# BOOK OF ABSTRACTS

This Book of Abstracts provides a comprehensive overview of the session content and is structured into three main sections:

**I. Session Description –** an introduction to each session, including its objectives and expected outputs
**II. Session Program –** a detailed schedule for each session, including speakers and timing
**III. List of Abstracts –** a complete compilation of all accepted abstracts

## I. SESSION DESCRIPTION

ID: X12

### Ecosystem-oriented approaches for urban, peri-urban and environmental resilience under Climate Change

Hosts:

| | Name | Organisation | E-mail |
|---|---|---|---|
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Abstract:
In advancing global sustainability objectives, Europe has set climate change mitigation and adaptation as key principles for promoting sustainable and resilient human settlements.

In this context, the potential of ecosystem restoration has long been acknowledged in the scientific debate, particularly for its capacity to foster simultaneous protection and enhancement of ecosystems while supporting human activities. Integrating the ecosystem services approach into climate and energy planning thus promotes strategies that are environmentally effective, socially equitable and economically viable. This also aligns with the broader goal of sustainable development.

However, although ecosystems' health and the services they provide are currently recognized as crucial elements to be safeguarded and enhanced along the urban-rural-natural gradient, evidence shows that they are experiencing a steady decline across Europe. This trend, as evidenced by the IPBES (2019) and MAES (2020) reports, heightens the exposure and vulnerability of both urban and rural areas to extreme events, thereby exacerbating a negative feedback loop that undermines the security and well-being of local communities.

This decay can be partially explained by the operational and knowledge gaps that still prevent such solutions from being properly implemented in the processes and interventions shaping modern urban areas. According to the European Climate Risk Assessment (2024), a poor understanding of the relationship between urban resilience and ecosystem services, as well as the interactions between climate change, urbanization, and socio-environmental factors, remains a significant issue. These barriers to the correct

implementation of ecosystem-oriented approaches can be related to different interpretations, priorities, terms, and intervention strategies.

The objective of this session is to foster lateral thinking and stimulate innovative and cross-sectoral perspectives on the design and implementation of ecosystem-based approaches, to advance their role in climate change adaptation and mitigation. The session aims to bring together contributions on ecosystem-based adaptation (EbA), urban adaptation plans, disaster risk reduction measures, and ecosystem restoration initiatives, focusing on approaches that deliver measurable and tangible ecosystem benefits to human well-being. A particular focus will be related to:

- The interplay between recent European frameworks (including e.g. Nature Restoration Regulation; EU Adaptation Strategy; EU Biodiversity Strategy 2030) and the opportunities they create for advancing sustainable, climate-resilient urban and rural development through ecosystem-oriented thinking.
- Approaches that generate reflections and insights into the synergistic use of both emerging and well-established technologies (e.g. Artificial intelligence, remote sensing data, geographic information systems), to support decision–making processes and planning ecosystem-oriented solutions for risk reduction and climate change adaptation and mitigation.
- Studies on urban biodiversity through participatory planning actions and effective management models that represent a key pathway for sustainable urban development for Climate Change adaptation. A thorough understanding of urban ecosystem dynamics is a fundamental prerequisite for designing and implementing resilient urban regeneration strategies.
- Development of methodological approaches and assessment frameworks to evaluate the effectiveness of Nature based Solutions (NbS) and ecosystem-oriented approaches, while providing guidance for their effective incorporation into ordinary planning practices.

## Goals and objectives of the session:

The aim of this session is to foster lateral thinking and stimulate innovative, cross-sectoral perspectives on the design and implementation of ecosystem-based approaches, with the aim of advancing their role in climate change mitigation and adaptation.

Main objectives are:

- Exploring the interplay between policy and planning frameworks on climate, environmental, and social issues, and assessing how these frameworks create opportunities for implementing sustainable, ecosystem-oriented solutions at the local and regional levels
- Showcasing contributions that stimulate debate on strengthening urban and rural resilience while promoting biodiversity and enhancing human well-being
- Presenting methodological approaches and assessment frameworks to evaluate the effectiveness of nature-based and ecosystem-oriented solutions, providing recommendations for better integration into planning practice and decision-making processes

## Planned output / Deliverables:

The session aims to produce an edited volume gathering the contributions of the participating authors, to further disseminate knowledge, case studies, and policy insights emerging from the discussions.

