BOOK OF ABSTRACTS

I. SESSION DESCRIPTION

ID: B10c

Tools and approaches for integrating ecosystem services and nature-based solutions in landscape and urban planning and policy

Hosts:

	Name	Organisation	E-mail
Host:	Roy Remme Ulla Mörtberg	Leiden University KTH Royal Institute of Technology	r.p.remme@cml.leidenuniv.nl mortberg@kth.se
Co-host(s):	Christian Albert Blal Adem Esmail Carl Anderson Clara Veerkamp Esmee Kooijman Francesc Baró Johannes Langemeyer	Leibniz University Hannover (1) Eurac Research, (2) Ruhr University Bochum Leibniz University Hannover PBL Netherlands Environmental Assessment Agency Dutch Ministry of Agriculture, Nature and Food Quality Vrije Universiteit Brussel Universitat Autonoma de Barcelona	albert@umwelt.uni-hannover.de Blal.AdemEsmail@ruhr-uni-bochum.de anderson@umwelt.uni-hannover.de Clara.Veerkamp@pbl.nl e.d.kooijman@minlnv.nl Francesc.Baro@vub.be johannes.langemeyer@uab.cat

Abstract:

A main challenge for sustainable development is the ongoing degradation of ecosystems, and complex challenges including climate change, biodiversity loss, and pressure on public health and well-being, due to unsustainable land use change and urbanization. This calls for stronger integration of nature-based solutions and the ecosystem services they provide into planning and policy on all levels. Efforts are ongoing to include these in current international and European policy developments. Notably, the Kunming-Montreal Global Biodiversity Framework

included an explicit target to enhance nature in cities, emphasizing the protection of urban biodiversity and ecosystem services, and the necessity for nature-inclusive urban planning. Likewise, the European Biodiversity Strategy 2030 strives to enhance green spaces in urban and peri-urban areas, encouraged by recent developments on a new legal policy instrument, namely the EU Nature Restoration Law. Such international strategies, agreements, and laws can create fertile grounds for significant and much-needed changes for more nature-based and resilient cities. International policy developments also inspire policies, initiatives, and actions at more local scales, ranging from national strategies (e.g., Agenda Natuurinclusief in The Netherlands or the Spanish National Plan for Adaptation to Climate Change 2021-2030, PNACC) to city-scale plans (e.g., Barcelona Nature Plan), and on-the-ground actions (e.g., Operatie Steenbreek (NL) which facilitates facade gardens by local residents).

To support and assess the implementation and adoption of such policies as well as landscape and urban planning, a broad and growing set of approaches and tools are available. A key challenge remains how such approaches and underlying tools can most effectively be implemented to support real world decisions. The knowledge gaps and questions may be differently identified by researchers and policy makers or planners. In order to effectively generate knowledge on nature-based solutions, ecosystem services, and biodiversity, alignment of scientific and policy questions is needed. An important step in such a process is understanding mutual interests, priorities and mismatches between research, policy, and practice.

In this session we focus on how different approaches contribute to more effective policy and planning of both cities and landscapes, addressing different topics in two sub-sessions. The first sub-session focuses on how approaches, ranging from highly quantitative to more qualitative, can be better leveraged to inform and improve urban policy and planning. The second sub-session assesses how geodesign as a methodological approach is used in landscape and urban planning.

For the first sub-session, we invite speakers to present their current scientific research on urban ecosystem services, displaying the broad array of available approaches (e.g., empirical research, participatory approaches, modeling, policy evaluation). We are specifically interested in research that directly links to or assesses urban policies, plans, or strategies. We ask speakers to reflect on how the research responds to needs of policy-makers and practitioners and where disconnects exist. We also invite speakers involved in or working with policy and practice to reflect on the scientific knowledge and its effectiveness in order to be policy-supportive. All session speakers will be involved in an interactive debate to identify key leverage points for better and more targeted quantitative research to improve effectiveness of nature-based solutions in cities and catalyze transformative change for future-proof cities.

The second sub-session delves into the role of geodesign in planning. Geodesign is a set of concepts and methods used to involve scientific knowledge, stakeholders and various professions in collaboratively designing [and realizing] sustainable solutions for spatial challenges in built and natural environments. Geodesign tightly couples the creation of proposals for change with impact simulations informed by geographic contexts and by systems thinking, with great potential for supporting sustainable planning practices. From a scientific point of view, ecological and socio-economic conditions are increasingly being monitored, mapped and modeled, and indicators are developed, promising to provide a basis for effective and smart integration of ES in urban and landscape planning. However, how to integrate such assets into the planning and decision making processes is not trivial but comes with many challenges. For instance, digital planning support tools need to fit scales, targets, legislation and interests imposed by the planning situation, as well as being accurate and sufficiently detailed from a scientific point of view. In addition, nature-based solutions need to be designed on par with and interact with other planning goals, be it urban development with needs for housing, urban services and transportation, new energy facilities, or other ongoing land use developments. Among challenges for implementing geodesign tools are the management of boundaries between different knowledge holders, accounting for the complex trade-offs and interactions of different scenarios, and facilitating participatory procedures. Overall, more knowledge in the science-technology-planning interfaces is needed for full integration of knowledge-driven nature-based solutions in planning practices.

