dune ecosystem, where we map *Acacia*-driven changes in ecosystem functioning using LiDAR-derived proxies of ecosystem structure to account for site variability. We further highlight the complementary use of airborne hyperspectral and LiDAR data for impact assessment and showcase how LiDAR-derived environmental heterogeneity improves impact evaluations.

Oral presentation

In agricultural landscapes, bats respond to very fine-scale vegetation structure retrieved from high resolution LiDAR point clouds

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Forested habitats are an important driver of biodiversity in agricultural landscapes. They are particularly important for specific taxa such as bats, as many of these species use these habitats at some point in their annual cycle. Among forested habitats, riparian corridors have been identified as moving or hunting paths for bats — water being generally a source of food and riparian vegetation acting as a protection in their travel. However, information is lacking within forested habitats, and specifically riparian corridors, on the role of fine-scale vegetation structure on bat activity and movement. In this study, we aim to evaluate the relationship between forested habitat types, vegetation structure and bat activity in an agricultural landscape of Normandy in France. We recorded bat activity over 9 weeks between May and July 2024 in 36 plots belonging to three types of forested habitats: riparian vegetation, forest interior and forest edge (between pasture and forest). The plots were located in a 2 km buffer around a *Rhinolophus ferrumequinum* roost. We calculated several landscape metrics (e.g., proportion of water or forest) and vegetation structure indicators into 20 m and 50 m buffers around the plots. Vegetation structure was retrieved using high density LiDAR point clouds, allowing a very fine description of three-dimensional structure of the plots (canopy cover, canopy height or Plant Area Density (PAD) all over the canopy). The results revealed a large preference of bats for riparian and forest interior plots over forest edge ones, with a positive correlation with the length of water corridor and the proportion of water around the plot. Moreover, when focusing only on plots located into riparian vegetation, canopy height and height of the maximum PAD showed high positive correlation with bat activity. These results highlight the great interest of using new three-dimensional technology such as LiDAR point clouds to describe precisely vegetation structure in relation to bat activity. Moreover, they allow to build three-dimensional resistance maps in order to predict probabilities of bat activity at the landscape scale. Finally, our results also demonstrate the importance of keeping various riparian areas in agricultural landscapes to preserve biodiversity.

Oral presentation

Application of LiDAR visualisations for mapping the tillage direction

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Contour tillage is an agricultural practice that significantly contributes to enhancing water retention, reducing the risk of flooding, and mitigating soil erosion. Information about the tillage direction is used for modelling water and tillage erosion. In our study, we used Light Detection and Ranging (LiDAR) visualizations, originally developed for archaeological research, to visualise tillage traces and map tillage direction in the Nitra district (SW Slovakia). The tillage traces were visible in all agricultural parcels, on various agricultural fields, under various agricultural crops. The LiDAR visualisations also revealed pre-collectivization field patterns and even prehistorical field patterns in certain areas. Among the 5 961 investigated points, we recorded the application of contour tillage in 30.63% of the cases. The preference for contour tillage varied among farmers, with the highest reported percentage reaching 49.74%. Our analysis did not reveal a significant correlation between the preference for contour tillage and the slope steepness.

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Oral presentation

Europe's Salt Pan Laboratory: High-Resolution UAV Analysis of Sal 'e Porcus

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In July 2023, a comprehensive campaign was conducted to acquire geomorphometric and spectral data of the seasonally dry salt lake of Sal 'e Porcus in West Sardinia, Italy, the largest natural salt flat in Europe. The study involved UAV-based LiDAR and hyperspectral imaging to capture both spectral and morphological data from a low altitude. Hyperspectral data was collected using the AISA Kestrel 10 camera in 400 – 1000 nm spectral range, while LiDAR data were acquired with the VUX-1 sensor, both mounted on a DJI AGRAS T30 UAV. The mutual use of these data provided a comprehensive analysis of the salt flat's surface from the geomorphological and surface material point of view. LiDAR data confirmed a flat terrain gently sloping towards the eastern shore where the water persists the longest time throughout the year, with a maximum elevation variation of 30 cm. The spectral data revealed the mineral composition of the salt flat, including gypsum, polyhalite, and halite, identified through both field spectrometry and laboratory analysis. A comparison of spectral curves obtained from the field spectroradiometer ASD FieldSpec and the airborne hyperspectral camera AISA Kestrel 10 demonstrated spectral stability of salt flat surface in the range of 400-1000 nm across the mapped area of approximately 0.2 km² in the northern part of the lake. The study also incorporated multi-temporal Sentinel-2 imagery to track the water level change, confirming seasonal drying of the pond mainly from July until September. The results demonstrated spectral homogeneity of the salt flat surface, coupled with minimal topographical variation. The results indicate the suitability of this site for calibration/validation of space-borne hyperspectral sensors, supporting satellite missions like PRISMA, EnMAP, and CHIME. The findings not only contribute to building a spectral library and validation of Earth Observation data but also offer valuable insights into the ecosystem dynamics of the salt flat.

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Oral presentation

Structure and function of green infrastructure in Switzerland: Current status and future scenarios

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Urban greening, improved connectivity and enhanced ecological infrastructure are increasingly key components of spatial planning and landscape management policies as planners and decision makers strive to reach the sustainable development goals. Green infrastructure, particularly trees, hedges and shrubs outside forests, is of high ecological, economic and recreational relevance as well as its contribution to carbon storage and sequestration. Yet there is a deficit in knowledge about the current spatial distribution and characteristics of non-forest woody elements, as well as how this might be expected to change into the future. National and regional extent aerial laser scanning (ALS) data offers opportunities to detect and characterise these woody elements at landscape scales. Firstly, we take advantage of Switzerland's nation-wide program for ALS capture, flown over a 6-year period, with planned 6-yearly repeat cover with point density averaging 15-20 pts/m², to map shrubs and trees outside of forest. We determine their structural characteristics, such as height, vertical complexity, and green volume. This mapping provides essential information on the provision of landscape services where the first focus of our work is on carbon storage in woody biomass. A spatially explicit model of non-forest tree biomass is trained with field inventory data (tree height and diameter at breast height) from over 5500 non-forest trees. In addition, the mapping is integrated into Swiss-wide habitat mapping, an invaluable data source for ecological assessments, planning for biodiversity management, and understanding ecological networks. Secondly, with the NetZero 2050 and Sustainable Development goals in mind, we construct and model spatially explicit land use change scenarios for Switzerland for 2050. The scenario narratives were derived in the context of IPCC Shared Socioeconomic Pathways but defined to be specifically relevant for Switzerland and with a focus on green infrastructure. The scenarios include a business-as-usual scenario, a greening scenario and a land use intensification scenario. In each scenario we model both coarse land use change patterns and the potential distribution and structure of green infrastructure outside forests, particularly in urban and agricultural areas. Spatially explicit analysis of the resulting maps provides insights into how well future green infrastructure can meet demands for landscape service provision under different scenarios, again with a first focus on non-forest woody biomass.

Oral presentation

LiDAR and point cloud for environmental monitoring of sediment dynamics in river channel

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Riparian zones are among the most biologically diverse and productive ecosystems on Earth. High-resolution topographic point cloud data offer new opportunities for detailed assessment and monitoring of riparian zones. Three-dimensional stream morphology can also be mapped at a resolution that can be used for direct inference of processes, detection of volumetric changes, species monitoring, channel bathymetry, flow velocity detection, or automatic calculation of grain size and channel substrate. This paper focuses on the development of a protocol to automatically generate a 3D point cloud to detect spatio-temporal changes in river channels with biophysical properties of the river ecosystem and vegetation properties for assessing and understanding in-channel properties and for evaluating hydromorphological quality. Lidar-generated topography of the river channel by airborne and UAV scanning is used for the identification of sediment sources and deposition areas on the Ondava River system (Western Carpathians, Eastern Slovakia). Spatio-temporal differentiation of elevation model (DoD – DEM of differences) between 2017 and 2024 was applied with detailed analyses of LiDAR datasets uncertainties and errors. The effect of point-cloud density and roughness was tested for the detection of the spatial distribution of grain-size distribution that is directly linked with erosional/depositional processes. Moreover, a comprehensive approach with the detection of the vegetation's physical structure is applied to understanding biogeomorphological interaction in river channels by creation new habitats (gravel bar) and the subsequent succession. The paper was solved with the financial support of the Scientific Grant Agency of the Ministry of Education, Science, Research and Sport of the Slovak Republic and the Slovak Academy of Sciences (VEGA) No. 2/0016/24 and the Agency for Research and Development Support on the basis of the Contract No. APVV-23-0265.

Oral presentation

Studying the impact of point density for forest layer segmentation from ULS point clouds.

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The increasing number of ULS point cloud datasets has favoured the development of ML models for forest monitoring. This is especially critical in fragile environments such as protective forests, which are important for landscape and infrastructure preservation. Assessing forest layers such as the understory plays a key role in predicting the long-term evolution of an area. However, two major limitations often arise with common datasets. First, point clouds are typically captured with the highest possible resolution and point density. Although valuable for case studies, high point densities may not scale up well in extensive areas. Second, datasets frequently capture overly simplified forest structures and lack adequate representation of understory layers, particularly sparse in areas not adhering to biodiversity-focused management practices. This leads to incomplete datasets and models that fail to generalise to these cases.

To tackle both problems, we propose a pipeline to generate scenes that combine real tree scans with synthetically generated trees to close the gaps in the vegetation distribution. Not only can we oversample the frequency of young trees, but we can also produce synthetic trees of certain species or ages in targeted ways. Additionally, we control the sampling density to quantify the impact of scan density in the final product. This pipeline allows us to train models for layer segmentation, and extensively assess the impact of different point densities for the accuracy of this segmentation. While synthetic data allows detailed parametrisation, validating the approach's effectiveness/performance with real data remains equally important.

Therefore, we ground our data in strong realistic foundations in several ways. First, the fully synthetic trees we use follow ratios and characteristics extracted from real yield tables. Second, the pipeline enables flexible adjustment of the degree of realism, allowing many degrees of realism between fully synthetic scenes and entirely real-world datasets. Finally, our analysis is fuelled by a comprehensive data acquisition and annotation campaign in areas rich in understory trees, ground vegetation and overstory trees to fully represent the rich interplays between these layers in real environments. This pipeline allows us to draw sensible conclusions about the usability of ULS data in large-scale scenarios where point density decreases, including in seasons when canopy foliage significantly obstructs the acquisition UAV and the lower forest layers.

Oral presentation

Airborne LiDAR vs. UAV Imagery: structural accuracy or species identification for Carbon stock quantification in riparian forests?

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Riparian forests are fundamental carbon (C) sinks that help mitigate climate change, particularly in water-stressed regions like the Mediterranean Basin. Quantifying C stocks in these ecosystems is essential for understanding their mitigation potential and supporting conservation efforts. However, research on Above-ground Biomass (AGB) in riparian forests remains limited, especially in Europe and Mediterranean regions. Despite this knowledge gap, current studies highlight both the potential and challenges associated with LiDAR and UAV imagery approaches. Accurate methods for estimating C stocks, in more dense and complex forests, is still a challenge. LiDAR data is increasingly used for C estimation, providing efficient and detailed structural information such as tree height and canopy density, without requiring species identification. On the other hand, Unmanned Aerial Vehicle (UAV) optical imagery, validated with field-based species identification, enables species-specific C estimates.

This study evaluates whether LiDAR-derived structural variables can accurately quantify C stocks in riparian forests or if species-level identification via field-validated optical imagery is essential. The research was conducted along a 3 km stretch of the River Alcolobre, a medium-sized river in central-west Portugal, with distinct and separated areas of *Salix salviifolia* and *Alnus lusitanica*. LiDAR data was acquired in 2024, while a previous survey in 2018 used fixed-wing UAV imagery.

Our results show a strong spatial correlation between AGB estimates derived from UAV imagery in 2018 and LiDAR data in 2024 (Spearman's $\rho = 0.9787$), indicating consistent biomass patterns across years despite methodological differences. Bland–Altman analysis revealed a mean bias close to zero (0.011 Mg) and narrow limits of agreement, suggesting overall agreement between the two methods. Using a Two One-Sided Test (TOST) with bootstrap resampling, the methods were found statistically equivalent within a margin of ± 0.04 Mg. Species-level analysis showed greater agreement for *Salix salviifolia* (TOST margin ± 0.075 Mg) compared to *Alnus lusitanica* (± 0.085 Mg), reflecting higher variability in the latter. While LiDAR and UAV data proved comparable for general AGB estimation, species-specific analysis showed reduced equivalence species specific samples, and particularly for *Alnus*, likely due to the absence of floristic information in the LiDAR-based approach. These results underscore the potential for methodological interchangeability in biomass monitoring, while highlighting the importance of species identification in structurally complex riparian communities. This contributes to optimizing remote sensing protocols for long-term carbon assessments in Mediterranean riparian zones.

Oral presentation

The Use of LiDAR for Determining Urban Vegetation Parameters in the City of Zvolen

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In the era of the climate crisis, urban vegetation plays an indispensable role. It provides numerous ecosystem services, with cultural and regulatory ecosystem services being particularly significant. These include air purification, dust reduction, noise attenuation, mitigation of temperature extremes, and more. One crucial regulatory ecosystem service is carbon sequestration—a natural process of capturing and storing atmospheric CO₂, one of the primary greenhouse gases.

The LiDAR point clouds can be used to measure various tree parameters, which can be utilized in urban green space management plans. We determined tree height, crown projection in two directions (north–south and east–west), crown base height, crown shape and the biomass of trees.

This study focused on morphometrics woody parameters and estimating the biomass of urban woody vegetation in the city of Zvolen. Field measurements were conducted on 60 reference plots, where all trees were mapped, and biomass amounts were calculated based on their parameters. We measured tree parameters such as height, crown base height, and crown projection. Airborne LiDAR data was used to filter points corresponding to medium and tall vegetation. We modeled individual trees from LiDAR data and extracted tree parameters that were mapped in the field. Subsequently, we compared these parameters.

From the filtered point cloud, rasters for various height indices were created. Using linear regression analysis in the R programming environment, we determined which index had the strongest correlation with biomass values across the reference plots. The resulting equation was then applied in ArcGIS to model biomass in areas where field measurements had not been conducted.

By converting woody biomass data, we estimated the amount of carbon stored in trees. Using atomic weights of carbon and oxygen, we further calculated the amount of atmospheric CO₂ captured by the vegetation.

Finally, we determined the economic value of the carbon sequestration ecosystem service based on CO₂ emission quota prices.

Poster presentation

Automated Detection of Dry Stone Walls in Terraced Landscapes Using Airborne Laser Scanning Data

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Dry stone walls, a common feature in terraced landscapes worldwide, have both cultural and ecological value. They serve as prominent markers of cultural heritage and as indicators of historical and recent land use, reflecting how humans have shaped the landscape over time. In 2024, UNESCO recognized the art, knowledge, and techniques of dry stone construction as an Intangible Cultural Heritage of Humanity, underscoring the importance of these traditional practices. Moreover, dry stone walls are ecologically significant for local biodiversity because their crevices and temperature gradients create microhabitats for insects, reptiles, small mammals, and specialized plants. Thus, detecting and monitoring both active and abandoned or overgrown dry stone walls is crucial for preserving cultural heritage and advancing ecological research.

Airborne Laser Scanning (ALS) data provides a high-resolution representation of landscape topography, making it a reliable basis for mapping these small-scale landscape features. Accordingly, we utilize statewide available ALS point cloud data to establish a workflow for extracting dry stone walls in the Wachau region, a UNESCO World Heritage site in Lower Austria. The workflow is designed to map active walls—most prominently found along the region's vineyards—as well as overgrown walls indicating former agricultural use. The available data has a mean point density of 54 points/m² (ranging from 29 to 185 points/m²). We derive a high-resolution digital terrain model (DTM) with a grid size of 0.25 m using a hierarchical iterative approach on the classified ground points. Subsequently, we compare two approaches for automatically mapping dry stone walls using linear feature extraction on the DTM: (1) combining Canny edge detection with random forest classification based on topographic features used in geomorphological mapping (e.g., slope, topographic position index, curvature); and (2) adapting a pre-trained deep learning model for edge detection in images. The results are further semantically filtered using a national forest map, buffered street layers, and land use classification based on the digital cadastral map.

For training, testing, and validation, we use manually digitized reference data derived from the interpretation of shadings, slope maps, orthophotos, and the original point cloud. Additionally, we include publicly available data from detailed ecosystem mapping of selected sample regions in the Wachau area. Initial tests show promising results for both approaches. With the developed approaches, nation-wide automatic detection of these cultural and ecological import structures becomes feasible.

Poster presentation

Session 4D – Transdisciplinary Approaches in Landscape Research

Symposium – speed talks

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Keywords: transdisciplinarity, sustainable development, integrated landscape approach, collaborative solutions, co-design

Landscapes serve as boundary objects, accessible to various disciplines and actors from multiple sectors. They are increasingly promoted as entry points for addressing real-world challenges in the interests of sustainable development, such as climate adaptation and mitigation, regional sustainability or robust food systems. Methodologically, transdisciplinary (td) approaches, such as Real-World Labs, Integrated Landscape Approaches, Joint Problem Framing, and Co-Design, have gained traction for tackling landscape ecological research questions. Our session targets those applying such td-approaches and methods to bridge diverse perspectives and knowledge systems to tackle societally relevant issues at the landscape scale. We will convene to exchange practical examples and to foster dialogue aimed at further anchoring td-approaches in the realm of landscape research. In this session, speakers will present their projects through brief speed talks (5 minutes each), highlighting key discussion points. Following these presentations, participants will have the opportunity to participate in small discussion groups, where they can delve deeper into topics of interest and explore collaborative solutions. The session will conclude with a brief summary and reflections in the plenary. Overall, the session aims to provide a platform for shared learning and networking.

Knowledge-co-production on future climate-change-induced mass movement risks in Alpine regions

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Climate change is expected to have massive impacts on Alpine mass movements. Therefore, early local discussions on anticipatory prevention measures would be important. However, high uncertainties and in particular a shared understanding of the issue is lacking. Regional stakeholders, experts in natural hazards management and scientists hold specific knowledge on future regional risks. This diversity of views makes it difficult to find common and broadly accepted prevention measures. An knowledge exchange among these actors on eye level in a knowledge-co-production process is expected to enables a broader and shared understanding of such complex risks and to allow for finding shared long-term solution strategies. However, studies that examine the effect of knowledge co-production on future hazard risks are lacking so far.

The transdisciplinary project tested and evaluated the feasibility of knowledge co-production for the anticipatory prevention of climate change-induced mass movement risks in Alpine regions using an intervention research design. In this knowledge co-production process, representatives of the three basic actor groups co-developed system models of the future hazard risks and mentally simulated the effects of potential solutions. The evaluation of this process based on repeated measurement of participants and non-participants perspectives on the issue and the monitoring of the process confirmed that participants perspectives on the issue converged during the process, and that a shared understanding of the issue and shared long-term solution strategies could be achieved within a few hours of intensive exchange.

Oral presentation

A year-long process of joint problem framing

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The project “Real-World Lab Jurapark Aargau” applies transdisciplinary approaches to foster collaboration between researchers and stakeholders from civil society, the private and public sectors. The goal is to jointly identify sustainability challenges and explore measures to address them in real-world experiments. We understand “experiments” broadly as “jointly developing and testing measures to strengthen sustainable landscape management.”

Our study region, the Jurapark Aargau, is one of 17 regional nature parks in Switzerland in a peri-urban and rural area. Regional nature parks must balance nature conservation and regional economic development. In the Jurapark Aargau, 55'000 residents live on an area of 299 km², organised in 31 municipalities. To ensure alignment with local priorities, the first project phase was dedicated to a joint problem framing. The challenge was to identify topics that (a) match the expertise of ETH domain researchers, (b) align with regional sustainability strategies, and (c) reflect Jurapark residents' interests. Based on surveys and discussions we identified “Water management”, “Climate adaptation” and “Circular economy” as key starting points.

For each topic, we applied a structured co-design process. Over several months, three workshops (each 2h) brought together 15-25 participants, including researchers, local decision-makers, landowners and government representatives. Scheduled in local venues and structured to encourage open dialogue, the workshops combined elements of soft systems methodology, design thinking, and knowledge co-production: - Workshop 1 – Developing rich pictures of current situation and identifying key intervention points. - Workshop 2 – Translating intervention points into concrete measures and rating them. - Workshop 3 – Refining selected measures into real-world experiments. We will present and discuss (a) the problem-framing approach and workshop methodology and (b) pathways that selected topics took throughout the process. Additionally, we will reflect on how aligning researcher expertise with stakeholder needs influenced topic evolution and outcomes.