## Session format:

Session format will follow the structure of a Scientific debate. Contributions will be presented in a maximum time span of 10-15 minutes. The scientific debate will take place after the presentations and will be supported by the questions that emerged from the participants during the ongoing presentations, as well as by the ones previously calibrated by the session hosts (by analysing the contributions presented in the session).

The estimated duration will depend on the number of contributions presented.

## Related to ESP Working Group:

Other

## II. SESSION PROGRAM

**Room:** C1
**Date of session:** Friday, 22 May 2026
**Time of session:** 11:00-15:30

**Timetable speakers:**

| Time | First name | Surname | Organization | Title of presentation |
|---|---|---|---|---|
| | Emmanuel | Kodwo Sackey | Centre for Climate Change and Sustainability Studies, University of Ghana, Legon, Ghana | Urban Ecosystem services under pressure: advancing community-led green infrastructure in Sekondi-Takoradi,Ghana |
| | Yinuo | Zhou | Eindhoven University of Technology | Modelling stakeholder-driven nature land dynamics: the case of the Randstad, Netherlands |
| | Anton | Shkaruba | PhD student, Department of Sustainable Energy and Environmental Engineering, The University of Osaka, Osaka, Japan; Department of Environment and Forest Engineering, Environmental Engineering Laboratory and Institute for Sustainable Development, National University of Mongolia, Ulaanbaatar, Mongolia | Constrasting percpetions of ecosystem services, disservices, and quality of life across demographic groups in urban green spaces |
| | Leonard | Nzabonantuma | Lund University | Evaluating the performance and cost-effectiveness of nature-based solutions in freshwater ecosystems: insights from the Nyabarongo Catchment, Rwanda |
| | Viviana | Pappalardo | Department of Civil Engineering and Architecture, University of Catania | Nature-based solutions scnearios design: guiding consideratios on modelling tools and spatial simulation criteria |
| | Dagmar | Haase | Humboldt University Berlin and Helmholtz Centre for Environmental Research UFZ | Green-blue sponge city in existing housing stock – more of a dream or reality? |
| | Sabrina | Lai | Department of Civil & Environmental Engineering, and Architecture - University of Cagliari | A regional-scale method for ecosystem service hotspot identification: an empirical assessment from Southern Italy |
| | **Afternoon slot** | | | |

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|---|---|---|---|---|
| | João | David | Humboldt-Universität zu Berlin, Landscape Ecology Lab | What do we really know? Identifying research frontiers and gaps in urban ecosystem services under environmental pressures |
| | Danial | Owen | UK Centre for Ecology & Hydrology | Vulnerability of urban nature-based solutions to climate-related hazards and implications for ecosystem services: a rapid review |
| | Bau-Show | Lin | National Taiwan University | Remote sensing-based modelling of climate regulation services of urban green infrastructure and its application for decision support |
| | Megan | Critchley | Basque Centre for Climate Change | Understanding vulnerability and enhancing resilience to hotter summers in rural mountain communities, an interdisciplinary approach |
| | Zixin | Sun | Department of Civil and Environmental Engineering, Graduate School of Engineering, Nagoya University, Furo-cho, Chikusa-ku, Nagoya, 464-8601, Japan. | Investigating spatial and ecological patterns of forests in urban and peri-urban areas |
| | Jakob | Bogenreuther | Professorship of Ecological Services, Bayreuth Center of Ecology and Environmental Research (BayCEER), University of Bayreuth, Universitätsstr. 30, 95440 Bayreuth, Germany. | Ecosystem services under heat and drought: agricultural management to balance crop yield, erosion, and nutrient regulation |
| | Firat | Caglar Yilmaz | Pamukkale University | Tourism-driven landscape change and cultural ecosystem service trade-offs on Bozcaada Island assessed through landscape metrics and InVEST modelling |

## III. LIST OF ABSTRACTS

*The first author is the presenting author unless indicated otherwise*

### 1. Urban Ecosystem Services under Pressure: Advancing Community-Led Green Infrastructure in Sekondi-Takoradi, Ghana

***First author***: Emmanuel Kodwo Sackey
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Urban ecosystem services are increasingly threatened in rapidly expanding African cities, particularly secondary cities where urban growth often outpaces planning and governance capacity. In Ghana, the Sekondi-Takoradi Metropolis has experienced accelerated urbanisation driven by oil-related development, infrastructure expansion, and population influx. This growth has resulted in extensive conversion of vegetated land, wetlands, and other natural ecosystems, undermining the delivery of critical urban ecosystem services.
This study examines how rapid urbanisation in Sekondi-Takoradi is reshaping urban ecosystem services and evaluates the implications for developing green, resilient cities through participatory governance. Using spatio-temporal land use and land cover analysis, the research quantifies patterns of urban expansion and associated ecosystem loss, with a focus on declining green spaces and ecologically sensitive areas. Population growth trends are analysed alongside land cover changes to illustrate how unplanned urban development erodes regulating and cultural ecosystem services such as heat regulation, flood mitigation, air purification, and recreational space.
The study argues that conventional, top-down urban planning approaches are insufficient to halt ecosystem degradation in fast-growing secondary cities. Instead, it highlights the need for community-led green infrastructure strategies that actively involve residents, traditional authorities, and grassroots organisations in protecting, restoring, and co-managing urban ecosystems. Such participatory approaches are essential for sustaining urban ecosystem services, enhancing local stewardship, and ensuring socially inclusive green city transitions.
This study contributes place-based evidence to support ecosystem-based urban planning in African cities, by situating Sekondi-Takoradi within broader debates on urban ecosystem services and participatory governance. The findings aim to inform policy and practice on integrating green infrastructure and community engagement into sustainable urban development pathways.

***Keywords***: Urban ecosystem services; green infrastructure; participatory governance; urbanisation; Ghana

## 2. Modelling stakeholder-driven nature land dynamics: The case of the Randstad, Netherlands

***First author***: Yinuo Zhou
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Nature areas provide critical ecosystem services (ES) such as climate regulation, biodiversity support, recreation, and flood mitigation, whose provision is directly linked to the spatial allocation, quantity, and quality of nature land. These characteristics of nature land are shaped not only by environmental conditions but also by human (interactive) decision-making and governance structures. However, most land-use models represent nature land changes as a spatial or environmental process, with limited consideration of how they are influenced by stakeholder interactions and institutional constraints.
To address this gap, this study develops a multi-stakeholder land-use competition (SI-LUC) model that integrates stakeholder decision-making and negotiation processes into a multi-type land-use competition framework. We applied the model to the Randstad metropolitan region (2012–2023) to simulate nature land dynamics beyond conventional biophysical-driven land-use models, explicitly incorporating stakeholder decision-making and governance constraints.
The validation result shows that SI-LUC improves simulation accuracy by around 5% in global Figure of Merit (FoM) compared with a conventional patch-generating land use simulation (PLUS) model. Sensitivity analysis shows that stakeholder-related parameters, such as negotiation costs and agreement thresholds, strongly influence nature land changes, demonstrating the importance of human interactive decision-making in shaping nature conservation outcomes. Scenario analysis further demonstrates SI-LUC's capacity as a virtual policy laboratory for exploring long-term impacts of alternative governance strategies. By linking stakeholder interactions to spatial nature land outcomes, the model supports more informed and effective land-use planning in complex metropolitan regions, helping to protect nature land and enhance the ES it provides.