Oral presentation

Harnessing open science, digital innovations and local engagement for landscape resilience in Africa

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African landscapes are increasingly vulnerable to the impacts of climate change, urbanization, biodiversity loss, and resource degradation. These challenges are further exacerbated by limited access to up-to-date digital information, complexity of existing solutions and lack of local ownership. However, the digital revolution, the rise of open data, and the skills and motivation of Africa's youth present transformative opportunities for scalable, locally driven landscape solution that enhance climate resilience. Advances in landscape ecology, including Earth observation, artificial intelligence (AI), and open-source tools offer unprecedented potential to study, assess and manage rapidly changing landscapes.

Resilience Academy (RA) is as a university-driven partnership model that fosters landscape resilience through demand-driven, scalable, and locally sustainable landscape solutions. By leveraging open data, affordable digital technologies, and inclusive participation, it empowers young scientists, citizens, and multiple stakeholders to rethink how landscapes are mapped, designed, and managed. We present and reflect lessons learnt from several landscape mapping, change detection and participatory planning case studies from Tanzania, where we have been working in multi-stakeholder environments to address losses, degradation and fragmentation challenges of landscapes with RA approaches. The presentation explores integrated landscape approaches and digital geospatial methodologies for addressing Africa's landscape challenges. It examines how the synergies between citizen and student engagement, learning new skills and using AI, Earth observation, and digital tools can drive innovations in landscape ecology.

Key discussions will include success factors, barriers, and the broader societal shifts needed to ensure that digital landscape solutions are impactful, locally owned, and scalable. The session will challenge participants to envision the future of landscape management in Africa, where technology, policy, and grassroots engagement converge to tackle climate and biodiversity crises effectively. Integrating these tools with nature-based solutions and community-driven data collection can bridge the gap between scientific research and real-world applications

Oral presentation

Understanding Science-Society Interactions: Diverse Viewpoints from Mountain Biosphere Reserves

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Addressing global challenges necessitates innovative and participatory forms of knowledge production such as transdisciplinary (td) research initiatives and other forms of high-engagement science-society interactions (SSI), increasingly endorsed in Biosphere Reserves (BR). Despite strong policy advocacy from the UNESCO MAB Programme for such initiatives, how they are understood and implemented within BR remains underexplored. To address this gap, this study employs Q-methodology to investigate the understandings of SSI among representatives of mountain BR and examine the extent to which these reflect the said UNESCO MAB policy directives. Q-methodology is a unique semi-quantitative research method used to study subjective viewpoints by having participants rank and sort statements according to their perspectives, which are then analyzed to identify shared patterns of thought. Findings reveal distinct viewpoints among respondents: some emphasize SSI as collaborative endeavors involving diverse actors and knowledge systems, prioritizing inclusive decision-making and integrating local and traditional knowledge to address sustainability challenges (aligning closely with the principles of td research). Others, however, emphasize research-driven SSI, prioritizing scientific expertise and monitoring, reflecting historical conservation-focused BR approaches. A further perspective integrates aspects from both collaborative and research-focused perspectives, positioning BR as catalysts for SSI. The paper illustrates that despite a strong conceptual basis and policy support, the nuanced and subjective nature of td research initiatives and other high-engagement SSI presents significant challenges for researchers and other actors in understanding them. The absence of a prevailing shared understanding highlights the nuanced and subjective nature of such SSI as well as a lack of consensus regarding specific actions or the ideal form that they should take. Furthermore, our findings suggest that the latest UNESCO MAB policy documents, intended to guide the understanding and implementation of SSI within BR may not fully resonate with the diverse perspectives observed on the ground. While these documents advocate for knowledge co-production and collaborative research, core principles of td approaches, our findings indicate that this emphasis is not uniformly embraced across all BR. This discrepancy underscores the difficulty of translating policy directives into practical applications as well as the need for further exploration and clarification to better guide actors in implementing td research initiatives and other high-engagement SSI tailored to the contexts and challenges of their BR. This paper contributes to ongoing discussions on bridging diverse knowledge systems and fostering co-designed solutions at the landscape scale. It highlights the importance of dialogue, shared learning, and contextualized approaches to advancing td research initiatives in BR and beyond, offering insights that resonate with the broader goals of the landscape ecology community.

Oral presentation

A transdisciplinary approach towards Nature-Based Urban Planning for adaption to climate change: Insights from the Plann@t project in Portugal

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In the context of climate change adaptation, Nature-Based Solutions (NBS) hold a prominent place on the policy agenda. Despite a well-established understanding of NBS and the development of practical applications, their comprehensive integration into urban planning remains limited. One potential reason for this gap is the prevailing urban planning paradigm, which fails to adequately address current and future challenges. Although scientific knowledge supporting NBS has advanced significantly, further efforts are needed to scale NBS within existing urban planning frameworks. We investigate the usefulness of adopting the concept of Nature-Based Urban Planning (NBUP). To achieve this, a transdisciplinary approach is employed to explore how legal frameworks and norms can be reshaped to integrate biodiversity into urban planning, thereby enhancing spatial planning quality and making urban landscapes more resilient to climate change. The ARENA concept serves as a platform for merging multiple knowledge bases, including input from experts across various disciplines and stakeholders involved in urban planning, such as decision-makers, public administrators, practitioners, and end-users. The collaborative co-creation process is structured into four phases: ignite, match, assess, and validate. Throughout the working sessions, structured discussions explored a vision for the future of urban planning to enhance climate resilience in cities and promote biodiversity in urban environments, building on Transition Theory. Key knowledge gaps were identified regarding natural processes, best practices in urban planning legislation, and the benefits and beneficiaries of NBUP implementation. The outcomes highlight pathways for aligning planning tools and instruments with data from scientific literature, serving as a basis for revisiting current urban planning policies. This approach fosters transformative changes in planning and design practices, better equipping them to address the climate crisis.

Oral presentation

Using planning games and interactive visualisations labs for collaborative planning and local knowledge integration in the development of scenarios for ground-mounted photovoltaics in Austrian biosphere reserves

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Today's wicked problems require holistic considerations and new perspectives to address multiple trade-offs, between economic, environmental and social expectations for creating sustainable pathways. Key challenges such as climate change and the loss of biodiversity are strongly interlinked, which is why solutions and approaches for one challenge can counteract efforts for another. In addition, on a societal level conflicts, political lock-in effects and institutional inertia contribute to the complexity of these wicked problems and a lack of problem-solving capacities.

The decarbonization of our energy system is a key tipping point in the fight against climate change. Ground-mounted photovoltaics is next to wind energy a key technology in the field, but can have negative effects on habitats and various organism groups. In addition, there are also concerns about the impact on the landscape scenery, particularly in scenically attractive locations.

This discourse on PV is often fueled or exacerbated by the media and political statements and supports a general expression of having no room for maneuver. While the increasing availability of data and new methods such as deep learning allow for more precise models and analyses on energy supply or biodiversity impacts, the social dimension is often missing. It is becoming increasingly difficult to communicate these complex interrelationships and to shape them in the sense of transdisciplinary learning and research processes in dialogue with society. With the Landscape.Lab approach, we are aiming to close this gap between research complexity and lay participation. Within workshops in three Austrian Biosphere reserves, we examine the potentials and conflicts for the development of ground-mounted photovoltaic plants to reach energy goals for 2030 and 2050 and at the same time visualize its impact on biodiversity at a local level. By providing new human-computer interfaces, interactive and immersive visualisations and a planning game approach, we create a transdisciplinary space that enables the embedding of local knowledge for experiencing and evaluating different energy futures.

Preliminary results show that the data-driven approach and the comprehensive visualisation options allow an active examination of the possible effects and impacts of ground-mounted photovoltaic systems. The playful approach reduces access barriers and encourages an exchange between laypeople and experts at eye level.

Oral presentation

Landscape scenarios for regional development under climate change: a transdisciplinary approach

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Climate change significantly impacts landscapes and the services they provide. Landscapes, understood as a manifestation of the interaction of nature and people, are far more than an important resource for humankind. More so, they frame regional identities, including a sense of belonging through memories. As such, they provide important elements for a high quality of life. Interacting impacts of climate change on landscapes are not yet well researched. This paper argues that, due to the inherently relatable and tangible characteristics of landscapes, a landscape perspective facilitates the creation of common visions, thus offering potential for participatory solution-orientated experimentation and collaboratively identifying pathways to sustainability.

To support our argument, we present the concept and initial findings of the transdisciplinary research project “Climate change – landscapes: designing sustainable futures (KLANG)”, which investigates the development and use of participatory landscape scenarios focussed on climate change in transformative regional processes towards sustainable development. Within KLANG, local landscape visualisations and stories of landscape change are being developed by way of a transdisciplinary process involving local stakeholders and scientists in three case study regions in Switzerland. Embedded in a co-design process, the emerging landscape scenarios are being specifically tailored to contribute to ongoing planning processes in the regions. We will present findings from the case study region Lenzburg-Seetal where the issue of ‘climate change impacts and measures for climate resilience’ was integrated into a regional landscape management policy for 26 municipalities.

By combining visualisations and storytelling, we (1) strive to facilitate the integration of local knowledge on the landscape system, including regional identity, with scientific knowledge on the impacts of climate change, adaptation and mitigation strategies. In working at the local landscape scale, we (2) aim to contribute to the audience-orientated climate change communication and, in doing so, enable stakeholders to forge connections between the global phenomenon of climate change and everyday life, identity and personal scope of action. By using futuring techniques, our goal is to (3) foster a solution-oriented mindset and allow individuals, regional stakeholder groups and decision-makers to discover opportunities to influence future landscape development under climate change. Overall, this transdisciplinary social learning process aims to collaboratively envision solutions to real-world problems at the landscape level and empower those involved to actively shape the(ir) future.

Oral presentation

Enhancing Biodiversity in Agricultural Landscapes through Integrated Landscape Approach and Co-Design: The CLEAR Project.

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Globally, agriculture faces unprecedented challenges in sustaining food production while restoring biodiversity and adapting to climate change. This calls for agricultural landscapes to be multifunctional and resilient, delivering a broad range of ecosystem services beyond food production. In response, the CLEAR project (Collaborative Landscape Planning for Enhanced Agrobiodiversity and Resilience)—funded by Suscrop-Era Net—embraces an integrated landscape approach and co-design principles to foster biodiversity-friendly agricultural management through participatory and collaborative planning. The project's core objective is to develop and implement an interdisciplinary framework that identifies and evaluates agricultural practices enhancing agrobiodiversity. By engaging stakeholders throughout the process, CLEAR ensures that solutions are context-specific, practical, and scalable. The research is grounded in four regional case studies across France, Germany, Poland, and the UK, representing diverse agroecological and socio-political contexts.

CLEAR employs a multi-step participatory approach that integrates stakeholder engagement, modeling, and empirical data collection to assess agrobiodiversity at field and landscape scales. This involves:

1. Identifying and validating biodiversity-enhancing practices using a combination of participatory methods, spatial modeling, and field data.
2. Co-developing priority indicators through stakeholder dialogue to ensure locally relevant and actionable biodiversity metrics.
3. Scenario-building and spatial modeling, where stakeholders contribute to shaping future land-use visions, exploring trade-offs and synergies of upscaling agroecological measures.
4. Informing policy design by co-developing collaborative and result-based agri-environmental schemes that support biodiversity while maintaining agricultural productivity.

By integrating landscape-level collaboration and co-design, the CLEAR project aims to establish policy pathways that encourage collective action, ensuring that agricultural landscapes become more resilient, biodiversity-rich, and capable of sustaining food security amid global changes.

Oral presentation

Session 4E – Modelling Vegetation Dynamics: Integrating Ecological Processes and Climate Change Impact

Symposium

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Keywords: models of vegetation dynamics, ecological modelling, environment

Understanding the drivers and pressures of landscape change is essential for predicting and managing vegetation dynamics and assessing the contribution of different landscapes to biodiversity protection, the provisioning of ecosystem services and nature-based solutions. This session will explore the latest advancements in modelling vegetation dynamics, focusing on the integration of ecological processes and the impacts of climate change. We aim to address how ongoing and emergent drivers, such as global warming, conflicting societal demands, and biotic threats, influence vegetation processes and landscape patterns. Various data, tools, and methods that enhance our ability to model these dynamics accurately will be considered. This session aims to foster interdisciplinary collaboration between ecologists, climate scientists, and data analysts, providing a platform for sharing recent research findings and methodologies. By identifying gaps in current models and proposing future research directions, we aim to advance the field of landscape ecology and to raise the capacities for activating more effective environmental management strategies. Key topics include: • Investigating the roles of ecological processes in shaping vegetation dynamics. • Assessing the projected effects of climate change on vegetation and landscape patterns. • Comparing empirical, process-based, and machine learning models in capturing vegetation dynamics. • Leveraging remote sensing, field data, and other sources to improve model precision and reliability. • Presenting real-world applications of vegetation models in conservation, land management, GHG inventory reporting and policy-making.

Simulating the increasing role of drought as a trigger for bark beetle outbreaks and its potential to transform Central European forests under climate change

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Windthrows have traditionally been the major trigger of large-scale outbreaks of the European spruce bark beetle (*Ips typographus*); nevertheless, severe drought in 2018 generated the most widespread bark beetle outbreak to be documented in Europe. Our capacity to assess the impacts of drought on bark beetle outbreaks remains limited. The objective of this study was to develop and test a modeling framework capable of simulating drought-triggered outbreaks and to assess the interactive effects of wind- and drought-triggered outbreaks on forest ecosystems throughout the 21st century. Employing threshold values of vapour pressure deficit as outbreak triggers, we incorporated a module for simulating drought-induced bark beetle outbreaks into the forest landscape simulation model, iLand. Model parametrization and validation were performed using forest management records and remote sensing-based disturbance maps of a representative Central European forest landscape. Model performance was evaluated over the period 1961–2021, while simulations were extended until 2100 for scenario analysis. Climate projections indicate an increase in the frequency of conditions capable of producing drought-induced outbreaks, with a larger probability under RCP8.5 than RCP4.5. The introduction of drought as an inciting factor resulted in a decoupling of wind- and bark beetle-induced disturbances in model simulations. While simulated forests were resilient to wind-induced disturbances, the combined effects of wind and drought dramatically decreased Norway spruce growth stock by 56.6% to 86.8% by 2050, with long-term implications for species composition and forest structure.

The study underscores the urgent need for disturbance models that explicitly integrate drought as a triggering factor for bark beetle outbreaks. The findings suggest that future bark beetle outbreaks may be more severe than previously anticipated, emphasizing the importance of adaptive forest management strategies to mitigate the effects of climate change on Central European forests.

Oral presentation

Projected upward shifts of the Carpathian treeline in response to climate change and their implications to mountain landscapes

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The treeline is a critical ecological and landscape boundary in mountain regions, marking the transition to alpine environments. It influences ecosystem structure and composition, as well as energy and water balance. While local treeline positions are affected by various factors such as soil conditions and disturbance patterns, the broader concept of the climatic treeline refers to the transition zone between forests and alpine shrublands or grasslands, primarily determined by climatic conditions. At high elevations, low temperatures are the main constraint on tree growth. With rising global temperatures, treelines are expected to shift upward. In the Carpathians, this shift threatens to eliminate alpine habitats across many mountain ranges. However, the extent to which climate change will impact treeline positions in the region remains uncertain. In this study, we identify the climatic factors that determine the current location of the climatic treeline in the Carpathians and use these insights to project future treeline shifts. We mapped the present-day climatic treeline in the Carpathians using high-resolution satellite imagery and analyzed its relationship with twelve climatic variables believed to influence treeline position. Our approach combined statistical analysis, which involved computing the ratios of standard deviations and coefficients of variation, with a machine learning approach, assessing variable importance in Random Forest models. Our findings indicate that in the Carpathians the mean temperature of the warmest quarter exhibits the strongest correlation with treeline position, which predominantly align with a value of approximately 10°C. Using this threshold, we estimated the current total area of the climatic envelope for alpine ecosystems in the Carpathians at 1,370 km². Applying CMIP6 climate projections, we assessed how this climatic envelope will change under various future timeframes and emissions scenarios. Our results indicate that by 2060, alpine ecosystems will shrink to less than a quarter of their current extent under all scenarios. In the highest emission scenarios, alpine ecosystems in the Carpathians could nearly vanish by 2080. These changes will have profound ramifications for ecosystems, water and energy balance, and the carbon cycle, while also endangering the region's rare and endemic alpine species. A deeper understanding of how climate change impacts alpine and subalpine ecosystems is essential for guiding ecosystem management and conservation planning in the Carpathians.

Oral presentation

Long-term Dynamics and Carbon Balance Forecasting in Renaturalizing Forest Ecosystems: A Case Study of Wielkopolski National Park (Poland)

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The European Union, in its strategic documents emphasizes the need to increase the area of protected forests. The objectives of these activities are broad and include the protection of biodiversity, ensuring the sustainable development of forest ecosystems, and counteracting climate change. Currently, increasing emphasis is being placed on the last of these objectives. In this context, the key ecosystem service provided by forests is carbon sequestration and its long-term storage, which is increasingly recognized as essential for mitigating climate change. The implementation of EU goals by member countries may result in at least some of the new reserves being established within forests with lower naturalness. To understand the dynamics of changes in such ecosystems following the introduction of protection and their impact on provision of ecosystem services, multiple data sources are required. Wielkopolski National Park (WNP), established in 1957, is currently one of 23 areas under the highest form of protection in Poland. Historically, it was created in areas that were intensively utilized by humans, which is why it is one of the few parks where renaturalization of former managed forests plays a significant role.

The aim of this research was to assess long-term (80 years) changes in the structure of fresh forests in WNP in the context of renaturalization, evaluate the current state, and the current carbon balance in relation to stand age. The study was conducted in seven strictly protected forest stands dominated by *Quercus petraea*. To reconstruct the history of changes in these forests, historical maps and forest stand inventory descriptions from 1940–2013 were used. The current state of the tree stands was derived from field inventory surveys, including the assessment of living trees and deadwood volume and biomass. The inventory data were used to initialize simulations with a process-based model that was applied to examine the carbon balance of the forests after the cessation of forest management. Information on soil characteristics required by the model were obtained from the soil survey included in the WNP protection plan, ensuring consistency with existing environmental assessments. Meteorological and hydrological data necessary for the modeling were sourced from measurements conducted within the park's area, providing high accuracy and relevance to local climatic conditions. The model output was evaluated using historical data on stand characteristics.

We tested the following hypotheses: (1) the structure and species composition of forests in Wielkopolski National Park have undergone significant changes over the past 80 years, with a tendency toward increased naturalness and biodiversity, (2) after eighty years of protection the carbon balance of forest ecosystems is approaching an equilibrium of old-growth forests.

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Oral presentation

Scaling Matters: How Input Data Resolution Affects Biomass Projections in LANDIS-II

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Accurate projections of forest dynamics are vital for sustainable management under climate change. Although forest landscape models are useful for simulating forest changes, the combined effects of grain size chosen for different input data (e.g., climate, sites, stands composition, stochastic processes) on biomass projections remain unclear. Preparing comprehensive input datasets for landscape dynamics models is time consuming, and detailed data are often unavailable, requiring simplifications. Although the importance of the calibration of species parameters is recognised, the relative importance of using high- versus low-resolution climate, ecoregion, and forest community data and the role of stochasticity, have not been quantitatively assessed.

We have parameterized the species parameters and used a factorial design to investigate the effect of the resolution of main input data on 80-year forest biomass forecasts obtained for a Mediterranean forest landscape (Southern Italy) using the forest landscape model LANDIS-II. We analysed the differences in the time series of total aboveground biomass using mixed-effects models.

The results indicate that the fine-resolution input better approximate expected biomass accumulation, species turnover, and composition by capturing spatial environmental spatial heterogeneities and local climate impacts. The resolution of climate data played a crucial role, as low-resolution climate data resulted in dramatic changes in biomass production. Initial community resolution also influenced biomass, but only when combined with high-resolution climate data, suggesting an interaction between these two factors. In contrast, the resolution used to delineate ecoregions had little effect, except for a small but significant interaction with climate resolution, possibly indicating redundancy. Over time, interactions between settings and temporal dynamics emerged, with the impact of initial community resolution increasing slightly and climate resolution becoming even more important. Finally, the stochastic effects (standard deviation of biomass among 10 replicates) were minimal, probably due to the absence of disturbances or other random factors in the landscape.