***Keywords*:** nature land planning, nature land simulation, nature governance, ecosystem service provision, stakeholder decision-making

### 3. Contrasting Perceptions of Ecosystem Services, Disservices, and Quality of Life across Demographic Groups in Urban Green Spaces

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As urbanization continues to expand, cities increasingly face negative impacts on human health and the environment, particularly due to limited access to urban green spaces (UGSs) that support urban quality of life (QOL). Understanding how different social groups perceive ecosystem services (ESs) and disservices (EDSs) is essential for informing urban planning and management. Incorporating socio-demographic characteristics into UGS planning can support more inclusive, equitable, and context-sensitive strategies for enhancing ecosystem benefits while addressing perceived disservices. This study investigates perceptions of ESs, EDSs, and QOL across two contrasting UGSs in Ulaanbaatar, Mongolia: a multifunctional urban park (National Garden Park, NGP) and a suburban natural area within the Bogd Khan Mountain Strictly Protected Area (BGS), based on a questionnaire survey of 594 visitors. The results revealed clear demographic patterns in ecosystem perceptions across both UGSs. While UGS type was a key driver of ES perceptions, overall ES perceptions were primarily influenced by distance and visit duration, whereas overall EDS perceptions were more strongly associated with visit duration and awareness of terms. Older visitors, retirees, visitors from distant areas, and those with longer stays reported higher perceptions—particularly in BGS—along with higher perceived QOL. In contrast, younger visitors and lower-income and lower-education groups placed greater value on social interaction benefits. EDSs differed by site and visitor group: allergies were more frequently reported by nearby residents and were more strongly associated with NGP, while concerns related to unsafety and insecurity were more prominent in BGS, especially among visitors with higher awareness of ES and EDS. Anti-social behaviors and conflicting uses were perceived in both UGSs, with specific disservices varying across demographic groups. Overall, higher ES perceptions were positively associated with perceived QOL, whereas stronger EDS perceptions were linked to lower QOL, demonstrating that ES perceptions directly contribute to visitor well-being across different UGS contexts.

***Keywords*:** ecosystem services and disservices; urban green spaces; demographic characteristics; quality of life; and visitor perceptions**Evaluating the Performance and Cost-**

### 4. Effectiveness of Nature-Based Solutions in Freshwater Ecosystems: Insights from the Nyabarongo Catchment, Rwanda

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Freshwater ecosystems in the Nyabarongo catchment, Rwanda, encompassing both rural and urban areas, provide essential ecosystem services, including flood risk regulation, water provision, and livelihood support. However, these systems are increasingly degraded as a result of inadequate stormwater management, rapid urban expansion, and unsustainable land-use practices. In this context, this study integrates ecosystem restoration strategies, economic valuation, and nature-based solutions (NBS) to inform policy development and decision-making processes.
The study adopts a structured survey, integrating stakeholder surveys with expert interviews to evaluate the implementation and performance of NBS across the Nyabarongo catchment. Community-based

questionnaires assess the types and spatial distribution of NBS interventions such as wetland and riparian restoration, their perceived effectiveness in flood mitigation and livelihood enhancement, as well as challenges related to operation, maintenance, and monitoring. In parallel, expert consultations focusing on blue-green infrastructure (BGI) planning in Kigali examine stakeholder roles and institutional arrangements, site-selection criteria, hybrid NBS-grey infrastructure strategies, evaluation indicators encompassing hydrological, ecological, and socio-economic dimensions, and key knowledge and implementation gaps.
Findings indicate that local communities widely recognize the effectiveness of NBS in addressing environmental challenges, particularly flash flood mitigation and erosion control. Nevertheless, implementation is constrained by limited financial resources, technical capacity gaps, weak institutional coordination, and insufficient long-term maintenance and monitoring frameworks. Experts further emphasize the importance of hydrology-based, context-specific NBS selection and improved quantitative performance indicators, such as runoff reduction, alongside stronger stakeholder integration.
Economic valuation demonstrates that NBS generate cost savings through avoided flood damages and enhanced agricultural productivity, thereby outperforming conventional grey infrastructure in terms of cost-effectiveness. The study recommends hydrologically aligned catchment governance, formalized BGI planning frameworks, and hybrid solutions to strengthen resilience. By linking stakeholder perspectives, valuation approaches, and performance assessments, this research supports the scalable adoption of NBS to enhance ecosystem services and climate adaptation in Rwanda.

***Keywords***: Freshwater ecosystems, Nature-Based Solutions, Flood Risk Management, Economic valuation, Blue-green infrastructure.

## 5. Nature-Based Solutions scenarios design: guiding considerations on modelling tools and spatial simulation criteria

***First author***: Daniele La Rosa
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Modeling Nature-Based Solutions (NBS) in urban areas is a relevant step for informing spatial planning and integrating natural processes and ecosystems into urban transformations. Simulation of NBS scenarios is also crucial for visualizing potential spatial heterogeneity and trade-offs among the benefits these solutions can generate.
Different spatial configurations of NBS can optimize the environmental performance of an urban area. However, decisions regarding NBS design require careful consideration of several key criteria to ensure their effectiveness, feasibility, and acceptance.
This paper reviews the current understanding of NBS modeling and proposes a hierarchical approach to inform NBS scenario planning and design, in relation to different types of urban issues.
As a first step, we integrate the InVEST Urban Cooling model and the SWMM model to identify geographical demands for urban heat island mitigation and stormwater runoff reduction. Simulation results across the case study areas are based on existing land cover patterns and urban morphologies, which determine current capacities to cope with high temperatures and surface stormwater flooding.
Subsequently, we mapped spatial opportunities for the implementation of NBS, focusing on solutions for urban cooling and reduction of runoff volume and flow rate.
The study identified multiple determinants influencing NBS-oriented land use transformations and built upon modeling simulation results to define a comprehensive set of planning and design criteria for NBS scenarios implementation, including environmental justice principles, policy opportunities, urban morphologies, urban transformation strategies, site-specific constraints, current land uses, and priority performance targets.
As a result, spatial NBS scenarios that align with local socio-ecological characteristics and address key urban challenges are proposed, alongside a discussion of the cost-effectiveness of different NBS configurations. The research focuses on two areas of Naples and Catania, in southern Italy, selected as

case studies within the Project "Nature for sustainable cities: planning cost-effective and just solutions for urban issues", PRIN 2022, funded by European Union, Next Generation EU.

***Keywords***: nature-based solutions; scenario modelling; regulating ecosystem services; decision support systems

## 6. Green-blue sponge city in existing housing stock – more of a dream or reality?

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This paper looks at the idea of the 'sponge city' and why it is important in dealing with climate change. It asks whether it is possible and useful to add "sponge city" elements to existing urban neighbourhoods. It also looks at how sponge city ideas could be used in different neighbourhoods and how they might affect the local climate and water storage. Information collected during fieldwork in two districts of Leipzig, Germany – one old and built-up, and the other prefabricated – provides a great overview of urban elements that match the sponge city properties. The prefabricated district of Paunsdorf has a lot more and larger flat roof systems, green spaces, urban trees, and in-situ gravel drainage beds. The Southern Suburb has more paved road surfaces, buildings with pitched roofs and smaller green spaces. The study shows that, because of these natural features, prefabricated housing estates have the potential to be designed in a way that is sensitive to water. Green roofs can reduce the amount of water that runs off buildings by 90%. This is important because green roofs cover a large area of the city. In both areas, it was found that changing the surface finish of parking areas led to a significant increase in infiltration when changing recent asphalt or composite pavers. Using grass pavers would reduce the amount of water that runs off the site, allow more water to soak into the ground, and have a really positive effect on heat and storms in towns and cities. The results of this pilot case study show how designing and implementing "green-blue" approaches can help cities adapt to and reduce the effects of climate change.