Our findings underscore the importance of high-quality inputs in ecological modelling and especially the role of downscaled climate inputs, even if only summary statistics over large landscapes are used.

Oral presentation

Modelling forest soil organic carbon dynamics with Biome-BGCMuSo model

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Due to the ongoing impacts of climate change, alterations in soil organic carbon (SOC) are expected, hence monitoring and forecasting of this carbon pool is relevant. To be able to accurately predict SOC, model results need to be verified with field data. In this research we evaluated the applicability of the process-based model Biome-BGCMuSo for estimating changes in SOC down to 30 cm soil depth (SOC30) in the oak chronosequence in Croatia. Biome-BGCMuSo was validated for estimating short-term and long-term changes in SOC30 using measured SOC30 in six pedunculate oak stands from the chronosequence experiment. The soil was sampled at permanent plots for three consecutive years (2012, 2017, 2022). Trends in measured and modelled SOC30 were investigated for a ten-year period (2012–2022) and throughout the rotation period. Measured and modelled SOC30 was found to be stable in the investigated ten-year period. Nevertheless, the divergent trends observed in measured and modelled SOC30 (decreasing for measured and increasing for modelled SOC30) suggest more thorough research including longer time series and higher sampling density is required. Analysis of the long-term SOC30 dynamics using a repeated chronosequence approach (all sampling years combined) revealed a significant increasing trend in measured SOC30 with the stand age, while modelled SOC30 showed no age trend. Acknowledging the general assumption that under the shelterwood regeneration system (commonly used in oak forests) SOC is stable with time, the observed increasing age trend of measured SOC30 should be interpreted carefully. On the other hand, stable modelled SOC30 with stand age could be potentially explained by the great impact of soil texture on the modelled SOC30, indicating that the soil texture is a stronger driver of modelled SOC30 than the stand age.

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Poster presentation

Landscape patterns as a storyteller. Treeline shifts in the Greek mountains

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The treeline ecotone, a critical transitional zone between forested and alpine ecosystems, serves as an impact monitoring indicator of climate change and broader environmental dynamics. However, the phenomenon of tree line shift is complex, resulting from an interplay of climatic, biological, topographical, environmental, anthropogenic, and other influencing factors. This study investigates temporal changes in the treeline area across high- altitude Greek mountain ranges over a 70-year period (1945–2015) in order to unravel the patterns of treeline shift. We used remote sensing techniques for shift detection and landscape metrics assessing landscape structure to analyze the spatial patterns and configuration of the treeline and its dynamics. We assessed the congruence between the spatial patterns observed and geophysical attributes of the area in order to develop hypotheses about the underlying causality. Upward shifts in treeline over the studied period were detected, the patterns of which varied across mountain ranges. The observed differences exhibit variations in the intensity and the homogeneity of these shifts. The agricultural exploitation of plateaus and other deep-soil areas at high altitudes in mountainous regions, along with extensive livestock grazing are primary anthropogenic activities influencing the treeline ecotone. Furthermore, the frequent occurrence of forest fires, which act as a significant disturbance in the forest ecosystems of the Mediterranean region, also plays a critical role in shaping these environments. In addition, no relations were found between changes in treeline position and latitude. Findings underscore the importance of a complicate understanding of treeline dynamics in Mediterranean mountain ecosystems, where climate change and human activities co-occurred. The insights derived from this study are critical for informing biodiversity conservation and climate adaptation strategies, emphasizing the necessity of integrated management approaches to safeguard vulnerable alpine and subalpine habitats. Continuous monitoring of treeline dynamics is essential for anticipating and mitigating the ecological consequences of ongoing climate changes.

Poster presentation

Projected impacts of climate change and natural disturbances on the dynamics of European beech (*Fagus sylvatica* L.) forests

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Dynamics of natural and managed forest ecosystems are greatly impacted by climate change and shifts in the frequency of natural disturbances. As a result, it becomes more challenging to forecast and manage future development of forest stands using only conventional methods such as empirical growth models (e.g., yield tables). Better long-term forest management is made possible by the development of process-based models that offer a robust alternative by integrating ecological processes, vegetation-climate interactions, and disturbance dynamics. They can support better decision-making and guidelines in forest management planning by accounting for various risks like the occurrence of natural disturbances and the impact of climate change. Process-based models provide a useful framework to incorporate specific responses to altered environmental conditions and can offer significant advantages in predicting the effects of climate change, as compared to purely empirical models.

This research analyses and quantifies the impact of various climate change and natural disturbance (wind) scenarios on the long-term dynamics of managed and protected (e.g., old-growth) stands of common beech (*Fagus sylvatica* L.) in the Republic of Croatia. A model of forest landscape dynamics iLand will be used and evaluated for the above analysis. The model simulates the long-term dynamics of forest ecosystems through the interaction between vegetation, climate, natural disturbances and management regimes. Forest dynamics under different climate (RCPs) and disturbance (changes in wind speed) scenarios will be compared against historical (reference) periods.

To enhance long-term planning of forest management, the research aims to demonstrate the feasibility of adopting a process model for modelling the future dynamic of beech forests in interaction with climatic changes and natural disturbances. Understanding how forest ecosystems will respond to complex climate changes can provide valuable insights into adaptive strategies for sustainable forest management, aimed at strengthening resilience and preserving both the economic and ecological functions of forest ecosystems.

Poster presentation

A comparative assessment of vegetation indices based on RGB bands of phenocams imagery in Bab Forest

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Phenocams are widely used to observe vegetation growth patterns and seasonal behaviour. We used phenocams to study phenology in the forested LTER site Bab, Slovakia (<https://deims.org/79e10639-dd60-4f30-9c43-7b2bae0f359a>). We analyzed four vegetation indices—GCC (Green Chromatic Coordinate), ExR (Excess Red), VARI (Visible Atmospherically Resistant Index), and ViGreen (Vegetation Greenness Index)—based on RGB bands from Phenocam imagery for 2024. Two experimental plots of Bab forest (A-73 and P-35) were selected to analyze the forest phenology, where two phenocams were installed for capturing images every hour. Forest vegetation was categorized into two layers: the herb layer and the woody layer (trees and shrubs). Due to data constraints, we focused on analyzing the start of the season (SOS) for woody layer and spring season for the herbaceous layer. To assess vegetation changes, two methods were used: standard index calculation for the woody layer and a classification-based approach for the herb layer. For the woody layer, we used four indices (GCC, VARI, ViGreen, and ExR) to assess SOS. For the herbaceous layer, we applied a classification method based on index thresholds, with values from -1 to 0.4 for non-vegetated pixels and 0.4 to 1 for vegetated pixels. Our analysis showed that SOS in the herbaceous layer followed a distinct pattern. Growth started in the first week of April in both plots, with peak greenness in mid-May in both experimental plots. SOS for the woody layer was observed in the first half of April in both plots. GCC detected the growing season earlier, during the first week of April, whereas VARI and ViGreen indicated a later onset. While GCC effectively captured SOS due to its sensitivity to vegetative components, it was less effective at detecting the end of the season. In contrast, VARI and ViGreen were more sensitive to non-vegetative elements, successfully detecting the dry period in the woody layer and season end in the herbaceous layer. The ExR index showed a different behavior, likely due to its increased sensitivity to non-vegetative components, making it more responsive to soil background and dry vegetation. All four indices were susceptible to noise, with shadows and brightness affecting the data. Shadows impacted the herbaceous layer more, while brightness influenced the woody layer. These factors introduced variability, requiring careful interpretation. In conclusion, this research demonstrates the usefulness of Phenocams and RGB-based indices in observing forest phenology. The study highlights the importance of selecting indices based on vegetation layer. While GCC captured early-season vegetative growth, VARI and ViGreen were more sensitive to the non-vegetative phase, aiding in identifying dry periods in the woody layer and season end for the herbaceous layer. The ExR index showed different behavior, being more sensitive to non-vegetative elements. These findings emphasize considering environmental factors such as shadows and brightness to minimize noise in data analysis.

Poster presentation

Application of Biome-BGCMuSo model at the country-scale of Croatia and Slovakia

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Biome-BGCMuSo (BBGCMuSo) is a process-based stand-level biogeochemical model frequently used for investigating dynamics of carbon stocks and fluxes in forest ecosystems under various environmental conditions. Considering a growing need for regional-scale estimates and temporal dynamics of carbon stocks in different forest carbon pools, initiated with the goal of supporting national greenhouse gas inventory reporting systems, we tested the applicability of the BBGCMuSo at the country level.

We estimated country-scale forest carbon stocks in Croatia and Slovakia based on simulations of temporal forest dynamics using BBGCMuSo model. Our approach included (1) country stratification based on available data on biogeoclimatic regions and soil texture in each country, (2) model simulations of representative stands in each stratum, and (3) up-scaling of simulation results using information on species composition and age structure in individual strata. The model was driven with ERA5-Land meteorological dataset (in accordance with the Inter-Sectoral Impact Model Intercomparison Project protocol - ISIMIP3a), site-specific soil characteristics, and optimized eco-physiological parameters for main tree species in each country. Historical simulations were obtained using country-specific business-as-usual management practices and evaluated with the best available data in each country. Future simulations were performed using different future climate scenarios (in accordance to ISIMIP3b protocol). The plausibility of the results was discussed regarding data and model limitations. The applied approach enables the analysis of the temporal development of carbon stocks driven by climate and management for the two countries that have not been explored by previous studies yet with a process-based model operating at a similar level of detail.

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Poster presentation

Modelling of flowering phenology to support the prediction of the spatio-temporal availability of floral resources for pollinators in human-altered landscapes

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Pollen, along with nectar, constitutes a critical food source for pollinators and plays a significant role in the soil-plant-pollinator nutrient cycling pathway. The availability of balanced food resources is crucial for the development, health, and fitness of bees and other pollinators. Changes in land use and land cover, coupled with the loss of potential pollinator habitats and phenological shifts in flowering plants due to climate change, may affect the accessibility of floral resources, thereby influencing pollinator population dynamics. We have developed a modeling framework to predict the spatio-temporal availability of floral resources at the landscape level. This framework integrates data on the quantity of floral resources (pollen, nectar, and sugars) produced by individual plant species with information on plant species abundance, habitat plant composition, and habitat mapping within the landscape. The dynamic component is provided by flowering phenology models, which predict the start and end of flowering in response to varying climate conditions. We combined various European databases and published data with in situ observations of individual plant flowering to assess the effects of climate parameters (related to temperature and precipitation) on the flowering time of plant species important to different pollinator groups. We applied and compared different multivariate regression models and utilized ERA5 global climate and weather data to trace phenological shifts in flowering plants from 1940 to the present. This analysis allowed us to evaluate the impacts of these shifts on the spatio-temporal availability of floral resources for different types of pollinators across various habitat types and landscapes.

This study is part of the Better-B project, which has received funding from the European Union, the Swiss State Secretariat for Education, Research and Innovation (SERI) and UK Research and Innovation (UKRI) under the UK government's Horizon Europe funding guarantee (grant number 10068544).

Poster presentation

Session 4F – Using Remote Sensing Data to Understand 3D Structure and Function in Urban Areas

Symposium

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Keywords: remote sensing, connectivity, urban, 3D, nature-based solutions, green infrastructure

Urbanisation is rapidly increasing globally and existing urban areas densifying, resulting in significant changes to the composition and configuration of urban landscapes. These changes result in increased pressure on urban green spaces and blue-green infrastructure with a myriad of implications for urban ecosystem functions. At the same time, in many urban areas nature based solutions are being implemented to enhance urban blue-green infrastructure, promote biodiversity and improve resilience to climate change and invasive pests and pathogens. Urban ecosystems are characterised by complex three-dimensional (3D) structures, including buildings, vegetation, blue and green spaces, and transportation networks. The ability of urban green elements to meet ecological infrastructure needs for services such as biodiversity and heat and flood mitigation while maintaining resilience to pests, pathogens and climate change depends on numerous factors including their structural composition and that of the surrounding areas/buildings. Traditional two-dimensional (2D) approaches to studying and planning urban infrastructure fail to capture the full scope of interactions between vertical and horizontal urban elements. Remote sensing, especially through advanced techniques like LiDAR (Light Detection and Ranging) and high spatial and temporal resolution aerial, terrestrial and satellite imagery, offers innovative ways to map and understand green infrastructure and urban connectivity by considering all urban structures in 3D. This symposium will explore how remote sensing technologies are being utilised to map, analyse, and improve blue-green infrastructure and connectivity in 3D in urban spaces. We welcome contributions considering all forms of remote sensing data (e.g. LiDAR, satellite images, aerial photographs, UAV data, terrestrial scanning, webcams, photographs, streetview imagery) and considering any aspect of urban ecological infrastructure, connectivity and nature based solutions where a 3D perspective is of importance. The symposium will be a mix of full and flash presentations with related posters and time for discussion, depending on the number of appropriate submissions.

The role of vegetation complexity in urban green areas in shaping arthropod communities and heat mitigation potential

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The last 30 years have seen a sharp increase in the rate of urbanization across the world, with more than half of the world's population living currently in urban areas. The urbanization process has drastically altered landscapes in and around cities, leading to significant negative consequences for ecosystem services at the global and local scale. In this context, urban green areas (UGA) represent important elements for the urban environment. They enhance human well-being, help mitigate the urban heat island effect, and act as fundamental habitat or stepping-stones for local biodiversity and ecological infrastructure.

UGA play a key role in supporting biodiversity in cities. Among groups, arthropods are functionally significant and highly diverse, thus playing an essential role in maintaining urban biodiversity. Despite their importance, research specifically addressing the role of UGAs on arthropod communities has been limited to date.

This study aims to explore the 3D vegetation structures of UGAs, with a particular focus on the complexity of vertical vegetation and its influence on arthropod communities. For this scope, an ecological assessment was conducted across 60 selected public green spaces in Zurich, representing varying degrees of vegetation structural complexity, greenness and vegetation height. Arthropods have been collected during seven weeks in summer 2024 and species were identified through a DNA metabarcoding approach. Additionally, local temperature data were recorded to investigate the potential of cooling effect from the different vegetation structure types.

The findings of this research will contribute to a better understanding of how urban green areas support and enhance arthropod biodiversity in cities, which is ultimately important for biological conservation and enhancement of urban biodiversity and ecological infrastructure.

Oral presentation

Investigating the Influence of 3D Urban Morphology on Land Surface Temperature in Central Asian Cities

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Central Asia remains an understudied region in remote sensing (RS) and climate research despite its diverse landscapes and vulnerability to climate change. Compared to North America and Europe, where high-resolution climate datasets and remote sensing products are widely available, Central Asia suffers from data scarcity, limited ground-based observations, and fewer dedicated studies. This lack of research hinders a comprehensive understanding of regional climate dynamics, urban heat island effects, and land cover changes. Given the region's rapid urbanization, increasing temperatures, and environmental challenges, there is a critical need for more RS-based climate studies to support sustainable development and climate adaptation efforts. As cities expand both horizontally and vertically, their thermal environments become increasingly complex. Urban morphology, encompassing both two-dimensional (2D) and three-dimensional (3D) structural characteristics, plays a crucial role in shaping urban heat island (UHI) intensity. While previous research has primarily focused on 2D indicators such as building density and land use, the influence of 3D urban features on land surface temperature (LST) remains underexplored. This study examines the impact of urban morphology on LST across nine cities in Central Asia, a region largely overlooked in remote sensing and climate change studies. Unlike studies in regions with readily available LiDAR data, our approach leverages high resolution stereo satellite imagery to derive detailed digital surface models (DSMs). Using high-resolution stereo satellite imagery and freely available building footprint data, we generate 3D building models to assess their relationship with urban temperature variations. By integrating 3D urban morphology indicators with contemporary LST data, our findings highlight that significant urban temperature deviations are driven not only by 2D factors but also by vertical urban structures. The results underscore the need to incorporate 3D urban metrics into climate adaptation and urban planning strategies.

Oral presentation

Connectivity of urban green infrastructure in 3D for Swiss cities

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Rapid urbanisation, which is occurring globally, can result in significant changes to the composition and configuration of urban and peri-urban landscapes, including both urban sprawl and urban densification. There are multitude of implications for urban ecosystem functions. Urban ecosystems are characterised by complex interactions of three-dimensional (3D) structures, including buildings, vegetation, blue and green spaces, and transportation networks. The ability of green infrastructure to improve ecological functionality of urban landscapes is dependent on how well it improves connectivity in urban environments. While traditional assessments of connectivity and urban green infrastructure consider the urban landscape in 2 dimensions, the third dimension is of critical importance in determining how well-connected green infrastructure is. This is both because the ecological value of green landscape elements varies with vertical structural characteristics and because the effectiveness of non-green elements to serve as barriers to connectivity depends on their height and structure.

In this study we demonstrate the importance of considering 3D aspects of urban landscapes for connectivity by comparing 2D and 3D assessments of connectivity in three Swiss cities. Using the Swiss nationwide aerial laser scanning dataset (point density averaging 15-20 pts/m²), we map and characterise the vertical structure of urban green elements (trees, shrubs and grass). The vertical and horizontal dimensions of non-green urban elements (building, roads, infrastructure) are determined from the 3D nationwide topographical landscape model. City-wide connectivity assessments are undertaken by calculating landscape configuration metrics and landscape network assessments (ConScape) for a 2D realisation and 3D realisations of the urban landscapes considering different organism requirements and movement or dispersal abilities. A comparison of the different results reveals significant differences in connectivity and demonstrates the importance of considering structural aspects of the landscape in evaluation and planning for urban green infrastructure.

Oral presentation

Urban habitats for species: quantification and characterization using 2D and 3D data

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The preservation of urban biodiversity is a major challenge of territorial development to fight against effects of climate change and to preserve ecosystemic services. It is in this context that a public policy called “Trame verte et bleue” (green and blue infrastructure) was created in France in 2007 to include ecological continuities to regional planning. In most of studies, the modelling of these continuities are based on land use maps (BD TOPO) produce from satellite or aerial imageries and so in 2 dimensions (2D). However, these maps don't take into account neither the internal vertical structure of vegetation nor the under canopy vegetation. However, this may be an essential parameter to evaluate the functionality of ecological continuities. Indeed, depending on the species studied, dense vegetation or bare asphalted soil can constitute uncrossable barriers, thus biasing the identification and evaluation of ecological continuities between habitats by underestimating barriers to movement or overestimating movement paths.

The integration of 3D data, particularly from LiDAR, provides a more detailed characterization of vegetation, which makes it possible to better characterize and identify the vegetation used as habitats and/or corridors by urban biodiversity. Moreover, as in other countries, the French LiDAR HD project (IGN), currently map all France with LiDAR à 10pts/m² of resolution and will complete and provide those data for free. So, LiDAR data become much more accessible and used by scientists especially in ecology, where 3D LiDAR data offer numerous and innovate perspectives.

Our Bio3DiverCity project, seeks to evaluate the contribution of 3D LiDAR data for the modeling of functional urban greenways frames. In this first study, we aim to evaluate the contribution of 3D LiDAR data - compared to 2D maps - to more realistically quantify and characterize the habitats available in the city for animals with different modes of movement (e.g. walking or flying). To do this, we will determine the quantity of habitats according to the heights and inner structure of vegetation layers and their relative proportions, based on 3D LiDAR data, in several cities in France.

Then, based on those maps and animal locations from censuses and tracking in Rennes (Brittany, France), we will characterize the 3D specificities of the habitats (height, density, etc.) and of the 3D surrounding landscape they exploit thanks to neural networks approach. This study will provide an overview of the value of 3D data for better quantifying the availability of habitat for animals in cities, compared with conventional 2D maps, and will propose an associated methodological framework.