***Keywords***: Ecosystem-oriented approaches for urban, peri-urban and environmental resilience under Climate Change

## 7. A regional-scale method for ecosystem service hotspot identification: An empirical assessment from Southern Italy

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The assessment of ecosystem services (ESs)—encompassing both tangible resources and intangible benefits fundamental to human survival and the enhancement of well-being—is a key element of spatial planning practices. Through the regulation of land-use change, spatial planning has the capacity to alter ecological structures and processes in both urban environments and natural or semi-natural systems. These alterations directly affect the provision of ESs, with consequences for environmental quality and human welfare. Within this context, the present study proposes a methodological framework for identifying ES hotspots, defined as spatially identifiable areas characterized by particularly high levels of ES supply, with the aim of fostering more ecologically sound planning approaches.
The proposed methodology is articulated in two phases. The first involves a biophysical evaluation of three core regulating ESs: habitat quality, representing the ability of ecosystems to sustain biological diversity; carbon storage and sequestration, reflecting the contribution of ecosystems to climate change mitigation via greenhouse gas absorption; and land surface temperature, used as an indicator of the thermal regulation capacity of vegetated areas. The second phase focuses on the delineation of ES hotspots through the integration of multiple spatial statistical methods, thereby enhancing the robustness of the results and reducing the sensitivity inherent to individual techniques.
Applied to the southern Italian regions of Campania and Basilicata, the framework enables a comparative analysis of the extent, spatial arrangement, and distribution patterns of ES hotspots. The approach can be adapted to any context where relevant biophysical data are available, and it offers planners and decision-

makers a reliable, evidence-based tool to inform more sustainable and territorially responsive planning strategies.

***Keywords***: Climate neutrality, Regional planning, Regulating ecosystem services, Biophysical assessment, Hotspots

## 8. What Do We Really Know? Identifying Research Frontiers and Gaps in Urban Ecosystem Services Under Environmental Pressures

***First author***: João David
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Urban ecosystem services (UES) research is expanding rapidly, yet the robustness of its evidence base under accelerating climate change (CC) and land-use pressures remains unclear. Many studies mention both drivers, but it is unresolved whether they are analysed as testable exposures, including CC and land-use interactions, or referenced contextually, limiting evidence-based urban planning. Fundamental questions persist: How do climate and land-use drivers interact to shape UES outcomes? Where are the critical gaps, inconsistencies, and missing links in the literature?
We conducted a global systematic review following CEE and ROSES standards, developing the CoPEOS framework (Context–Population–Exposure–Outcome–Study type) to separate ecological context from spatial setting and to treat CC and land-use pressures as analytical exposures requiring empirical or scenario-based evidence. Searches in Scopus and Web of Science retrieved over 3,500 unique records. Screening combined machine-learning prioritisation with ASReview and independent reviewer assessment using predefined eligibility criteria. For each included paper, we coded the UES examined, city context and world region, the climate and land use pressures considered, study approach and indicators, CC×land-use interactions, and links to planning or governance.
The review delivers: (1) a global evidence map showing where UES research is concentrated versus missing across service types, urban contexts, and regions; (2) priority gaps in understudied services, spatial and temporal scales, and explicit climate–land use interactions; and (3) explanations for divergent findings, linking inconsistencies to differences in metrics, scales, exposure definitions, and study designs. By revealing where knowledge is robust versus fragmented, redundant versus absent, and where critical links remain missing, this synthesis sets priorities for advancing UES science and strengthens pathways from ecosystem services evidence to urban planning and governance under accelerating environmental change.

***Keywords***: Systematic review; Knowledge gaps; Research frontiers; Land-use changes; Climate change

## 9. Vulnerability of Urban Nature-Based Solutions to Climate-Related Hazards and Implications for Ecosystem Services: A Rapid Review

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A growing body of evidence has demonstrated the effectiveness of urban nature-based solution (NbS) in mitigating and adapting to climate change through the delivery of ecosystem services (ES). Urban NbS, such as parks and street trees, provide cities with a range of important ES, including heat and flood regulation. The importance of these ES in urban areas is increasingly evident for several reasons. First, the intensity, duration, frequency, and spatial distribution of climate-related hazards are projected to increase. Second, most of the world's population lives in urban areas, where certain hazards, such as heatwaves, are exacerbated by phenomena such as the urban-heat island. Despite this, far less attention has been paid to how NbS themselves and the ES they provide are affected by climate-related hazards. In this study, we conducted a structured rapid evidence assessment to explore the impacts of four climate-related hazards (extreme heat, rain, wind, and drought) on different typologies of urban NbS. We find that

climate-related hazards can have profound impacts on the health and functioning of urban NbS, with both direct and indirect implications for ES provision. For example, extreme heat affects plant physiological processes and causes physical damage, inhibiting key mechanisms through which NbS deliver cooling services, such as transpiration and shading. This presentation will highlight the main findings on the mechanisms by which each of the four climate-related hazards impacts urban NbS and their associated ecosystem services, contributing to improved understanding of NbS resilience and the future vitality of urban areas under a changing climate.