Oral presentation

Towards Ecology of and for city: AI-driven Landscape Contextual Analysis of Private Urban Green Spaces

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Private Urban Green Spaces (PrUGSs) play pivotal role in fostering urban biodiversity. Their ability to support biodiversity is shaped by various factors, including the composition and configuration of surrounding urban landscape elements, as well as socio-economic context and management practices. However, conventional pixel- or object-based two-dimensional approaches often fail to capture the cross-scale, three-dimensional heterogeneity necessary to inform the design of comprehensive biodiversity inventories across the city. To bridge this gap, we propose using advanced deep learning techniques combined with high-resolution spatial datasets (land cover map and LiDAR) to systematically map and characterise the diverse landscape context of PrUGS, enabling a strategic design of intra-city biodiversity monitoring. Pre-trained deep learning models, coupled with unsupervised clustering aided to identify and map regions with varied morphological contrast, providing urban typologies of residential landscape contexts. This approach also facilitates the identification and evaluation of edge dynamics within UGSs, as PrUGS and other UGSs are often characterized by a high degree of fragmentation and connectivity. By integrating remote sensing data with artificial intelligence, our study offers a scalable and transferable framework for characterising landscape contexts in urban areas, including around PrUGSs. This supports biodiversity inventory design while accounting for cumulative measures of urban heterogeneity and the interplay between landscape ecological components and built-vegetation elements. Our work advances data-driven landscape ecology and attempts to bridge urban and landscape ecology, aligning with emerging methods in remote sensing and AI-driven urban analysis. Ultimately this facilitates a more nuanced understanding of urban ecological infrastructure and hybrid heterogeneity in complex, three-dimensional urban environments.

Poster presentation

Analysing the impact of greenery on urban surface heat using street IR imagery

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Decrease in canopy cover in cities is leading to higher risks for extreme heat events that affect citizens' health. These often occur in so-called urban heat canyons – hyperlocal areas with distinguished characteristics. These depend on a wide variety of factors, such as terrain and urban geometry, building materials, greenery, and water. We focus on applying novel empirical methods to studying the impact of these characteristics. In this way, we can help to come up with better strategies for incorporating greenery for ecosystem services for urban citizens in existing city districts and planning for more sustainable urban development

The aim of this study is to apply novel, hyperlocal data capture methods to assess the impact of urban greenery as an agent of cooling ecosystem services for urban citizens.

We created sensors, City Scanners, that are able to collect surface heat data dynamically when being placed on a vehicle (<https://senseable.mit.edu/cityscanner>). With this opportunistic big data approach, the urban landscape can be covered with hyperlocal data on a street scale. The study area was the central parts of the City of Stockholm, measured during the summers of 2021 and 2022. We analysed the effect of urban form, greenery and water variables on hyperlocal surface heat. Urban form was expressed as urban density as well as the number of sun-exposure hours across the urban canyons, on surfaces visible to the scanners. The number of buildings, canopy cover and water on larger scales were also used as explanatory variables. The results show that the sun-exposure hours, building density and canopy cover had strong impacts on the surface heat, especially when heat was measured as the difference between surface heat and air temperature. Also canopy and built-up areas on larger scales influenced the heat. During some periods of the summer, a waterfront anomaly occurred, warming up the adjacent land instead of cooling it down.

The novel methods enabled studying the urban surface heat across both time and space, which are both crucial for understanding heat dynamics in urban areas. Altogether, the work conducted in this study will contribute to knowledge on how to improve ecosystem services for urban citizens and reduce the negative impact of heat on human health. However, further research is needed to gain more insights in the complex dynamics of urban heat and its relation to urban greenery.

Oral presentation

Session 4G – Remote Sensing of the Grassland-Dominated Landscapes

Symposium

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Keywords: grassland diversity, biodiversity, earth observation, spatial modelling

Advances in remote sensing technologies offer the opportunities to capture plant and faunal diversities and their complexities. Sensors of different satellites, aerial photos, or other specific devices provide unique opportunities to study herbaceous flora and associated fauna and their changes at different spatial and temporal scales. This session aims to bring together the contributions of advances in monitoring with remote sensing techniques grassland landscapes at different spatial and temporal scales. In this context, we particularly look at the approaches to capture the details of the grassland-dominated landscapes, their productivity and dynamics. We are welcoming contributions on: • monitoring the grassland landscapes and land use intensity, • changes in grassland composition, productivity and management, • integration of remote sensing data with the ground-truth observations, • modelling the grassland diversity based on the geospatial models, • analysing the changes in the grassland-dominated landscapes that affect the grassland diversity, • challenges and limitations of the remote sensing methods on capturing the grassland diversities. The symposium is expected to serve as a platform for mutual knowledge exchange, for instance, across relevant EU Biodiversa Plus projects.

Effects of management on plant diversity in Swiss grasslands

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Semi-natural grasslands are an important habitat because of their large extent, their agricultural productivity, and the high biodiversity that they host. They differ from many habitat types because their existence and persistence require human management. Specific management events and their timing may support biodiversity, but management can also be detrimental, especially if the management intensity expands beyond the sustainable boundary of the ecosystem, and thus understanding the effect of different human management is crucial for supporting and preserving the biodiversity of these ecosystems. Switzerland presents a good opportunity to evaluate the influence of different types and intensity of management on biodiversity because of the availability of both country wide grassland management intensity and plant diversity data. Switzerland also has high climatic, topographical and cultural heterogeneity, resulting in a range of different grassland types and management regimes in a relatively small area. We examine the drivers of grassland diversity using remote-sensing-derived vegetation, management, land-use change, and topography-derived indices alongside soil and climate data and existing vegetation compositional data from grasslands across Switzerland. We examine the species, functional, and phylogenetic diversity of vascular plants to capture the multifaceted consequences of land management. This type of detailed understanding of the effect of management intensity on grassland species diversity will be useful to help inform policy.

Oral presentation

Anomaly detection in permanent grasslands using Sentinel-2: A tool for monitoring CAP compliance

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Permanent grasslands play a critical role in maintaining biodiversity by providing habitats for numerous plant and animal species. They act as vital carbon sinks, sequestering carbon dioxide and helping mitigate climate change. Grasslands also contribute to soil stability, preventing erosion, and improving water retention, which supports local water cycles. The ploughing of permanent grassland should therefore be avoided as this can lead to a loss of ecosystem services, reduced productivity, loss of biodiversity, and increased greenhouse gas emissions. The ban on permanent grassland conversion is codified in the Common Agricultural Policy (CAP) of the European Union (EU) as one of nine measures for maintaining Good Agricultural and Environmental Conditions (GAEC). Monitoring compliance with these measures is essential to ensure that valuable ecosystems are preserved and efforts to achieve environmental and climate goals are not undermined. Here we propose a monitoring approach for permanent grasslands which leverages the high temporal and spatial resolution of Sentinel-2 and aims to identify anomalous activities on permanent grasslands in near real-time, allowing timely intervention measures through administrative bodies. We derive various spectral features for every permanent grassland parcel in the German state of Saxony from ready-to-use Sentinel-2 data. After the elimination of insufficient and low-quality data, we group the parcels based on management practices (mainly grazing and mowing) and climatic conditions (clusters defined from grassland temperature sums and growing degree-days). It is assumed that grassland parcels appear similar under similar conditions, which allows the approach to be carried out unsupervised. Following this, we apply a two-stage sequence to identify anomalous parcels. In the first stage, we apply an Isolation Forest algorithm to each group and define a threshold for the resulting anomaly scores to detect outliers in the dataset. The second stage consists of narrowing down the anomalies to possible ploughing events through the elimination of parcels above/below a certain quantile threshold of mean NDVI (Normalized Difference Vegetation Index) and BSI (Bare Soil Index). The approach was evaluated on Sentinel-2 data for several dates in the second half of 2024. We validated our results through on-site inspections, which revealed a reliable performance in detecting ploughing events. The algorithm also proved to be suitable for detecting other anomalous occurrences like the presence of construction or infrastructure material on the grassland, recently spread manure, or flooded parcels. The strengths of the approach lie in its little need for preprocessing and its unsupervised nature, facilitating transferability and interpretation for end-users. It is planned to integrate the approach into an interactive tool to channel the on-site CAP inspections regularly conducted by the authority in charge of Saxony.

Oral presentation

Multitemporal analyses on grassland habitat change of Southeast Bulgaria using open access satellite images

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Land cover changes affect the state of ecosystems conditions, services, and biodiversity. Monitoring those changes is essential to understand the environmental shifts caused by both natural processes and human activities. This is particularly true in regions where agricultural land use and natural habitats intersect. This study provides a detailed analysis of grassland dynamics within an area of 9,210 km² in the Sakar Mountain region, Southeast Bulgaria. We use freely available satellite remote sensing data and research techniques to investigate the transitions between four land cover types: grasslands, agricultural lands, woody vegetation, and non-vegetated land cover—along the three periods between 2006, 2014, and 2021. To detect land cover transitions, we employ Random Forest (RF) land cover classification with spectral-temporal metrics and vegetation index bands on Landsat-5 and Landsat-8 satellite missions. The satellite images were accessed and analyzed in the cloud computing platform Google Earth Engine (GEE). The land cover classification achieved 83-85% overall accuracy (F1 score). Results for the period between 2006 and 2014 showed a conversion from grassland into agricultural land for more than 1,200 km². From 2014 to 2021, the trend showed partial recovery with potential agricultural abandonment leading to a resurgence of grassland habitats in some regions. These findings highlight the importance of continued monitoring and adaptive land management policies in Bulgaria. We recommend prioritizing conservation efforts to improve grassland restoration, to mitigate habitat fragmentation, to promote sustainable land-use practices, and to enhance ecological connectivity and related ecosystem services in the Sakar Mountain region. This research highlights the advantages of integrating open access remote sensing data for grassland monitoring to discover changes at high spatial resolution. The methodology provides a scalable framework for ecological monitoring initiatives to support evidence-based decision-making for biodiversity conservation and sustainable land management, especially for the need to assess the biodiversity impact from the EU's Common Agricultural Policy and Agri-environmental Programs.

Oral presentation

Mapping of invasive goldenrods (*Solidago* spp.) in Poland

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Drones are a crucial tool for monitoring vegetation, allowing access to hard-to-reach areas, and acquiring high spatial resolution data. As part of the SolidES project, which focuses on invasive goldenrods (*Solidago* spp.) in Poland, a nationwide field survey was conducted between August and September 2024. During this campaign, 80 areas were mapped, resulting in the creation of 80 orthophotos and 80 Digital Surface Models (DSM). The primary objective of this study was to identify and map invasive goldenrods based on drone-derived orthophotos. The analysis was part of a broader classification process, with one of its key stages being the acquisition and processing of drone data. Derivative products were calculated on the orthophoto, including Gray Level Co-Occurrence Matrix (GLCM) texture features and indices. The Random Forest classifier was applied, achieving an F1-score above 0.9 for 31 study areas, between 0.8 and 0.9 for 35 study areas, and below 0.8 for 14 study areas. The application of drone imagery for mapping invasive goldenrods provides reliable, high-resolution, spatially explicit data, facilitating effective monitoring and informed management of invaded areas. Moreover, this high-quality dataset may serve as a critical reference for scaling up mapping efforts using satellite imagery.

This contribution is funded by Poland's Ministry of Science and Higher Education (grant no. NdS-II/SP/0216/2024/01)

Oral presentation

Mapping grassland management regimes in the Alps and Carpathians using Harmonized Landsat Sentinel-2 time series

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The semi-natural grasslands of the Alps and Carpathians are among the most species-rich habitats globally, providing ecosystem services such as climate change mitigation and food security. The persistence and functionality of these grasslands in many areas depend on human management practices, particularly grazing and mowing events, as well as the distribution and frequency of these events. However, mapping grassland management regimes over large areas remains inefficient and poses significant challenges for remote sensing. In the case of mowing, recent advances in remote sensing and data processing techniques have contributed to high accuracy in detecting these events using Sentinel-2 and Landsat time-series data. A considerable challenge persists in identifying grazing activities due to the variability of these events and the environmental conditions that heavily influence grassland phenology.

This study aims to map mowing and grazing activities using Harmonized Landsat Sentinel-2 (HLS) data available through Google Earth Engine. By employing these harmonized images, we derived time-series data and developed indicators of mowing and grazing regimes to detect vegetation changes associated with grassland management practices. We hypothesized that management events, such as mowing or grazing, could be detected by comparing observed measurements with a potential vegetation index for the growing season, calculated from nearby grasslands not influenced by management activities. To determine the potential vegetation index for each observation, we used the 90th percentile of vegetation index values from surrounding grass pixels, enabling us to accurately represent typical vegetation growth under local climatic conditions.

Mowing and grazing typically result in a decline in the vegetation index. Mowing causes a rapid and abrupt decrease, whereas grazing leads to a gradual decline and fluctuations in the vegetation index over an extended period. The mowing indicator detects observations where mowing results in an abrupt drop in vegetation index values. The grazing indicator identifies cumulative negative changes in vegetation index values caused by grazing. Thresholds for these changes are defined using the average residuals of change between observations, incorporating data from surrounding grasslands for improved precision.

We demonstrated the applicability of the proposed approach in selected localities characterized by high species richness within the Alps and Carpathians. The results were validated using field-based botanical surveys, geotagged photographs from the field, and imagery from panoramic cameras available in these localities. Since the proposed method relies on local data, comparing phenological measurements with a locally derived potential phenological curve enables the application of this approach in other regions.

Oral presentation

Satellite-based Assessment of Grassland Management Units and Land Use Intensity of Mountain Hay Meadows in Armenia and Austria

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Mountain hay meadows (MHM) in Europe are biodiversity hotspots increasingly threatened by changing management regimes, leading to either abandonment or overuse. In this study, we used multisource satellite remote sensing data to detect and analyze the intensity of grassland management across mountain regions in Austria (the Alps) and Armenia (the Caucasus) along a broader biophysical and socio-economic gradient. Specifically, we combined 3-meter resolution PlanetScope imagery with NDVI time series data from Sentinel-2 and Landsat-8/-9 satellites to: 1) generate grassland management units, 2) estimate the intensity of management in year 2023. To achieve these objectives, we employed object-based image analysis, time series detection of management events, and structural analysis of NDVI time series. Our findings demonstrate the suitability of PlanetScope data for delineating grassland management units that correspond to actual management activities. Furthermore, we found that a single mowing event predominated in the studied areas in both Austria and Armenia. We conclude that the approaches presented here have the potential to analyze management intensity over larger mountain regions where cadastral data is often lacking or outdated, making grassland management monitoring challenging.

Oral presentation

Improved grassland habitat map for the Alps and Carpathians

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Grasslands are a globally important habitat due to their high biodiversity, large aerial coverage, contribution to agricultural production and range of important ecosystem services. Central Eastern European grasslands in particular, are among the most species rich globally. Nonetheless, species richness and composition within these grasslands varies as a result of topographical and edaphic factors, management, and evolutionary history, among others. The current version of the EUNIS system contains a significant number of grassland habitat types, which allows us to identify their ecological particularities and assess spatial variation in their species richness. Despite previous efforts to map EUNIS habitat types at various spatial scales and hierarchical levels these initiatives have often been limited by data availability.

In this study, we attempt to overcome spatial limitations and develop a grassland habitat map covering the entire mountain ranges of the Alps and Carpathians. For the classification system we used the phytosociological data from the European Vegetation Archive (EVA) supplemented with the phytosociological data available from various national institutions and previous projects. We coupled the botanical data with Earth Observation information such as phenological indices derived from the Sentinel-2 satellite sensor and climate data from Chelsa. We used two different ensemble modelling frameworks to develop a continuous 20m spatial resolution map of ~20 EUNIS grassland habitat types. Preliminary results show largest classification uncertainties within the most rare and most common EUNIS grassland habitat types. Subsequent analyses will focus on refined mapping of these habitat types to provide a robust and valuable map of grassland habitats in the Alps and Carpathians.

Oral presentation

Remote Sensing-Based Assessment of Agricultural Land Use

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In the context of a changing climate and increasing extreme weather events (droughts, floods, soil erosion), sustainable management of water resources and agricultural land productivity is becoming critically important. Shelterbelts have historically played a key role in moisture retention, yield enhancement, and soil erosion prevention in the agro-landscapes of Kazakhstan. They help reduce wind erosion, retain moisture in the soil, and preserve the snow cover, which is particularly relevant for Kazakhstan's regions. However, over the past three decades, the number of protective forest belts has significantly decreased due to a lack of support, increasing the risk of degradation of agricultural land productivity. This study focuses on analyzing the impact of shelterbelts on productivity, the distribution of agricultural crops, and the dynamics of agro-landscape cover using remote sensing image classification, machine learning methods, and field data. Applying sample-based classification with an emphasis on supervised learning algorithms, we used remote sensing data to determine the types of agricultural crops. The integration of vegetation indices (NDVI, NDWI) allows for assessing plant health, soil moisture, and identifying critical changes. The accuracy assessment of the algorithms is carried out based on ground-truth data. The obtained results will help determine the impact of protective shelterbelts on agro-landscape cover dynamics. This research is supported by the Kazakhstan Ministry of Science project AP19679749: "Mapping of shelterbelts, their impact on productivity and water resources, expansion prospects, using geospatial technologies in the Akmola region." The project aims to develop scientifically based approaches for effective water resource management strategies in the arid regions of Kazakhstan.

Poster presentation

Session 4H – Biodiversity Monitoring in the Era of Big Data: From In-Situ Data to Large-Scale Ecosystem Mapping

Symposium and workshop

Jose Manuel Álvarez-Martínez¹, Borja Jimenez Alfaro², Jose Valentin Rocas Diaz³, Adrian Regos⁴, Salvador Arenas Castro⁵, Javier Martínez López⁶, Domingo Alcaráz Segura⁷

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Keywords: biodiversity, remote sensing, Copernicus, ecosystems, EUNIS, vegetation, habitats

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. 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 symposium, we look forward for case studies ranging from regional to biogeographical scales on which a comprehensive pool of predictions for monitoring the conservation status of habitat types following the Habitats directive framework are applied. Data ranging from readily available Copernicus Land Monitoring Service products and indicators derived from different RS platforms such as Landsat and Sentinel, LiDAR, UAV flights and field spectroradiometry will be welcome. Methods should apply modelling approaches that combine in-situ, expert-based data and spatial predictors for getting suitable estimates of forests to shrubs, pastures and wetlands at different scales and with different purposes. In the corresponding workshop, we will present and apply different methods for mapping the distribution and conservation status of vegetation types at the landscape to biogeographical scales, providing an overview on database collection and processing, analytical methods and model applications, ranging from R based models to GEE workflows. The workshop will seek fostering a critical thinking for discussing the strengths and limitations of different approaches for different applications and across multiple scales.

Bridging Copernicus services with user needs: AI-Enhanced LULC and habitats monitoring for the conservation on European Protected Areas

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Accurate land use and land cover (LULC) monitoring is essential for addressing biodiversity loss and climate change. Protected Areas (PAs) are key conservation tools that require up-to-date and operational LULC information to support evidence-based decision-making. While the Copernicus Land Monitoring Service (CLMS) provides valuable datasets, translating these products into European Nature Information System (EUNIS) habitat types—aligned with Annex I typologies of the Habitats Directive—remains a critical challenge for end-users.

This study presents an integrated framework tailored to enhance user uptake of Copernicus services for conservation planning and policy implementation. By leveraging CLMS PA datasets and Sentinel-2 time-series imagery, we employ advanced Artificial Intelligence (AI) and super-resolution techniques to generate high-resolution LULC and habitat maps across the whole Natura 2000 network. The methodology is designed to align with user requirements, incorporating feedback from conservation practitioners, land managers and policymakers to ensure compatibility with operational workflows. The hierarchical habitat modeling approach, structured across biogeographical regions, maximizes efficiency in data collection and reduces bias, ultimately improving accessibility and usability of remote sensing products.

Preliminary results indicate over 90% classification accuracy for Level 1 LULC categories, with promising potential for refining EUNIS habitat maps providing information on ecosystem extent and condition. By embedding Copernicus-derived products into scalable AI-driven workflows, this framework would directly support reporting obligations under Article 17 of the Habitats Directive, while also strengthening the EU Biodiversity Strategy and the European Green Deal. This research highlights the necessity of user-centered approaches in Earth Observation, ensuring that Copernicus services effectively meet the needs of conservation stakeholders.

Oral presentation

Satellite-derived habitat dynamics of key species to guide conservation prioritization in Southern Europe

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Biodiversity loss is accelerating due mainly to human activities, and conservation decision-making needs to be more efficient. Ex-situ biodiversity modelling and monitoring using satellite time series data offer a cost-effective approach to improving the prioritisation of conservation areas. In this study, we present a set of dynamic indicators for conservation prioritisation by analysing trends in habitat suitability indices (HSI) over 19 years (2001–2019) for six flagship species at a regional scale (Andalucía; southern Spain). The HSI trends were derived from ecological niche models (MaxEnt) and MODIS satellite sensor time series data as predictors. We combined annual HSI models for all species with the spatial conservation prioritisation tool Marxan to generate inter-annual dynamic indicators such as cost-effectiveness, adequacy, stability, and conservation legacy. Models predicted a general habitat decline with 31% negative trends and only 19% positive trends in habitat availability across species. Key predictors were related to vegetation composition (land cover), climate (land surface temperature), and energy balance (evapotranspiration), aligning with the species' ecological requirements. Marxan identified dynamic priority areas both within and beyond existing protected areas. Our findings suggest: (1) additional areas beyond current protections should be prioritised and (2) recently degraded areas may be suitable for restoration, given their historical importance for the target species. Overall, this model-based system, supported by established conservation planning software, provides dynamic priority-area indicators to assess the adequacy and effectiveness of conservation areas, helping to meet long-term conservation goals at a regional scale. The approach is adaptable to other species, ecosystems, and socio-economic contexts across different scales.

Oral presentation

Modelling the Potential Area of Occupancy of habitat types at regional scale: the Role of Anthropogenic Factors

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Assessing the distribution of natural and semi-natural habitats is essential for achieving global biodiversity conservation targets. To achieve this, modelling the potential Area of Occupancy (pAOO) may offer a valuable approach to generate distribution maps of habitat types at large spatial scales. In this study, we use a database containing vegetation plots related to the EUNIS habitat classification to model the pAOO of 60 habitat types (including forests, shrublands and grasslands) in the Ibero-Atlantic biogeographic region of SW Europe. Our main aims were to evaluate (1) the performance of distribution models across habitat types and modelling techniques, (2) the relative role of anthropogenic drivers when compared with climatic and edaphic drivers, and (3) the influence of environmental and anthropogenic variables to model the distribution of late-successional compared to early-successional habitats. Model performance was in general good, with machine-learning methods outperforming regression-based approaches. Climatic drivers were the most important factors shaping the potential distribution of habitat types, followed by edaphic and anthropogenic drivers. The occurrence of late-successional habitats was negatively correlated with road density, urban areas density and distance to protected areas. Additionally, we observed significant differences in both the predictive performance of the models and the influence of drivers when comparing late-versus early-successional habitats. Our results indicate that modelling the pAOO of habitat types in biogeographically meaningful regions is useful to understand the environmental and anthropogenic factors modulating their spatial distribution.

Oral presentation

Wild plants in Ma(i)ze: the population genetic structure of isolated forest herb populations is affected by the crop cover in the surrounding landscape matrix

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Spatially isolated plant populations in agricultural landscapes exhibit genetic responses not only to habitat fragmentation per se, but also to the composition of the surrounding landscape matrix. Since plants cannot move on their own, these responses can only be explained by understanding how the landscape matrix influences the movement dynamics of their genetic linkers, i.e., their pollen and seed vectors.

To examine whether wild forest herb populations and their pollinators are affected by the surrounding landscape, we studied the population genetic structure of three forest herb species and the current pollen flow among populations of the bumblebee-pollinated *Polygonatum multiflorum*. Additionally, we analyzed the movement activity of the pollinator species *Bombus pascuorum* using genetic nest assignment analyses. Finally, we modeled genetic measures of plant and pollinators as a function of landscape metrics, including the crop cover of maize, rapeseed, and cereals.

We found that maize cover affected (i) the population genetic structure of all three forest herb species, (ii) the movement activity of bumblebee workers, and (iii) the recent pollen flow of *P. multiflorum*.

Our research highlights that, at a landscape scale, the expansion of maize cultivation impacts the genetic structure of long-living plant species within neighboring semi-natural habitat patches. These effects are at least partly mediated by pollinating bumblebee species.

Oral presentation

Effects of six years of organic fertilisation on the soil seed bank of two different types of mountain meadows

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Meadows form an important part of the European landscape and play a crucial role in the maintenance of the native biodiversity. Additionally, in different European countries meadows provide through agronomical management a large part of the forage needed for animal husbandry. For a higher production of forage, these meadows have been often intensified in terms of mowing frequency and nutrient input through fertilisation. In general, across the entire range of fertilisation intensity, there is a clear trade-off between yield and plant diversity in managed meadows. When striving an increase of plant diversity, the transition of an intensive, species-poor to an extensive species-rich meadow can be a big challenge. The soil seed bank (SSB) in this context is one of the main addressed points in literature, but still to the best of our knowledge, there is no clear understanding how management, and especially the fertilisation, is affecting the SSB. Moreover, there is no study in literature which is simultaneously investigating the effect of different organic manures and of a nutrient input gradient on the SSB. The aim of our study was therefore to investigate the mid-term effects of different organic manure types (MT; farmyard manure, slurry, and farmyard manure combined with manure effluent) and different nutrient input (NI; 0, 0.65 and 1.3 livestock units (LU) ha⁻¹) on the SSB of moderately species-rich and moderately species-poor meadows in South Tyrol (Italy). In a field experiment conducted from 2018 to 2024 arranged as a split plot design, we tested every pair of organic fertilizer and nutrient level with three replicates (n = 54) randomly distributed in two different meadow classes (MC; legacy effect of mowing frequency and vegetation type) in three different study areas (S). We sampled the SSB in spring 2018 and 2024. In our model the interaction S*MC was set as random term, while S, MC, MT, NI and their interactions were set as fixed terms. A significance level of $p < 0.05$ was considered. In total, we found 3943 seedlings of 80 species emerged in the SSB in both years. From the initial average of 10 species emerged in each tray (no differences between MC's), we didn't find any clear trend, whether positive nor negative, even if we found significant three-way interactions on the species number and density of extensive and intensive indicator species, suggesting limited effects of organic fertilisers on the SBB on mid-term.

Oral presentation

Identifying promising occurrences and opportunities for habitat type restoration

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In the Netherlands, extensive species distribution data is available for native flora and fauna, along with high-resolution spatial data on factors such as soil type and hydrological conditions. We believe this wealth of data presents an opportunity for guided nature restoration. Therefore, we are developing a GIS tool that integrates species distribution data of characteristic species per habitat type with relevant spatial information. With this tool, we aim to identify promising areas for habitat type occurrence and restoration.

A possible advantage of this tool is that it could be used to target further detailed (field) on those areas that are the most promising, as opposed to having to execute these time-consuming studies on a broader scale. This is particularly relevant now, as all EU countries must submit a National Restoration Plan under the Nature Restoration Law. A comprehensive overview of the current distribution of habitat types and potential restoration sites should be included in this plan.

However, developing a tool that is both ecologically valid and useful for researchers as well as for policymakers is challenging. This is partly due to the nature of this type of research. For example, the presence of a few characteristic species does not necessarily indicate the occurrence of a habitat type. Moreover, this type of research traditionally relies on expert judgment and local knowledge. As a result, the outcomes of this type of research depend on the included criteria – such as characteristic species, suitable soil types, hydrological conditions, and historical land use – as well as on researcher decisions.

Currently, we are gathering insights from literature and experts on the desired characteristics and included criteria of such a tool, and on when and how expert-judgement is needed. We are also testing different variations in case studies, which will provide valuable insights. Additionally, we invite our peers to share their perspectives and ideas on its development.

Ultimately, this tool will not replace the traditional work of ecologists in assessing habitat restoration potential. Instead, it will help us focus our research on the areas where it is most useful.

Oral presentation

Species-specific or habitat-based networks to conserve biodiversity under climate change?

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As climate shifts, there is a pressing need to create habitat networks that enable species movement across fragmented landscapes to follow suitable conditions. Conservation practitioners face difficult decisions about how to prioritise habitat creation or restoration and safeguard existing networks given the competing pressures on land. Condatis is a planning tool that assesses the connectivity of an existing habitat network and prioritises potential restoration opportunities. Condatis models long-distance, multi-generation shifts across landscapes, that will be needed under climate change. Its development has been informed by a range of partners from the practitioner community. However, until recently, Condatis has mainly been used for habitat-type networks and generic species' traits, rather than specific, named species. We present two novel studies where Condatis has been used to pinpoint the most effective restoration locations. In doing so we highlight the advantages and limitations of using a species-specific approach.

Firstly, we assessed connectivity 'bottlenecks' in networks of broad seminatural habitat types across England. Stakeholders trialled using the bottleneck data in workshops, overlaying them with other spatial data that would be important for their 'local nature recovery strategy'.

Secondly, we developed a multi-species pipeline which took into account moth and butterfly species' current and predicted 2080 distributions, their dispersal ability and their preferred habitat type. Species- and climate-scenario- specific bottlenecks were then calculated for each species.

Comparing the outputs of the two studies, the biggest differences seem to be attributable to the inclusion of climate change projections. This underlines the fact that connectivity in all directions may not be needed. However, climate projections are highly uncertain, and there are risks associated with assuming that a few species can act as proxies for many. We suggest ways forward for future planning, to increase our confidence that habitat restoration will lead to a resilient, climate-proof network.

Oral presentation

eDNA on the go: A direct comparison of fixed and vehicle mounted airborne eDNA sampling methods for terrestrial vertebrate species detection at large spatial scales

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Air is increasingly being recognised as a biologically rich source of taxonomically diverse environmental DNA (eDNA). Multiple proof-of-concept studies have now been published that explore air as a medium for the detection of single species and even whole communities of terrestrial species, including mammals, non-anemophilous plants and insects. Environmental DNA Airborne eDNA has been sampled using various stationary devices but if we can access it using mobile collection methods, we can rapidly assess biodiversity at large spatial scales. We compared passive eDNA filters deployed for short (30 mins) and long periods (24 hrs) with 3D printed filters attached to cars that carried out rapid transects through different types of Australian environments. Across all three DNA air sampling approaches our metabarcoding procedure detected 49 vertebrate taxa (33 birds, 15 mammals and 1 amphibian), with 29 of these detected in samples collected using the mobile method. All sampling methods detected differences in vertebrate communities between woodland and agricultural landscapes whereas no significant differences in taxa richness or community composition were observed between the different sampling methods. We therefore propose that our car-mounted airDNA sampler could be a game changer for large scale, rapid biomonitoring efforts. We discuss how this novel approach can be integrated into biodiversity monitoring across the tree of life at the landscape scale.

Oral presentation

Multi-source data fusion for automatic forest cover classification across various climatic conditions

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Forests, that cover around one-third of the Earth's land surface, play a crucial role in landscape ecology. The advent of big data in Earth observation (EO) enables near-real-time monitoring of status and dynamics of forests. Various global EO-based forest-related products often serve as baseline layers in various applications, such as in disturbance detection and in policy- and decision-making. However, their accuracy and temporal availability vary across regions and climatic zones. Accurate and up-to-date forest cover information is essential for real-world applications. This study aims to develop a highly accurate, automated approach and a tool to classify forest cover that is adaptable to any time frame and location globally. The approach is implemented in Google Earth Engine and integrates open-access multispectral optical (Sentinel-2 and Landsat), synthetic aperture radar (SAR) (C-band Sentinel-1 and L-band ALOS-2 PALSAR-2), topographic (Copernicus DEM) and meteorological data (ERA5-Land mission). A Random Forest machine learning approach is then used to classify forest and non-forest areas. Automation is achieved by generating training data for each run, based on the selected region and time range, by intersecting multiple forest-related and land cover datasets to reduce uncertainty. The accuracy is assessed in selected case study sites across Europe, South America, Africa and Asia, covering various climatic zones and biomes, using high-resolution satellite imagery and time series analysis of optical and SAR data. The accuracy of individual input data sources and the benefits of multi-source data fusion are assessed and discussed. Initial results suggest better overall accuracy using multi-source data fusion compared to single-sensor approaches, with SAR data being particularly useful in cloud-prone regions. The automatic training using a strict forest mask proved to overcome the limitations of individual input datasets. However, challenges remain in areas with distinct wet and dry seasons, where seasonal variability affects the classification performance. Additionally, input satellite data availability can strongly influence the results. Overall, the open-access nature of the developed tool enables global application and encourages its further testing and development. Multi-source data fusion enhances accuracy, provides up-to-date forest cover information that can support a wide range of applications.

Oral presentation

Integrating ecosystem functioning into ecological niche modeling: A pathway for enhanced biodiversity assessments

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Biodiversity is declining globally at unprecedented rates, requiring innovative tools to assess and mitigate the impacts of global change. Ecological niche models (ENMs) are widely used to predict species distributions, but they often neglect ecosystem processes that influence habitat suitability. Here, we highlight the advantages of integrating remotely sensed ecosystem functioning attributes (EFAs) into ENMs, offering a more dynamic and process-based approach to biodiversity assessments.

Despite significant advancements in Earth observation technologies, ENMs have yet to fully exploit the potential of high-resolution satellite imagery and cloud-based geospatial platforms like Google Earth Engine (GEE) and Sentinel missions. EFAs—such as primary productivity, carbon fluxes, surface energy balance, and hydrological cycles—enable systematic biodiversity monitoring and improve predictions of species responses to environmental change. Unlike traditional static variables (e.g., climate or land cover), EFAs provide high-frequency, spatially explicit insights into ecosystem dynamics, helping to refine species-habitat relationships.

In this presentation, we will showcase the application of EFA-based ENMs to diverse taxa, including endemic plants and bird communities (apex predators and wet grassland specialists). These models allow a more accurate assessment of habitat suitability trends, improving our ability to monitor biodiversity changes and anticipate future distribution shifts.

To bridge the gap between remote sensing and ecological modeling, a coordinated effort between remote sensing experts and biodiversity researchers is essential. The Group on Earth Observations Biodiversity Observation Network (GEO BON) and Essential Biodiversity Variables (EBVs) provide a framework for incorporating EFAs into conservation planning. Moving forward, the development of global datasets and satellite-derived EFAs tailored for ENM applications will be crucial for biodiversity assessments and environmental policy.

Our study demonstrates that integrating ecosystem functioning into ENMs represents a significant advancement for conservation biogeography, allowing cross-scale, repeatable, and cost-effective biodiversity monitoring in a rapidly changing world.

Oral presentation

Monitoring Forest Vegetation Spring Phenology in Slovakia Using Biweekly NDVI Composites from Harmonized Sentinel-2 and Landsat-8 Products

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Vegetation phenology, the timing of seasonal plant development through phases of active growth and dormancy, plays a fundamental role in regulating terrestrial ecosystem processes. It directly influences carbon sequestration, water cycling, and energy exchange between the land surface and the atmosphere. Moreover, shifts in phenological events serve as a critical indicator of climate change impacts on ecosystems. Satellite phenology, valuable for large-scale, long-term monitoring, differs from ground-based observations. While Landsat and Sentinel-2 offer powerful time-series data for modelling vegetation seasonality, their use is complicated by irregular sampling and data gaps due to weather and short growing seasons. The Harmonized Landsat and Sentinel-2 (HLS) dataset, by combining these satellites into a consistent, freely available product, addresses these challenges and provides optimal coverage for phenological studies. Accurate monitoring and quantification of phenological responses are thus essential for understanding and predicting these vital land-atmosphere interactions. This study specifically investigates the spring phenology, particularly the Start of Season (SOS), of key Central European tree species – black locust, oak, hornbeam, beech and larch – using the HLS dataset. We analyze time series of the two most commonly used vegetation indices - Normalized Difference Vegetation Index (NDVI) and Enhanced Vegetation Index (EVI) to estimate SOS from 2018 to 2024. Four modeling approaches are employed: Generalized Additive Models (GAM), Logistic Regression (LOG), Piecewise Linear Models (PIECEWISE), and Nonlinear Least Squares (NLS) regression. Each method offers a distinct approach to capturing the temporal dynamics of vegetation growth. By examining the SOS of black locust, oak, hornbeam, beech, and larch, we aim to provide insights into their specific phenological responses to climate variability within the region. Our findings indicate that larch and black locust tend to exhibit relatively early SOS (lower DOY values) compared to other species. Furthermore, while a general positive relationship was observed between elevation and estimated SOS dates, significant variability was noted in some years, suggesting complex interactions between elevation and other factors influencing phenology. These variations highlight the importance of considering both species-specific traits and environmental factors when assessing phenological changes.

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Oral presentation

Land cover vs land use: a still ongoing debate

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Studies on landscapes often use two variables which are key to an understanding of them: land cover and land use. However, there is some confusion in the literature concerning the use of these two concepts. For example, the so-called LULCC (land use-land cover change) concept has been employed with categories that mix land uses and land covers, while the well-known CORINE land cover (CLC) is frequently used as LULCC or as land use classification. Thus, the objective of this work is to disentangle these concepts by re-conceptualising them. The classes considered to determine LULCC might include forest, non-forest natural formation, farming, non-vegetated areas and water, but we can see that these are all in fact land cover, except for farming which is a land use. Or the classes considered might be bare surface, pasture, cultivated area and forest, all of which are land cover, with no land use. Consequently, the LULCC seems to be a catchall in terms of its classes. This work proposes to address the conceptual problem identified by specifically relating land use and land cover to process- and structure-based attributes, respectively. In this way, land use would be considered as a process and land cover as a structure. By way of example to explain the above, irrigated agriculture is a land use (being the action of irrigation a process) which is cyclical in nature and generates different land covers corresponding to different phases of the process (e.g. crop, fallow land, or plowed land).

In another example, a forest is a land cover (a patch of land as part of a structure) that can have several main uses like forestry or wood felling. In turn, forestry groups together a set of practices which can be considered singularly as land uses: biomass collection, berry or mushroom picking, resin extraction, pasture (understorey). Following this reasoning, it seems clear that irrigated agriculture is a land use and forest a land cover. In terms of landscape ecology concepts, it can be argued that land cover is more about pattern or structure, whereas land use is more about process and landscape dynamics. The main conclusion is that there is no clear correspondence, or transferability, between land cover and land use categories. Furthermore, considering a combination of the two concepts in a single classification (LULC change) is confusing when it comes to interpreting the data and really understanding the landscape.

Oral presentation

Natura 2000 Habitats in the context of historical land use

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Numerous studies have demonstrated that historical land use has influenced habitat quality for centuries. The Natura 2000 network is the primary tool for protecting valuable habitats in Europe. However, the historical land use of sites designated as Natura 2000 habitats has received minimal attention.

This study aims to identify the 19th-century land use of sites registered as Natura 2000 habitats, analyze the main changes in land use, and assess habitat quality. Pilot areas were selected from Lahemaa National Park in northern Estonia and Otepää Nature Park in southern Estonia. The research was conducted using GIS, integrating historical manor maps and the Natura 2000 habitat database.

The results indicate that sites currently designated as Natura 2000 habitats have undergone significant land use changes over the past century. For example, in Lahemaa, up to 70% of the current lowland hay meadows (habitat type 6510) were arable fields in the 19th century, while in Otepää, this figure reached 100%. At the same time, traditional wet hay meadows remain underrepresented in the Natura 2000 protection scheme. While Western Taiga forest habitats (9010) have remained relatively stable, the use of Fennoscandian deciduous swamp forests (9080) has changed considerably—83% in Otepää and 76% in Lahemaa were historically hay meadows and pastures. Additionally, although bogs have remained largely unaffected by human activity, more than half of the protected fens and quagmires were once used as hay meadows and pastures.

The preliminary results confirm that the conservation value of Natura 2000 habitats is higher when historical land use aligns with present-day biotopes. Therefore, incorporating historical land use information would be beneficial for the planning and management of Natura 2000 habitats. In addition to international regulations, protective measures at the national level should account for regional specificities.