***Keywords***: Urban, Ecosystem Services, Nature-based Solutions, Climate Change, Natural Hazards

## 10. Remote sensing–based modeling of climate regulation services of urban green infrastructure and its application for decision support

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Against the backdrop of climate change and the increasing frequency of extreme heat events, heat risk in urban areas has become a critical challenge affecting human health and urban environmental resilience. The climate-regulation ecosystem services provided by urban green infrastructure are widely recognized as key nature-based solutions for mitigating urban heat stress. However, current urban planning and policy-making processes often lack spatially continuous, comparable, and operational quantitative evidence to support investment decisions and the prioritization of UGI interventions. This study proposes a remote sensing–based modeling framework for assessing climate regulation services in urban environments by integrating satellite-derived information with ground-based meteorological observations. The proposed approach systematically quantifies the cooling potential and spatial influence of urban green infrastructure. Spatial analytical methods are further employed to identify the relative contributions of different types of green spaces to urban thermal environments. By integrating cooling potential with population distribution and heat exposure scenarios, the framework supports the identification of high-risk areas and the prioritization of green infrastructure interventions.

***Keywords***: Green infrastructure, nature-based solutions, Urban heat island

## 11. Understanding vulnerability and enhancing resilience to hotter summers in rural mountain communities, an interdisciplinary approach

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The Pyrenees are one of the southernmost alpine mountain ranges in Europe and their location and diverse climatic zones makes them particularly vulnerable to heatwaves. Heatwaves are already a summer fixture, with extreme events seen in 2022 and 2025. Despite clear evidence of consistent temperature increases in the last decades, studies of local climate dynamics examining the relationship between biophysical landscape features and heat experiences in rural mountain communities are lacking. The intensification and increased frequency of summer heat stress under climate change affects socio-ecological systems across urban-rural gradients impacting people, animals, crop production and the environment. Heat vulnerability and risk modelling exercises often focus on urban contexts where the 'urban heat island' effect takes place, whereas the specific impacts and distribution of heat in rural settings remains fairly neglected.
The study aims to deepen the understanding of local climate regulation services in a Pyrenean case study. We explore how the presence of natural landscape features such as forests and waterbodies reduce heat exposure during heatwave events. The relationships between LST, landcover, vegetation health and biophysical features are investigated using desk-based methods. The work aims to highlight where exposure to heatwaves is greatest, those who are at the greatest risk of exposure (e.g. local populations, livestock and crops) and the biophysical features which contribute to local microclimate regulation.

This desk-based research is complemented by an interview-based study on how farming communities perceive, experience, and respond to increased heat exposure. The results of the interview-based research are used to contextualise and ground-truth the remote-sensed spatial analysis approach. Here, we present results of this participatory and interdisciplinary study which aims to enhance knowledge of local climate regulation services in rural settings, identify the changing relationships between people and nature, and present evidence which can enhance local climate change adaptation planning.

***Keywords***: Heat exposure, agriculture, participatory mapping, land surface temperature, local climate regulation

## 12. Investigating Spatial and Ecological Patterns of Forests in Urban and Peri-Urban Areas

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Under the combined pressures of climate change and rapid urbanization, urban green spaces—particularly forests—play a critical role in supporting urban ecological sustainability. Understanding both the spatial distribution and ecological dynamics of urban and peri-urban forests is therefore essential. However, the interactive relationships between urban spatial structure and forest ecological patterns over time remain insufficiently understood.
To address this gap, this study investigates forests within Nagoya City and its surrounding municipalities as a representative urban–peri-urban system. An integrated methodological framework is developed using multi-temporal remote sensing data and LandTrendr algorithm for time-series analysis. Spatial patterns are characterized through anthropogenic features such as roads, buildings, traffics and waterways, while ecological patterns are quantified using vegetation indices that capture forest disturbance, regeneration, and long-term trends.
The results show that forests farther from urban infrastructure experience fewer recent disturbances and consequently exhibit lower regeneration activity, indicating relatively stable or mature forest conditions. In contrast, forests closer to roads and buildings display more frequent disturbance–regeneration cycles. Moreover, the historical development of surrounding anthropogenic features is strongly associated with current forest ecological conditions, with earlier urban expansion linked to higher fragmentation levels. These findings are supported by forest survey data, which confirm spatial differences in forest structure and regeneration status.
This study provides an integrated spatial–ecological perspective on urban forest dynamics and offers practical insights for aligning urban forest planning with urban structure to support sustainable forest management in urban and peri-urban areas.