Oral presentation

Validation of plot locations in vegetation databases using remotely sensed Essential Biodiversity Variables

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Vegetation plot databases covering extensive geographic areas are unique data sources for large-scale assessments of ecosystem diversity, with applications in both fundamental research and nature conservation. In recent years, large efforts have been made to facilitate access to vegetation plot data worldwide, and this information is highly valuable for mapping and monitoring natural habitats. However, the application of habitat mapping approaches based on in-situ data from vegetation databases depends on the spatial uncertainty of plot locations. These locations are very heterogeneous, with spatial information ranging from vague textual descriptions to geographic coordinates with different degrees of accuracy. Here, we develop a framework for validating vegetation plot locations using remote sensing data and apply it to more than 2M plots from the European Vegetation Archive (EVA). We focus on metrics based on three Essential Biodiversity Variables (EBVs): ecosystem primary productivity, represented by the maximum Normalized Difference Vegetation Index (NDVI) in July; ecosystem phenology, represented by the difference in NDVI values between the end and the maximum of the growing season; and ecosystem structure, represented by canopy height. We extracted these EBVs for all EVA plots sampled in terrestrial habitats and evaluated their distribution for each EUNIS habitat type (at level 1) across biogeographical regions in Europe. This allows us to define ranges of membership to each habitat type (either globally or per biogeographical region) based on the three EBVs, and to decide which plots might be incorrectly located. Besides, we used the spatial uncertainty of plot locations in EVA, when available, to select the subset of most accurately located plots (e.g. those located with GPS). This subset of plots was used to train machine learning models based on the three EBVs that allowed us to classify all EVA plots into broad-level habitat types. We found that ranges of membership to each habitat type vary among biogeographical regions, that the location of a large proportion of points in EVA is incorrect and would need to be refined, and that our set of EBVs is capable of accurately classifying broad-level habitat types. Our framework will allow to improve the spatial resolution of vegetation databases and will contribute to the use of these valuable in-situ datasets for habitat mapping and monitoring from landscape to large scales.

Oral presentation

Land use and wild bee diversity: Insights from a large-scale monitoring project in Austria

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Various studies have shown a significant decline of wild bees in recent decades. So far, however, little is known about the occurrence and status of wild bees across the various cultural and natural landscapes in Austria, the most bee species-rich country in Central Europe, and which effects measures under the Austrian agri-environmental scheme such as biodiversity plots or organic farming practices have on the diversity and communities of wild bees. We recorded bees at 205 sites (625 m x 625 m each) across Austrians cultural and natural open landscapes (farmland, grassland, protected areas) in 2023 and 2024 using quantitative transect (10x 80m transects per site) and semiquantitative targeted netting approaches, and also recorded the habitat types and potential agri-environmental measures at the sites and transects.

Bee diversity and communities strongly varied across the different landscapes in Austria and we will present which land uses have a positive and which have a negative effect on wild bee diversity, how bees with different ecological traits (e.g., pollen specialists vs. generalists, parasites vs. nest-building bees) respond to different agricultural land use systems, and which effects measures under the Austrian agri-environmental scheme have on the diversity and community structure of wild bees.

Our study reveals key factors within the agri-environmental measures that contribute to the conservation and enhancement of wild bee populations, and gives an improved understanding of the effectiveness of the Austrian agri-environmental scheme, which will allow these measures to be further refined so that they make the best possible contribution to the protection of wild bees and potentially other pollinators as well. Overall, the study provides important insights into the protection of wild bees and the sustainability of agriculture in Austria. This knowledge makes it possible to specifically promote certain habitat types in the landscape in order to create more suitable habitats for wild bees.

The project was financed by the Biodiversity Fund of the Austrian Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology.

Oral presentation

A combined ecology/remote sensing review for heathland biodiversity conservation: an UAV perspective.

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Heathlands are among the most threatened ecosystems in Europe. Due to land-use changes with intensification of forestry and agriculture, their area has been reduced up to 80% during the 20th century. Because they belong to the oldest cultural landscapes in Europe, hosting a unique biodiversity, heathlands have a high conservation value recognized through international frameworks (NATURA 2000 conservation framework - annexe I Council Directive 92/43/EEC). Thus there is a need for relevant data on heathlands to assess their conservation state but having a spatially-exhaustive assessment still remains a challenge.

The main question is to assess if and how ecology and remote sensing have recently converged to define descriptors of heathland habitats. Thanks to the recent development of UAV technology, this paper aims to assess their contribution to this issue. The review is based on nearly 100 scientific papers from ecology and remote sensing covering a wide diversity of heathlands.

The analysis is based on the Essential Biodiversity Variables (EBVs) categories as a shared framework for scientists and managers. These categories describe descriptors at different ecological scales (from species genetic composition to landscape attributes). EBVs can be derived from ecology and/or remote sensing disciplines. Several attributes were extracted from selected papers such as data used, main outputs. This review provides the most consistent, spatially exhaustive and ecology-oriented variables for heathland conservation.

Results show that the most frequent EBV category for both disciplines is the Ecosystem structure. Ecology studies concern most of the EBV categories, with primary information on species composition, traits and populations (especially on species distribution, from field surveys data), and also disturbance regime and nutrient retention (management effects). Remote sensing studies report mainly on ecosystem extent and structure EBVs, and partially on species composition and traits. UAV-based studies allow more precise observations on phenology and population structure (age/size class at species level) which contribute to document habitat species composition and traits.

This review shows that UAVs, thanks to their improved spatial and spectral resolutions (from centimeter to decimeter and from VISNIR to Thermal spectral domains, respectively) and to sensors' interchangeability, are promising tools to characterize and monitor heathlands biodiversity and conservation, filling the gap between ecology and remote sensing approaches.

Poster presentation

Ground truth vs. aerial insight: overcoming challenges in detecting invasive goldenrods in Poland using UAV imagery

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Unmanned Aerial Vehicle (UAV) imagery, with its high-resolution capabilities, is a powerful tool for mapping invasive American goldenrod species (*Solidago canadensis* s. l. and *S. gigantea*) across diverse landscapes. However, fieldwork and expert knowledge are essential for validating these data. In this study, we explore two main challenges encountered while developing a training dataset for classifying goldenrod patches using orthophotomaps derived from UAV RGB images with a ground sampling distance of 2.18 cm/px. Imagery was captured in mission flight mode using a DJI Matrice 210 RTK V2 equipped with a Zenmuse X5S camera. The UAV missions were complemented by ground-level photography and detailed field surveys documenting plant composition, habitat characteristics, land use, and goldenrod morphology. Our field research spanned six weeks (Aug–Sep 2024), across 80 sites, each several hectares in size, located in various regions of Poland.

Challenge 1: Morphological variability of target species. Goldenrod distribution ranged from uniform spreads to dense clusters, with stems (ramets) 0.5–2 meters tall, and displaying diverse flowering stages. This heterogeneity – driven by species differences and local growth conditions such as soil fertility, moisture, and light availability – often resulted in false-negative detections, complicating reliable identification based solely on aerial imagery.

Challenge 2: Lookalike vegetation. Numerous plant species exhibit a growth habit or leaf color similar to goldenrods, including tall grasses, crop weeds, and sedges. Some plant species with yellow flowers or yellowish leaves, such as *Tanacetum vulgare*, *Solidago virgaurea* (a native species in Poland), *Crepis* spp., *Senecio* spp., *Inula* spp., and *Acer negundo*, closely resemble goldenrod blooms. These similarities increased the risk of false-positive classifications, underscoring the limitations of aerial perspectives alone.

Ultimately, our findings highlight the indispensable role of integrating UAV imagery with ground-based observations and botanical and ecological expertise. This synergy proved critical in reducing misclassifications, allowing for more precise differentiation between goldenrod patches and confounding vegetation.

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Poster presentation

Can cultural heritage assets explain landscape history?

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Some cultural heritage assets (CHAs) can be linked to former activities which have been shaping landscapes through time. With this aim in mind, an available database (FEDAC) of ethnographic heritage elements of Gran Canaria has become the main source to perform this work. It provides location (points) and other attributes, among which past activities can be identified. The data encompasses XVII - XX centuries CHAs, which are so interesting to construct a timeline. This material makes it possible to discover and/or “read” the landscape past. The study area is the central summits of Gran Canaria island (Spain). Nevertheless, CHAs not only inform about the existence of such activities, i.e. they are historical witnesses that certify the existence of certain natural resources in the past. And the integration of cultural, economic, and natural characteristics define how the society transforms the environment (determined by the socioeconomic systems), by using these CHAs. The research questions are: Which types of CHAs and natural resources are there in the study area, both in the past and in the present? Is there a subsequent use of these CHAs exploiting different natural resources than in the past, linked to socioeconomic systems? How was the relationship of the society with these resources in the past? And in the present? CHAs types in the study area are agricultural, livestock, hydraulic, transport, industrial production, and ethnographic interest set. On the other hand, natural resources are soil, water, vegetation, among others. The form of exploitation of these resources has changed according to socioeconomic systems and historical context. Thus, plantation, firewood extraction and grazing have been replaced by natural protection, cultural activities (interpretation centers) and sightseeing tours.

Poster presentation

Session 4I– Education and Teaching Perspectives in a Rapidly Changing World

Symposium

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Keywords: education, teaching, teaching methods, curricula

This symposium seeks to explore innovative teaching approaches and methodologies in the context of a world undergoing rapid transformation. Recent global events, including the COVID-19 pandemic, geopolitical tensions and economic fluctuations, and the surge in artificial intelligence and digital technologies, have created a landscape of uncertainty that significantly affects educational practices. This symposium will provide a platform for educators and researchers to discuss how these changes influence teaching strategies and learning outcomes, particularly in landscape ecology and related fields. We particularly encourage submissions about: • What are new trends in teaching landscape ecology? • How do the contents of landscape-related courses differ based on political, environmental, and social contexts? • What are the main themes in landscape ecology that should be prioritized for teaching the next generation? • In what ways can landscape concepts be incorporated into curricula of other disciplines beyond traditional landscape-related fields? • How can we enhance student exchange experiences to foster a broader global perspective on landscape ecology? • What are the implications of digital transformation on pedagogical frameworks? • How can educators effectively navigate and mitigate the challenges posed by technology lag in teaching practices? The symposium wants to provide a space for everyone interested in conceptualizing, planning and implementing landscape related teaching and education approaches. We want to will bring people together to provide an opportunity to learn from each other's experiences and exchange ideas. Furthermore, we want to provide an opportunity to connect with each other, to discuss ideas and maybe even initiate new collaborations to further develop landscape research education across Europe and beyond. The symposium is organised by members of the IALE-Europe Education Working Group but is explicitly open for everyone. All presenters and participants are invited to contribute to our own living special issue in the Scopus listed open access e-journal Landscape Online: https://www.landscape-online.org/index.php/lo/education_in_LE-call

The potential of board games to educate on Green Infrastructure and Ecosystem Services

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As stated in the European Commission's definition, Green Infrastructure (GI) refers to a strategically planned network of natural and semi-natural areas, along with other environmental features, that are designed and managed to provide a wide array of Ecosystem Services (ES) while also boosting biodiversity. Despite numerous actions at the European level to encourage the implementation of GI, few small entities have internalized the benefits of GI and initiated implementations in their territories. GI is still poorly applied at the local level due to a lack of knowledge transfer about its relevance in counteracting the effects of climate change. Training and education can act as catalysts to disseminate these concepts; however, to succeed, a hands-on approach that leads to emotional involvement and enjoyment is necessary. In Game-Based Learning (GBL), games are adopted to facilitate learning in a more realistic and engaging context. GBL is well-suited for both formal and informal training and information contexts and can help citizens and local stakeholders build higher-level scientific knowledge.

Nevertheless, GBL is still rarely used in university courses to convey landscape ecology concepts. Here, we explore the interest of university students in GBL and present a cooperative board game about GI and ES, created as part of the Interreg Alpine Space FRACTAL project (FosteRing green infrAstruCTure in the ALps) with the specific goal of bridging the awareness gap among younger generations about GI and their role in supporting ES and ecosystem conservation in the Alps. FRACTALgame is an educational cooperative game in which four characters with different peculiarities must address anthropogenic problems intensified by climate change, using GI-based solutions. These problems damage five typical ecosystems of the Alpine landscape: the urban ecosystem, the forest, the high mountain ecosystem, the river ecosystem, and the rural agricultural ecosystem. The damage results in the loss of various types of ES, from supporting services to regulating, provisioning, and cultural services. Thanks to GI, the ES provided by the ecosystems are restored, and the functionality of the Alpine landscape is maintained. We also present a qualitative pilot study with 47 university students, who played FRACTALgame during a biology education course. Through a short questionnaire, we explored their interests in board games, and their knowledge about GI and ES. It turned out that 65% of the students often play games and that their preferred games are board games. On the other hand, more than a half of the students do not know the terms GI and ES. These results, although limited to a very small sample, show that students could welcome the GBL approach to learn new concepts.

Oral presentation

Teaching Landscape Ecology in a Changing World: Insights from a global survey

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Landscape ecology is a well-established field that explores spatial patterns, ecological processes, and their interactions across scales. Its interdisciplinary nature and relevance to environmental management, spatial planning, and conservation have led to its widespread inclusion in research and university curricula. However, there is limited research on what is actually taught in landscape ecology courses and how well students are being prepared to address current global challenges. Moreover, pedagogical practices, including teaching methods and their alignment with educational best practices, remain underexplored.

To address this gap, we conducted a global survey to examine how landscape ecology is taught in higher education across different regions. The study investigates the content, teaching strategies, and modes of instruction employed, with a focus on how students engage with landscape ecological thinking and apply it in real-world contexts. We identify commonly used teaching methods, evaluate their alignment with established pedagogical principles, and highlight opportunities for innovation. Special attention is given to the integration of active learning approaches—such as field-based learning, spatial modelling, and interdisciplinary collaboration—and their role in shaping the next generation of landscape ecologists.

Oral presentation

Using geospatial technologies for field surveying: insights from a landscape ecology course

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The integration of geospatial technologies into landscape ecology education has been widely acknowledged as crucial for equipping students with practical skills in landscape ecology. This communication presents a teaching model for the Landscape Ecology course in the Environmental Engineering bachelor's program at the University of Lisbon, emphasizing the use of digital field survey mapping tools for structuring habitat monitoring procedures. The model incorporates a hands-on, field-based learning approach within a project-based framework, enabling students to model, collect, analyse, and interpret spatial data for ecological assessments. Through structured exercises, students gain experience in real-time data acquisition, GIS mapping, and environmental monitoring, fostering a deeper understanding of landscape patterns and ecological processes. This communication focuses on the pedagogical challenges of integrating this teaching method into the curriculum and its role in improving students' technical proficiency and ability to apply landscape ecology concepts to real-world environmental challenges. The approach supports the development of future professionals capable of leveraging geospatial technologies for sustainable landscape management and conservation.

Oral presentation

Importance of the dual training programs expansion for Kazakhstan in cooperation with Slovakia

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In an era of climate urgency and ecological degradation, integrating sustainability into education systems is critical for fostering resilient landscapes. For Kazakhstan—a country grappling with environmental challenges such as soil salinization, water scarcity, and steppe degradation—the expansion of dual training programs, in collaboration with Slovakia, offers a transformative opportunity to align workforce development with ecological stewardship. Dual education, increase of the practical training with intensive theoretical support, Technical and Vocational Education and Training (TVET) programs are in big demand in Kazakhstan, President Tokayev demands to train more technicians that is why he named the 2025 years as the "Year of Skilled Professions". The Kazakh Minister of Education twice increased the budget's expenses for Kazakh colleges. Slovakia's initiatives <https://www.youtube.com/watch?v=NPx-tiTrqNQ>, "water for climate healing - the new water paradigm and public policy", are our target to adapt with TVET programs development for Kazakhstan in cooperation with the Slovak experts. Cooperation with Slovakia, a leader in integrating ecology into vocational education, provides a strategic framework to improve the landscape sustainability for Kazakhstan. Dual training programs embeds ecological principles into technical and vocational education, equipping students with competencies in agroecology related to the sustainable farming practices to combat soil degradation, about 60% of arable Kazakhstan land under such complexities. TVET programs development with potential field apprenticeships in partnerships with organizations as Tatra National Park are our connected targeted plan. Joint research initiatives, collaborative projects on steppe restoration and sustainable pasture management, leveraging Slovakia's experience in Carpathian ecosystem conservation adaptation for Kazakhstan steppes practices are under investigations also. By embedding ecological principles into vocational training, Kazakhstan can cultivate a generation of professionals equipped to reconcile economic growth with environmental imperatives. The Kazakh Ministry of Science grant # BR27197639 "Development of Innovative Hydrogeological Methods for Water Resource Management in the Zhambyl, Almaty, Zhetysay, Abay, and East Kazakhstan Regions" supports this project. The current status of the project activities will be presented.

Oral presentation

Slovakia-Kazakhstan practical dual TVET eco farm training development

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Kazakhstan's president Kassym-Jomart Tokayev emphasized the need to address the critical shortage of experts, technicians, including water resources, agro industry, while also advocating for the training of specialists in future-oriented professions, dual Technical and Vocational Education and Training (TVET) support expansions. In order to raise the prestige of skilled workers and implement reforms in the system of technical and vocational education, President Tokayev has decreed 2025 the Year of Skilled Trades. Some of the difficulties to implement this program is related to the Kazakhstan educational system administration, which is divided into two Ministries: first, the Ministry of Higher Education and Science, and, the second, the Ministry of Education. These two Ministries are missing the proper connection and cooperation system. The Ministry of Higher Education is responsible for the Universities, which are located mostly just in several cities, without the proper connection to the rural regions. The Ministry of Education is responsible for the schools and colleges? including the rural region colleges. The rural region colleges are missing the proper support, including financial and TVET programs. Quality of the TVET programs are low. Educational programs are stronger in the cities, the rural Kazakhstan regions are poorly supported. The local people, farmers in the rural region are often excluded from the capacity building TVET programs, which are developed in the cities. EU expertise in the providing TVET college level dual, combination of the theoretical and practical training, similar to the DEULA, <https://www.deula-nienburg.de/> would be helpful to set up in Kazakhstan's rural regions. We are looking for the similar Slovation TVET college level based training provider to adapt Slovakia's initiatives in "water for climate healing - the new water paradigm and public policy," <https://www.youtube.com/watch?v=NPx-tiTrqNQ>, including the contour-strip land organization, and connected to the Flood-MAR programs to effectively accumulate snow, flood drainage water for Kazakhstan. We are targeted to set up the TVET college level dual educational program on the Eco farm Sultanbekova land facility, which is located in Kazakhstan's Almaty region's rural village Zhalkamus. We hope to transfer about three thousand hectares of the community owned pasture lands into forest shelter belts contour-strip Flood-MAR land organization, similarly as it works in Slovakia. These efforts is supported by the Kazakh Ministry of Science project # BR27197639 "Development of Innovative Hydrogeological Methods for Water Resource Management in the Zhambyl, Almaty, Zhetysu, Abay, and East Kazakhstan Regions". The current status of project activities will be presented.

Oral presentation

Educational cooperation in the field of biodiversity and nature-based solutions – the current state calling for transformation

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Higher and vocational education institutions are essential in addressing environmental problems by equipping future professionals with the skills to make informed decisions and manage natural resources sustainably. The present study is a part of the eNaBIS Horizon Europe project focusing on education and collaboration concerning biodiversity loss (BD) and Nature-Based Solutions (NBS).

The survey about perceived institutional cooperation and knowledge transfer related to BD and NBS was applied to higher and vocational education practitioners across European countries. Participants answered several questions about current networking and collaboration patterns. The dataset involved seventy-two questionnaire responses and eighty-one responses to interviews with open-ended questions.

Results reveal how and where the collaboration based on NBS and BD is perceived to be progressing. According to experts, even if the collaborative process has not stagnated in European educational institutions over the last decade, several changes are needed to achieve the desired state of academic cooperation.

Between the critical obstacles in cooperation, respondents often listed the current administrative hierarchy, disciplinary structuring, lack of time, energy, and strategic guidelines for required educational changes. Additionally, the present financial system settings often cause stressful competition between institutions and disciplines. Difficulties also exist in understanding terminology between disciplines and knowledge systems, hindering cooperation between educators and academic and non-academic worlds. The survey highlighted good practices in institutional cooperation, even if not commonly spread across European educational institutions. The shared characteristics of these examples are a) educational projects focusing on real-life environmental problems like restoration of degraded landscapes, b) multidisciplinary student teams solving landscape issues, c) collaboration between educational institutions, and d) transdisciplinary dialogue projects. Learning and capacity building for environmental sustainability, including BD and NBS, requires transdisciplinary education, with vanishing boundaries between disciplines, institutions and academic and non-academic actors. This journey needs to be leveraged by strategical guidelines for substantial modifications in how educational institutions are structured and funded and collaborate with other institutions and non-academic stakeholders.