***Keywords***: urban forest, landtrendr algorithm, spatial pattern, ecological patter

## 13. Ecosystem services under heat and drought: Agricultural management to balance crop yield, erosion, and nutrient regulation

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Climate change-induced heat and drought threaten several ecosystem services. While adaptation of crop management to maintain high yields has been widely studied, balancing its effects on groundwater recharge, erosion regulation, or nutrient uptake under climate change remains unexplored. Therefore, the aim of this study is to identify management options that balance these ecosystem services in years characterized by frequent heat and drought events. Special focus is put on maize in the watershed of the

river Vils, Germany, where it is grown in monocultures. Management options such as the use of different varieties, growing them in mixtures, or increasing the landscape heterogeneity are modeled in the Soil and Water Assessment Tool (SWAT+). Their effects on the different ecosystem services are quantified for the years 1983-2023 in relation to the number of heat and drought days. Increased surface runoff was identified in the source region of the river Vils, caused by greater precipitation and being especially pronounced in urban areas. This also led to enhanced erosion from croplands, amplified by steep slopes and the lack of cover crops in winter. Sediment yields were particularly high for maize grown in monocultures, with silage maize showing the largest values among all crops. Nitrogen regulation was lower in the source region as the high runoff facilitated the wash-off of broadcast-applied fertilizer. Nitrogen uptake by summer crops such as maize was lower during their vegetative phase than during their reproductive phase. The results from growing maize in monocultures will, in the next step, be compared to mixed cropping approaches using different varieties. This can be used to manage maize and other crops to support multiple ecosystem services under the increasing frequencies of heat and drought.

***Keywords***: Ecosystem services, Extreme events, Maize, Climate change, SWAT

## 14. Tourism-driven landscape change and cultural ecosystem service trade-offs on Bozcaada Island assessed through landscape metrics and InVEST modelling

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Small and medium islands (SMIs) host highly valued cultural landscapes that support recreation, aesthetic appreciation, and local identities, yet these landscapes are increasingly transformed by tourism-driven land use change. Bozcaada Island (Türkiye), characterized by its vineyards, coastal environments, and growing tourism economy, provides a representative case to examine how tourism-related pressures reshape cultural ecosystem services (CES) in island contexts.
This study assesses the spatial and temporal dynamics of tourism-related cultural ecosystem services on Bozcaada using a proxy-based approach that integrates remote sensing, landscape metrics, and ecosystem service modelling. Multi-temporal land use/land cover data derived from Landsat and Sentinel imagery (1990–2025) were used to quantify changes in landscape structure associated with tourism expansion and settlement growth. Cultural ecosystem service potential related to recreation and landscape aesthetics was represented using landscape metrics describing landscape diversity, fragmentation, and connectivity, combined with accessibility indicators such as proximity to roads, settlements, and coastal areas.
To explore trade-offs between cultural and regulating services, the proxy-based CES index was analysed alongside InVEST-derived Habitat Quality and Carbon Storage outputs. Results reveal increasing landscape fragmentation and declining habitat quality in areas experiencing intensified tourism accessibility, particularly along coastal zones, while vineyard–semi-natural landscape mosaics remain key hotspots of CES provision.
By demonstrating how cultural ecosystem services can be assessed without primary social data, this study provides a transferable methodological framework for island-specific ecosystem service assessments and supports place-based strategies for balancing tourism development and ecological integrity in small island ecosystems.

***Keywords***: Tourism Pressure, Landscape Metrics, Small-Medium Islands, InVEST