Oral presentation

Landscapes4Future: Living Labs as transformative Learning spaces

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We are facing major challenges such as biodiversity loss and climate change which threaten our landscapes and living environment. Nature-based solutions (NbS) offer promising potential to address key societal challenges through the protection, sustainable management and restoration of natural and modified ecosystems, benefiting both biodiversity and human well-being. However, it is not clear yet, in how far NbS are taken into account in university education and teaching. In the frame of the Horizon Project “eNaBlS - Education and Nature-Based Solutions: enable society to bend the curve for biodiversity” we investigate, how NbS and Biodiversity are currently anchored in University Teaching in selected countries and how new didactical approaches can support interdisciplinary and integrative learning.

In this context, Living Labs can serve as transformative learning spaces where academia, government and society collaborate on innovative solutions through experiential learning and co-creation. The presentation explores the learning potential of Living Labs in landscape planning education, with a particular focus on the implementation of NbS. Within the frame of the “Landscape4Future” Living Lab different formats are experimented with (e.g. interdisciplinary teacher workshops, excursions with practitioners, visualizations and gameful approaches). By engaging students, educators and stakeholders in real-world contexts, Living Labs foster experiences and competencies necessary for sustainability transformations. Our findings emphasize the potential of Living Labs as dynamic learning environments while also highlighting the challenges associated with integrating this approach into higher education. The results offer valuable insights for educators, policymakers, and researchers striving to implement transformative and interdisciplinary practices and multidisciplinary perspectives, which are essential to maximise environmental, social and economic benefits.

Oral presentation

Innovative Approach to Professional Education in Bioenergy and Landscape Management in the Context of Climate Change

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Bratislava Self-Governing Region implements an innovative, SMART-oriented strategy for vocational education in the fields of bioenergy and landscape management. This approach emphasizes enhancing the attractiveness of vocational studies for young people, strengthening synergies between educational institutions and industry, and establishing centers of excellence focused on the integration of renewable energy sources and climate change adaptation measures. Through the implementation of modern technologies and smart educational methods, the region supports the preparation of highly qualified professionals capable of responding flexibly to labor market demands and effectively addressing current environmental challenges.

Oral presentation

GIS tools applications for landscape climate changes emergency mitigation programs

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Kazakhstan has difficulties with water resources, with big extreme floods in spring and devastating droughts in summer. The proper adaptation strategy is required. The Kazakhstan Government relies mostly on the centralized controlling system to supervise, to control most activities including the flood-drought mitigation programs from its capital Astana city by the Ministry of Water Resources and Emergency Agency, which is very costly for the Kazakhstan state budget. Kazakhstan is increasing the taxes now to cover the flood-drought mitigation programs. At the same it would be more rational to expand the capacity building and involve more the local people in the regions to work on the flood-drought mitigation programs themselves, by adapting programs as Slovakia's initiatives in "water for climate healing - the new water paradigm and public policy" <https://www.youtube.com/watch?v=NPx-tiTrqNQ> with forest shelter belts contour-strip land organization. The implementation of this type Slovakia programs requires the proper preparations, including the local environment investigations, prediction analysis with modeling. The IT support tools as geographic information systems (GIS) can be helpful, including the open source free QGIS <https://qgis.org/> or ESRI ArcGIS, <https://www.arcgis.com/>. The introduction of such programs to be used in the rural regions of Kazakhstan requires development the proper user-friendly college based less than one year certification training programs similar to this type of courses, GIS Applications Specialist <https://www.cna.nl.ca/program/geographic-information-systems-applications-specialist>, which could be connected to the Ecosystem Restoration program <https://www.niagaracollege.ca/environment/program/ecosystem-restoration/>. We are hoping to set up a similar cooperation with Slovakian experts and develop the one year GIS Applications Specialist dual training program, so Kazakhstan and Slovakian students may opportunity to be involved in the exchange programs, to work on the practical expansions of the Slovakia's initiatives in "water for climate healing" to the rural regions with providing the user-friendly support in GIS applications. These efforts are in line with the current Kazakhstan's president Kassym-Jomart Tokayev incentives to provide more training support for the technicians, including water resources, agro industry, dual Technical and Vocational Education and Training (TVET) programs. In order to raise the prestige of skilled workers and implement reforms in the system of technical and vocational education, President Tokayev has decreed 2025 the Year of Skilled Trades. The rural region colleges are missing the proper support. EU expertise in the providing TVET college level dual, combination of the theoretical and practical training, including GIS Applications Specialist training cooperation programs will be helpful. We are targeted to set up the TVET GIS college level dual educational program with Slovakia. These efforts are supported by the Kazakh Ministry of Science project # BR27197639 "Development of Innovative Hydrogeological Methods for Water Resource Management in the Zhambyl, Almaty, Zhetysu, Abay, and East Kazakhstan Regions". The current status of project activities will be presented. *Poster presentation*

Dynamics of landscape ecology research questions in French theses

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Landscape ecology is a relatively young scientific discipline compared to others. In response to many socio-environmental challenges, it continues to develop in many countries, in different directions, associating concepts and methods from several disciplines. In France, landscape ecology has been recognized since the 1980s. The scientific community is active, with regular meetings and, since 2023, a new official chapter of IALE. In 2024, the IALE-France Chapter launched a survey of PhD dissertations related to landscape ecology in order to draw up a portrait of the main lines of research in landscape ecology in France, as well as their diversity. The study includes an online survey to identify ongoing theses and an analysis of the national database listing all theses defended in France since the 90'. The results show that landscape ecology is widely present in many French research organizations and universities, with about 20 theses defended per year related to this discipline. This number stays constant over time. The keyword analysis shows a bipolarization with, on the one hand, topics related to the social dimensions of landscapes, close to human geography, and, on the other hand, topics closer to spatial and community ecology, with much less reference to human activities. Today's environmental challenges require more research at the intersection of these two poles at the landscape scale. An analysis of completed theses provides a relevant overview of scientific orientations, such as the use of remote sensing data and connectivity, and orphaned or insufficiently addressed issues, such as urban ecology and risks. IALE-France is working to highlight these theses in order to stimulate strategic thinking about support from research organizations. Similar studies in Europe could serve to compare the dynamics of different countries.

Poster presentation

Teaching landscape ecology – returning to the roots, staying up to date or exploring new approaches?

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This *Poster presentation* aims at considering the different perspectives and needs of teaching and learning landscape ecology in the rapidly changing world. In this context, several prospective and often challenging questions emerge, i.a: in which aspects, and to what an extend landscape ecology should be treated and introduced to students as independent discipline, and to what extend as an interdisciplinary research field?; how to balance and integrate the theoretical frameworks with applied approaches to tackle the teaching challenges of complex social-ecological systems?; what kind of teaching methods (forms and techniques) are the most effective in this manner, and show the best learning outcomes? Proceeding from the fundamentals and main theoretical concepts of landscape ecology towards selected analytical tools (e.g. GIS, remote sensing, spatial modelling), and practical dimensions (e.g. human-environment interactions, nature conservation practice, ecosystem services approach, landscape management and governance) the above issues, and their role in training of the young generations of students will be discussed.

Poster presentation

Importance of the user-friendly web online platform for rural regions support in Kazakhstan

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Kazakhstan's water resources are facing increasing challenges due to a combination of environmental and human-induced factors. Deforestation, inadequate knowledge among farmers on managing excess water, and the construction of dams on major rivers have all contributed to worsening conditions. To bridge this gap, we plan to develop a comprehensive online platform similar to IALE-Europe and FloodMAR. This platform will feature a user-friendly interface designed to support policymakers, researchers, and local communities in combating floods and droughts. It will provide critical resources, including data-driven insights, best practices, and expert recommendations, to enhance water management strategies across Kazakhstan. For Kazakhstan's sustainability, the upgrade of the information literacy based on the expansion of the blended learning approach is an important effort. Water sustainability is one of the most important efforts. Sustainability of water resources and water availability are complicated issues in Kazakhstan. Kazakhstan depends much on the neighboring Central Asian (CA) countries in transboundary river basin water movements. Kazakhstan is located downstream of the most river basins, other CA countries upstream. Transboundary water movements are very complicated for negotiations and regulations. Climate changes also intensify the flood and droughts extremes. For the mitigation of these problems, it will be reasonable to collect water more efficiently and use it more rationally locally, similarly as Slovakia is doing with its initiatives in "water for climate healing - the new water paradigm and public policy," <https://www.youtube.com/watch?v=NPx-tiTrqNQ>, including the contour-strip land organization, and connected to the Flood-MAR programs to effectively accumulate snow, flood drainage water, which is a very big emergency, even disastrous events in Kazakhstan. Kazakh Government use and spend the budget money mostly on the few big construction companies connected to the Ministry of Water Resources and Disaster Agency, the local people, farmers in the rural region are often excluded in the proactive financial and capacity building programmed to mitigate the flood-drought themselves. However, it will be more rational to involve more the local residents of Kazakhstan themselves in the snow flood water retention programs locally, so people in the rural regions may use this accumulated water during the drought season in summer, similarly as it works in Slovakia with "water for climate healing", connected to the contour-strip land organization, Flood-MAR programs. All these efforts require proper information literacy and blended learning support for people, how to do it, based on the user-friendly programs, including the web online platform for rural regions, who have difficulties to travel. Kazakhstan is a big country and mostly just a couple of Kazakhstan cities as Almaty and Astana have access to good quality education and training support, the rest of the country are missing the proper education and TVET support programs. The user-friendly web online platform for rural regions combined

with the TVET support could; be useful for Kazakhstan's rural regions. By leveraging digital tools and fostering collaboration, this initiative aims to improve resilience against climate change-induced water crises and promote sustainable water management practices in the Kazakh rural region. These efforts is supported by the Kazakh Ministry of Science project # BR27197639 "Development of Innovative Hydrogeological Methods for Water Resource Management in the Zhambyl, Almaty, Zhetysu, Abay, and East Kazakhstan Regions". The current status of the project activities will be presented.

Poster presentation

Session 4J – Landscapes in Landscapes – Cultural Genome of Cultural Landscapes

Workshop

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I will present new integrated, data-driven approaches supported by new methods, and knowledge sources based on material and non-material cultural heritage for insight into new realms of integrated landscape ecology research. Archaeology, ethnology and biology are interconnected in European landscapes and cultural landscapes are systems of interaction between human and nature, systems of interactions between natural and cultural heritage. We don't have only endangered habitats but also endangered cultures in European landscapes and together with nature we are also losing cultures of these landscapes. In Slovenia a new term has been defined by Pleterški (2014), "cultural genome". Just as the biological genome determines our biological appearance, the cultural genome determines our cultural appearance. It is a set of knowledge about how the world works and the rules derived from it that govern individual and community life. This knowledge and these rules change according to changes in the environment, the economy, and social relations. Knowledge and rules can be considered as the fixed core of the elements of any cultural area. In the initial forms of the cultural genome, we can also see the primordial science from which modern science has emerged (Pleterški 2023). It was a spiritual state of our ancestors, connected to nature, which originated from antiquity and was passed down from generation to generation, despite the fact that they were all "Christianized" (Čok, 2015). What is the definition of the cultural genome from a landscape ecology perspective? In front of us is research of continuity of human presence in European landscapes, their alteration of landscapes, spirituality, traces of their activities and relations with today's landscape and biodiversity. New research approach is needed for new combined heritage protection – natural and cultural. Čok B. 2015 in Hrobat Viroglet K., Kavrečič P. ISBN 978-961-6963-41-1 Pleterški A. 2023. ISBN 978-961-07-1696-9

Possibilities of using historical documents, photographs, maps, aerial and satellite images in agricultural landscape changes assessment

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The aim of this paper is to present available historical documents, photographs, historical maps, aerial photographs and satellite images to describe their potential for a study of landscape changes of agricultural land. Landscape ecological research (and mainly a study of land use or landscape structure changes) is crucially dependent on these sources with information about the former of cultural landscape. In the paper, the available historical sources are listed and discussed from the point of their applicability for a study of landscape changes. Recently, digitization of photographs and its public access in books or via internet online portals enable analysis and comparison of a great number of graphic sources with contemporary reality.

This work was supported by the Scientific Agency of the Ministry of Education, Science Research and Sport of the Slovak Republic VEGA - Project No. GP 2/0015/24 and GP 2/0110/25

Poster presentation

The essence of the Wallachian genome of shepherd landscapes of the Western Carpathians – contemporary threats to maintaining cultural continuity

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The Wallachian genome of the shepherd culture of the Carpathians is ethnically diverse in spatial structure, but coherent through tradition and rituals – culture. The influence of the Wallachian epic on the formation of the mountain landscapes of the Carpathians is obvious and indisputable. Vlachs are considered the architects of the landscapes of Europe, constituting one of the elements of its cultural heritage from the 13th century to the present day. Currently, due to the socio-economic transformations of the countries of the Western Carpathians (Poland, the Czech Republic, Slovakia), pastoral landscapes are disappearing due to the abandonment of shepherds and shepherd-farming. The visible threat of loss of forest clearing habitats affects the disappearance of elements material and spiritual culture. The lack of protection of shepherd heritage causes a break in the continuity of the genome, and thus the identity of the societies inhabiting the Carpathians. The research concerns the reconstruction of shepherd landscapes of the Western Carpathians, showing the impact of human activity on landscape processes – indirect interactions (including through folklore events) and direct interactions (including through cultural grazing), with attention paid to contemporary threats resulting from the development of, among others, recreational and leisure tourism or the transition from traditional shepherd to farmer pastoralism. It is important to select reference landscapes that will secure the continuity of the DNA of shepherd culture.

Poster presentation

Session 4K – EU Grassland Watch – An operational service for landscape monitoring

Workshop

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Keywords: grassland watch

Grasslands are a key part of many landscapes whether as hay meadows, grazing marshes or woodland clearings. They maintain biodiversity and food production, but also influence ecological processes on a wide range of scales. These include critical functions such as pollination, water supply, carbon sequestration, and climate regulation. They cover a significant part of the EU and 70 % of the world's agricultural land, resulting in grasslands that are both diverse and extensive habitats. However, these important habitats are currently facing numerous threats, including extensification and abandonment, highlighting the urgent need for effective monitoring and conservation strategies. The European Union Grassland Watch (EUGW) service represents a significant step towards consistent and effective monitoring services for grasslands protected within the Natura 2000 site network. The platform exploits data and services within the Copernicus Programme to deliver operational grassland information at the pixel level for selected sites through to European level summaries to support national and EU-level management and reporting obligations. It produces yearly land cover maps going back to the mid-1990s with the help of Landsat data. Thanks to the Sentinel satellites, since 2016 the grasslands mapped by the service can also be characterized by their type, management and productivity and are categorised by a set of indicators. This provides a flexible a powerful tool to assess the condition of grasslands and how they are evolving over time in response to policies, management practices and climate change. The service is evolving to map more Natura 2000 sites, provide more detailed thematic information, generate more easily interpretable insights, and expose this information through a more user-friendly interface. This session will present the background and current status of EUGW and provide an interactive walk through of the platform to evaluate its capabilities in the context of the attendees' activities.

Session 4L – Posters without thematic classification

Changes of the small mammal community after the arrival of the striped field mouse

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Urbanization alters small mammal communities, affecting biodiversity, pathogen dynamics, and ecosystem functioning. We compared small mammal assemblages in Nitra before and after the arrival of the striped field mouse (*Apodemus agrarius*) and evaluated the influence of urban zones and landscape types on their community structure.

Small mammals were trapped at six sites representing three urban zones (suburban, peripheral, pericentral) during two periods: I (Dec 2012–May 2015; 3,350 trap-nights) and II (May 2019–Oct 2024; 1,500 trap-nights). In each site, 50 live traps were deployed for 3–4 consecutive nights per season. Diversity indices (Shannon index, relative abundance) were calculated. Relationships between community composition and environmental gradients (urban zone, landscape type, time) were analyzed by redundancy analysis (RDA) in Canoco 5.

In period I, 13 species were recorded; in period II, 9 species. In both periods, *Microtus arvalis*, *Apodemus sylvaticus*, and *A. flavicollis* were eudominant, although *M. arvalis* declined markedly in period II. *Apodemus agrarius* first appeared in 2021 and in period II occurred only in suburban and peripheral zones (58 individuals, ~10.7% of captures). RDA revealed a strong correlation between urban zones and landscape types: suburban sites associated with forested or semi-natural habitats, peripheral sites with agricultural mosaic, and pericentral sites with urban green spaces. Community composition differed significantly between periods (pseudo- $F = 2.5$; $p = 0.034$), with “time” and proportion of agricultural land as key predictors. Seasonal trapping success peaked in autumn across all zones; the pericentral zone consistently exhibited the lowest capture rates.

Urbanization and landscape transformation in Nitra drive homogenization of small mammal communities toward synanthropic species, reinforced by the arrival of *A. agrarius*. Maintaining a heterogeneous habitat mosaic (forest fragments, agricultural enclaves, urban green areas) and planning green corridors is essential to support native biodiversity. Continued monitoring of invasive and synanthropic species, together with adaptive management in response to climatic and landscape changes, is crucial for sustaining functional urban ecosystems.

Poster presentation

Knowledge Mapping of Ecological Migration Applied to Environmental Drivers, Governance Models, and Post-Migration Effects—A Scientometric Review with CiteSpace

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Ecological migration has become a vital strategy for mitigating environmental degradation and promoting human well-being in ecologically fragile regions, particularly under the mounting pressures of climate change and resource depletion. This study applies a scientometric approach using CiteSpace to analyze research trends, thematic evolution, and knowledge gaps in ecological migration studies. Based on 343 peer-reviewed articles published between 2006 and 2024, the analysis identifies key drivers, governance models, and post-migration impacts. The findings reveal that ecological migration is shaped by a convergence of environmental drivers (e.g., climate change, land degradation), socioeconomic dynamics (e.g., poverty alleviation, demographic shifts), and policy frameworks. Implementation strategies vary widely, from state-led ecological resettlement to community-driven adaptation, each presenting distinct challenges and opportunities. Post-migration outcomes show significant progress in ecological restoration but highlight disparities in socioeconomic integration and cultural adaptation. Despite these advancements, critical gaps persist, including the absence of long-term impact assessments, limited interdisciplinary collaboration, and a scarcity of comparative regional studies. Addressing these issues, the study advocates for integrated ecological-social-economic frameworks and dynamic monitoring systems to enhance the resilience and sustainability of ecological migration practices.

Poster presentation

Mierová Colony: history, present and perspective of the exceptional Bratislava green housing estate

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In line with the motto—nothing pays the capitalist more than healthy housing for the workers—as early as 1879, English factory workers began to try to build housing estates in which the public space is strongly dominated by greenery. In 1898, E. Howard initially proposed the concept of a garden city, which would include the main advantages of both the city and the countryside. In Bratislava, only a minimum of comprehensive residential workers' complexes have survived. The Peace Colony housing estate (originally Vistra), built for the workers of the participating firm Dynamit Nobel, is the oldest that has been preserved. The Stará kolónia (Old Colony), built between 1880 and 1890, consisted of 9 buildings, and in 1913 another 10 buildings were constructed to form the Nová kolónia (New Colony). Its residents also had a woodshop, laundry, and gardens. A residential colony for civil servants was also built during World War II. These buildings were followed by the Vistra Residential Colony, later the Mierová Colony, built between 1947 and 1950. The architecture of the Mierová Colony was proportionally related to contemporary German and Austrian housing estates. Each apartment overlooked a park or countryside, and there were gardens, which still survive today and cover 1.39 ha. New gardens were also created in other open spaces between the apartment blocks. To the south-east of the Mierová Colony, a new allotment garden was created on confiscated agricultural land. Of this area, 2.87 ha of land have been preserved and are still serving their original purpose. The 1.17 ha of land under these allotments was transferred to its heirs in the restitution process in 2020, and the future of these gardens became questionable.

Poster presentation

Biological Mosquito Control in the Morava River Region: A GIS-Based Approach

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Ecological migration has become a vital strategy for mitigating environmental degradation and promoting human well-being in ecologically fragile regions, particularly under the mounting pressures of climate change and resource depletion. This study applies a scientometric approach using CiteSpace to analyze research trends, thematic evolution, and knowledge gaps in ecological migration studies. Based on 343 peer-reviewed articles published between 2006 and 2024, the analysis identifies key drivers, governance models, and post-migration impacts. The findings reveal that ecological migration is shaped by a convergence of environmental drivers (e.g., climate change, land degradation), socioeconomic dynamics (e.g., poverty alleviation, demographic shifts), and policy frameworks. Implementation strategies vary widely, from state-led ecological resettlement to community-driven adaptation, each presenting distinct challenges and opportunities. Post-migration outcomes show significant progress in ecological restoration but highlight disparities in socioeconomic integration and cultural adaptation. Despite these advancements, critical gaps persist, including the absence of long-term impact assessments, limited interdisciplinary collaboration, and a scarcity of comparative regional studies. Addressing these issues, the study advocates for integrated ecological-social-economic frameworks and dynamic monitoring systems to enhance the resilience and sustainability of ecological migration practices.

Poster presentation

List of Poster presentations

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2	1B André Große-Stollenberg, Andreas Hanzl, Mojdeh Safaei, Till Kleinebecker: Dynamics and Condition of Traditional Orchards in a Central European Landscape
3	1B Matteo Dainese, Eleonora Palmeri, Lukas Egarter Vigl, Matteo Anderle, Yael Mandelik, Brenda Maria Zoderer, Verena Radinger-Peer, Livia Madureira, Léa Misiune, Radvila Ringailė-Vojcik, Luis Cayuela, Daniel Paredes: Back to the Future: Traditional Agroforestry Systems as NbS to Face Multiple Societal Challenges (TRANSForm)
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11	1E Ioannis Vogiatzakis: Biodiversity and Ecosystem Services Assessment in Degraded Agroecosystems, the LIFE-AgroOasis Project
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23	2B Sanne Poppeliers, Jelle Visser, Nina Smits, Anne Schmidt, Titus Breuning: Lost in Translation: from Monitoring in the Field to Policy Evaluation
24	2C Sebastian Mikolka-Flory, Erich Tasser, Uta Schirpke, Norbert Pfeifer: Historical oblique images for the documentation of the historical landscape around 1900
25	2C Marianna Bíró, Zolt Molnár, László Demeter, Milan Chytrý, Sándor Bartha, Batdelger Gantuya, Ábel Péter Molnár: The Landscape May not Have Been as Species-Poor in the Ice Age as Previously Thought – a New Hypothesis for Central Europe
26	2C Natália Huraťová, Jolius Vavák, Ivanka Hristova: Archaeobotanical and Archaeological Analysis of a Pit Feature from the Hradisko-Nestšč Site
27	2C Pavel Richter: The Trajectory of Wetlands Development in the Upper Part of the Výchovka River over the Last 180 Years
28	2C Petra Gašparovičová, Natália Huraťová, Veronika Piscová: The Impact of Invasive Plant Species on Biodiversity and Cultural Heritage at Historical Sites (Svätý Jur)
29	2C Edwin Raap: Creating 10% Green and Blue Infrastructure in the Netherlands to Restore Biodiversity and Create an Attractive Landscape: how Heritage and Design Combine
30	2C Mélani Almeida Vera, Jose Delgado Álvarez, Marcos Francos Quijorna, Carla Garcia Lozano, Aarón Moisés Santana-Cordero: Can Cultural Heritage Assets Explain Landscape History?
31	2E Krunoslav Sever, Antonia Vukmirović: Can Fertilization with Phosphorus Mitigate the Negative Impact of Drought on the Photosynthesis of Common Beech and Sessile Oak?
32	2E Pavol Kenderessy: Impact of precipitation on soil moisture variability at sites with presence of historical agrarian landforms (case study Lipovský Teplická)
33	2E Ema Škurlová, Eva Paudisová, Martin Šalkovič: Management of peatlands affected by drainage for agriculture and by climate change
34	2E Ranida Arystanova, Kanat Samarkhanov, Dani Sarsekova, Akmaral Perzadavaeva, Janay Sagin: Multi-criteria analysis applied to locate water accumulation zones in arid Kazakhstan
35	2E Issa Raqmet, Zhuldyzbek Onglassynov, Janay Sagin, Rahimov Timur, Talgat Usmanov: Droughts mitigation by improving the surface-groundwater interactions and sustainable use of the Shelek groundwater deposit in Almaty Region
36	2E Saltanat Jumassultanova, Talgat Usmanov, Murat Qasenuly, Issa Rakhmetov, Janay Sagin: Sustainable Water Management in the Talgar River Basin: Adapting Innovative Approaches for Climate Resilience and Resource Optimization
37	2F Daniela Ribeiro, Mateja Šmid Hribar: The Role of Common Lands in the Provision of Ecosystem Services: A Case Study from Triglav National Park, Slovenia
38	2F Francesco Comalada: Understanding the Spatial Drivers of Cultural Ecosystem Services in Freshwater Landscapes: a Systematic Review
39	2F Anna Kowalska, Ewa Kolaczowska, Edyta Regulka, Jacek Wolski, Zofia Jabs-Sobocińska, Martyna Zarzycka, Bożena Omeliańska, Piotr Sikorski, Andrzej Affek: Assessing Ecosystem Condition and Service Potential under Goldenrod Invasion: Methods and Indicators for a Multifaceted Approach
40	2F Viktória Miklósová: Exploring the Geoecosystem Approach to Ecosystem Services: Case Studies on Water Issues
41	2F Adeeba Rashid, Jana Špulerová: Elements of Green Infrastructure of Agricultural Landscape and Their Ecosystem Services
42	2F Weiwun You, Haiyun Xu, Jiaxuan Duan, Thanasis Kizos: Assessing Spatial Variations in CES Perceptions for Coastal Landscape Management: Urban-Rural Case Study in China
43	2I Ema Švecová: The Regulatory Ecosystem Service of Flood Protection through Hydrological Modeling
44	2I Mojdeh Safaei, André Große-Stollenberg, Till Kleinebecker: Green Strategy toward Sustainable Management of Green Space: A Case Study from Justus Liebig University Gießen
45	2I Renata Włodarczyk-Marciniak, Kinga Krauze, Agnieszka Bednarek, Aleksandra Trzczińska: Can Blue-Green City Design Unlock the Potential of Small Urban Lots? Integrating Cultural and Regulating Ecosystem Services
Theme 3. Responding to Changing Landscapes	
46	3A Piotr Krajewski, Monika Lebedzińska: Assessing the Driving Forces of Landscape Change in the Perspective of Polish Residents
47	3A Csaba Centeri, Alexandra Kruse, Eleni Athanasiadou, Debbie Bartlett, Sebastian Eiter, Martina Kaup, Zdeněk Kučera, Mateja Šmid Hribar, Martina Šlámová, Jana Špulerová, Hans Renes*, Pierre-François Toulzet*: Some Ethical Issues of European Agricultural Landscapes - the EUCLAND Approach
48	3B Evelyn Asante Yeboah: Integrating Socio-Spatial Approaches for Sustainable Multifunctional Landscapes: Insights from Southwestern Ghana
49	3B Federica Larcher, Paola Gullino, Enrico Pomatto: How Can Farmers Contribute to Enhance Peri-Urban Landscape Assessment? The Case Study of Stupinigi Royal Natural Park (Metropolitan City of Turin, Italy)
50	3B Jana Špulerová, Marta Dobrovodská: FarmBioNet - Farmer-focused Biodiversity and Agricultural Knowledge Network
51	3B Peter Bežák, Magdaléna Bežáková, Pavol Purgat, Eva Schlimbachová, Ľuboš Halada, Zuzana Baránková: Towards Agro-ecological Practices in the Context of the CAP in Slovakia: Initial Socio-Ecological Research at the Farm Level
52	3D Hana Vavroučová, Hana Štředová, Bronislava Špálčlová: Ecological Planning and Design Education Network for Environmental Safety through Sustainable Landscape Structure
53	3E Ivana Bajkovičová, Eva Paudisová: The Principles of Integrated Water Management in Slovakia
54	3F Tomáš Janík, Vladimír Zýka, Barbora Mrkviňová, Jaroslav Vojta, Michal Andreas, Marie Vymazalová, Olha Kachalova, Markéta Santrůčková, Alois Vokoun, Dušan Romportl: Priorities for Enlarging Czech National Parks and Protected Landscape Areas
55	3F Milena Moyzevová: Conflicts of Interest as a Significant Aspect in Proposals for Planting Non-forest Woody Vegetation to Support Ecological Stability in the Cultural Landscape
56	3F Andrzej N. Affek, Colson Tidkis, August Easton-Calabria, James D. Crall: Bumblebee Response to Flooding Events
57	3F Edyta Regulka, Vladimír Šimanský, Bogusława Kruczkowska, Jan Horák: Impact of Aged Biochar on Earthworm Communities (Lumbricidae) in Field Conditions
58	3F Francesco Piras, Antonio Santoro, Marta Allegri, Federica Romano, Mauro Agnoletti: The Importance of Traditional Rural Landscapes for Biodiversity Preservation: the Case of the UNESCO Site of the Prosecco Hills of Conegliano and Valdobbiadene (Italy)
59	3H Irene Ardito: Sense of Place as a Participatory Planning Tool to Develop Socioecological Resilience in River Territories at Hydrogeological Risk
60	3M Igor Dukay: Integrating of the Downtown Section of Bükkös Stream (Szentesend) in the Blue and Green Infrastructure Network
61	3M Ulrike Haase: ReBioClim - Restoring Urban Streams to Promote Biodiversity, Climate Adaptation and to Improve Quality of Life in Cities
62	3N Mette Vestergaard Odgaard, Tommy Dalgaard, Troels Kristensen, Sara Vangerschov Iversen: A Geospatial Approach to Assess Multiple Benefits of an Alternative Beef System
Theme 4. Advancing with New Data, Tools and Methods in Landscape Ecology	
63	4A Susana Suárez-Seoane, Daniel Pflitzer-López, Lucía García-Candanedo, Miguel Menéndez-Rodríguez, Jose Valentín Róces-Díaz: Landscape Mosaic Typologies as Nature-Based Solutions for Fire Risk Mitigation under Atlantic Conditions
64	4A Martina Sychrová: Historical and Contemporary Analysis of Landscape Heterogeneity: Methods and Challenges
65	4A Selina Gattiker, Dominique Weber, Céclie Nyffeler, Karina Liechti, Stephan Schneider, Lina Torregróza, Christian Ginzler, Marcel Hunziker: Towards a Comprehensive Landscape Character Typology: Method Development and Prototype for a Novel Swiss Landscape Characterisation
66	4A Georgios Lamproukopoulos, Fotios Lempesis, Androniki Tsouchlaraki, Dimitrios Alexakis: Assessing Ecological Dynamics and its Association with Socio-Economic Factors Utilizing the Remote Sensing Ecological Index (RSEI) and the Geographical Detector Method: A Case Study of Crete, Greece
67	4A Ivana Kozelová: Comparison of Detailed and Less Detailed Mapping of Landscape Fragmentation. Case Study Skalica District, Slovakia
68	4A Eric Koszcor, Matthias Forkel, Anna Cord: Mapping Agricultural Landscape Structure Over Six Decades: Automatic Field Segmentation Using Historic and Modern Remote Sensing Data
69	4A Viliam Pechanec, Peter Mederly, Pavel Cudlin, Michal Ševčík, Karel Macků, Jiří Jakubinský: Assessment of Landscape Vulnerability in the Czech-Slovak Border Region Using Manual Approaches
70	4B Léa Savary, Cédric Buron, Pierre Pouzet, Thierry Le Pors, Mohamed Maanan: Applying Machine Learning to Anticipate Crisis Management of Marine Submersion Events
71	4B Alexandra Jiricka-Pürer: The Role of AI in Spatial Energy Planning - to Tackle Both the Climate and Biodiversity Crisis
72	4B Momiř Polák: Detection of Asbestos-Cement Roofing Materials Using Image and Laboratory Spectroscopy in the Krkonoše Mts.
73	4C Roman Cimerman: The Use of LiDAR for Determining Urban Vegetation Parameters in the City of Zvolen
74	4C Anna Iglseder, Sebastian Mikolka-Flory, Markus Hollaus: Automated Detection of Dry Stone Walls in Terraced Landscapes Using Airborne Laser Scanning Data
75	4E Stefanos Boutos, George Kefalas, Roxanne Suzette Lorilla, Vassilis Detsis, Panteleimon Xofis, Evangelia Drakou: Landscape Patterns as a Storyteller. Tree Line Shifts in the Greek Mountains
76	4E Stepan Hima: Projected Impacts of Climate Change and Natural Disturbances on the Dynamics of European Beech (Fagus sylvatica L.) Forests
77	4E Maša Zorana Ostrogović Sever, Laura Dobor, Jan Merganić, Doroteja Bitunjac, Hrvoje Marjanović, Tomáš Hlasiň, Mislav Anić, Dora Hidy, Zoltán Barcza, Ivan Barka, Katarina Merganićová: Application of Biome-BGCMuSo Model at the Country-Scale of Croatia and Slovakia
78	4E Doroteja Bitunjac, Maša Zorana Ostrogović Sever, Katarina Merganićová, Darko Bakšić, Dora Hidy, Zoltán Barcza, Hrvoje Marjanović: Modelling Forest Soil Organic Carbon Dynamics with Biome-BGCMuSo Model
79	4E Sabica Naz, Tomáš Rusňák, Ľuboš Halada: A Comparative Assessment of Vegetation Indices Based on RGB Bands of Phenocams Imagery in Bab Forest
80	4E Elzbieta Ziolkowska, Elena Fini, Xiaodong Duan, Michal Filipiak, Jacek Jachula, Zuzanna Filipiak, Aleksandra Walczyńska: Modelling of Flowering Phenology to Support the Prediction of the Spatio-Temporal Availability of Floral Resources for Pollinators in Human-Altered Landscapes
81	4G Anuana Kezheneva, Ranida Arystanova, Saltanat Jumassultanova, Kyrgyzbay Kudaibergen, Dani Sarsekova, Akmaral Perzadavaeva, Janay Sagin: Remote Sensing-Based Assessment of Agricultural Land Use
82	4H Ewa Kolaczowska, Bożena Omeliańska, Anna Kowalska, Martyna Zarzycka, Jacek Wolski, Edyta Regulka, Anna Foks-Ryznar, Emil Wrzosek, Andrzej Affek: Ground Truth vs. Aerial Insight: Overcoming Challenges in Detecting Invasive Goldenrods in Poland Using UAV Imagery
83	4H Mélanie Almeida Vera, Jose Delgado Álvarez, Marcos Francos Quijorna, Carla Garcia Lozano, Aarón Moisés Santana-Cordero: Can Cultural Heritage Assets Explain Landscape History?
84	4I Maria Zachwatowicz: Teaching landscape ecology – returning to the roots, staying up to date or exploring new approaches?
85	4I Marc Deconchat, Aude Emoult, Laurent Berges, Solène Croci, Cendrine Mory, Sébastien Bonthoux, Audrey Algnier, Aude Zingraff-Hamed, Stéphanie Aviron, Cécile Albert, Nadia Michel, Clélia Sirami: Importance of the User-Friendly Web Online Platform for Rural Regions Support in Kazakhstan
86	4I Orazbek Zhanatayev, Ranida Arystanova, Saparova Nazira, Taimas Nurseit, Janay Sagin: Dynamics of Landscape Ecology Research Questions in French Thesis
87	4I Raushan Amanzholova, Abzal Kalygulov, Ranida Arystanova, Sholpan Kulbekova, Ainur Urkembayeva, Galymzhan Aliaskarov, Saule Kaidalova, Janay Sagin: GIS Tools Applications for Landscape Climate Changes Emergency Mitigation Programs
88	4J Martin Boltziar: Assessing Current Use and Visions for Sacral Complexes in a Landscape: An Example from Central Europe
89	4J Janusz Lach: The Essence of the Wallachian Genome of Shepherd Landscapes of the Western Carpathians – Contemporary Threats to Maintaining Cultural Continuity
90	4L Weiwun You, Haiyun Xu: Knowledge Mapping of Ecological Migration Applied to Environmental Drivers, Governance Models, and Post-Migration Effects - A Scientometric Review with CiteSpace
91	4L Ivan Baláz, Jakub Košša, Zuzana Poláčiková, Peter Klimant: Changes of the Small Mammal Community after the Arrival of the Striped Field Mouse
92	4L Daniela Babicová, Ivana Kozelová: Mierová Colony: History, Present and Perspective of the Exceptional Bratislava Green Housing Estate
93	4L Adam Rusinko, Martin Obuch, Mária Rajecká, Zdenka Mrázová, Samuel Ferenczi: Biological Mosquito Control in the Morava River Region: A GIS-Based Approach

Congress Programme

Monday 1 September	Time schedule							
	15:30 - 19:30	Registration and information - entrance of the Faculty						
	16:00 - 18:00	Working Group Landscape planning (Room C - B1-305)						
	13:30 - 18:30	IALE 2025 PhD course - Room E (AMOS)						
	18:00 - 19:30	Welcome drink - lobby of the Faculty						
Tuesday 2 September	Time schedule	Main Hall 1 (CH1-1)	Main Hall 2 (B1-301)	Room A (CH1-2)	Room B (CH1-3)	Room C (B1-305)	Room D (B1-307)	Room E (AMOS)
	7:30 - 18:00	Registration and information - entrance of the Faculty						
	8:30 - 9:00	Congress opening						
	9:00 - 10:30	Keynote presentations						
	10:30 - 10:50	Coffee break - lobby of the Faculty						
	10:50 - 12:20	3B (1/3)	2F (1/3)	1D (1/2)	1C	1B (1/2)	2E (1/2)	4K - W
	12:20 - 14:00	Lunch - Družba cantina						
	14:00 - 15:30	3B (2/3)	2F (2/3)	1D (2/2)	3C	1B (2/2)	2E (2/2)	3H (1/2)
	15:30 - 15:40	Break						
	15:40 - 17:10	3B (3/3)	2F (3/3)	1F	4I	4G	2A	3H (2/2)
	17:10 - 17:30	Coffee break - lobby of the Faculty						
	17:30 - 18:30	Poster session						
	18:30 - 19:30	IALE General Assembly						
Wednesday 3 September	Excursion day							
Thursday 4 September	Time schedule	Main Hall 1 (CH1-1)	Main Hall 2 (B1-301)	Room A (CH1-2)	Room B (CH1-3)	Room C (B1-305)	Room D (B1-307)	Room E (AMOS)
	8:30 - 9:20	Keynote presentation						
	9:20 - 9:30	Break						
	9:30 - 11:00	2I (1/2)	3M (1/2)	4C	2D (1/2)	2G	2C (1/2)	4D
	11:00 - 11:20	Coffee break - lobby of the Faculty						
	11:20 - 12:50	2I (2/2)	3M (2/2)	2B (1/2)	2D (2/2)	4B	2C (2/2)	3L (1/2) W
	12:50 - 14:50	Lunch - Družba cantina						
	14:50 - 16:20	3F (1/4)	4A (1/4)	2B (2/2)	3I	2H - W	4J - W	3L (2/2) W
	16:20 - 16:40	Coffee break - lobby of the Faculty						
	16:40 - 16:55	Congress Group Photo (outdoor)						
	18:30 - 23:00	Congress dinner - Hotel Double Tree by Hilton						
Friday 5 September	Time schedule	Main Hall 1 (CH1-1)	Main Hall 2 (B1-301)	Room A (CH1-2)	Room B (CH1-3)	Room C (B1-305)	Room D (B1-307)	Room E (AMOS)
	8:30 - 10:00	3F (2/4)	4A (2/4)	1E	3K	3E	4E	4H (1/3) W
	10:00 - 10:20	Coffee break - lobby of the Faculty						
	10:20 - 11:50	3F (3/4)	4A (3/4)	3D (1/2)	3G	3J (1/2)	3A	4H (2/3) W
	11:50 - 13:30	Lunch - Družba cantina						
	13:30 - 15:00	3F (4/4)	4A (4/4)	3D (2/2)	3N	3J (2/2)	4F	4H (3/3) W
	15:00 - 15:20	Coffee break - lobby of the Faculty						
	15:20 - 16:20	Congress closing						

Notes: W - workshop; (x/1), (x/2)..., session divided into several blocks



Congress Excursions

1. Great Lel Inner Island
2. UNESCO's Landscape: Lower Morava Biosphere Reserve and Lednice-Valtice Cultural Landscape
3. Protected Landscape Area Pálava
4. Devin Castle and National Nature Reserve Devinska Kobyla
5. Tracing the history of the viticulture landscape in Svätý Jur and the roots of the IALE history
6. Exploring the Agricultural Landscape of Slovakia
7. Banská Štiavnica – mining landscape
8. Changes and potentials of the urban environment
9. Bratislava Forest Park
10. Bratislava city tour

Congress Photo



Partners



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