Goals and objectives of the session:

The overarching goal of this session is to synthesize and discuss how to bring together different kinds of knowledge, such as quantitative data (e.g. field measurements or model outputs) and qualitative data (e.g., description of people's perceptions/values from interviews or observations) in nature-based solutions and ecosystem service assessments to make information useful for urban and landscape policy and planning.

The overarching goal will be addressed by focusing on (1) links between research and urban policy needs, and (2) the use of geodesign for landscape and urban planning, in two sub-sessions that collectively address the overarching goal. Speakers will present their research and reflect on their contribution to planning and policy. The latter will be done in their talks and in an interactive panel discussion.

Planned output / Deliverables:

We will set up a 'science brief', a short text that aims to inform researchers on how to better tailor their research to planning and policy needs. The brief outlines the needs from policy and planning as discussed during the session, as well as how current research does (not) align with this. The

briefs will provide clear guidance on what researchers need to do to produce research that is relevant to planning and policy.

Session format:

The session will be split into two sub-sessions, one focused more on research for policy, and one focused more on geodesign approaches for planning. The session will follow this structure:

- General session introduction
- Sub-session on ecosystem service assessments for urban policy
    - Policy introduction
    - Oral presentations
    - Panel discussion
- Sub-session on geodesign for landscape and urban planning
    - Planning introduction
    - Oral presentations
    - Panel discussion
- Session wrap-up by hosts

Throughout the session the audience will be provided opportunity to contribute discussion points and broad questions that will be addressed during the panel discussions

II. SESSION PROGRAM

Room: Expert Street 4

Date of session: 19th of November 2024
Time of session: 11:00 – 12:30 & 14:00 – 15:30

Timetable speakers

Sub-session I: Integrating research into policy

Time	First name	Surname	Organization	Title of presentation
11.00	Roy	Remme	Leiden University	Session introduction
11.05	Esmee	Kooijman	Dutch Ministry of Agriculture, Nature and Food Quality	The needs of policy makers from ecosystem service research

Time	First name	Surname	Organization	Title of presentation
11.15	Lianne	van Ruijven	Rebel group	Financial exploration of green spaces in and around the city
11.25	Gerid	Hager	IIASA	Measuring and assessing urban green infrastructure with citizens: stories from Urban ReLeaf cities
11.35	Joeri	Morpurgo	Leiden University	Field evidence on multiple ecosystem services in urban green infrastructure. Heat reduction, air remediation, water regulation and biodiversity, do they co-exist?
11.45	Harald	Zepp	Ruhr University Bochum	EnhancES – An Open Source GIS-based Toolbox for Assessing, Mapping and Enhancing Ecosystem Services
11.55	Thea	Wübbelmann	Leibniz University Hannover	Assessing the transformative power of policy strategies towards healthier cities in four European case studies
12.05	**Interactive panel discussion** Integration of ecosystem service and nature-based solution research into policy			

Sub-session II: Geodesign approaches for landscape and urban planning

Time	First name	Surname	Organization	Title of presentation
14.00	Ulla	Mörtberg	KTH Royal Institute of Technology	Session introduction
14.05	Blal	Adem Esmail	(1) Eurac Research, (2) Ruhr University Bochum	Planning for transformative change with nature-based solutions: a geodesign application in Stockholm
14.15	Carl	Anderson	Leibniz University Hannover	Geodesigning sponge landscapes to address floods, droughts and biodiversity loss
14.25	Ming	Fricke	Norman Foster Institute	Linking social challenges, spatial planning, and multifunctional green infrastructure design through an

Time	First name	Surname	Organization	Title of presentation
				ecosystem services lens to enhance urban resilience and health
14.35	Sana	Jajeh	Leibniz University Hannover	Collaborative Planning of Sponge Measures for Climate Adaptation at the Landscape Scale: Exploring the Potential of Geodesign
14.45	Agnese	Reke	Baltic Environmental Forum	Integrating cultural ecosystem services in Urban Nature Plans through Participatory Approaches: A Case Study of Riga
14.55	Javier	Babi Almenar	Politecnico di Milano	Biophysical and monetary modelling of air filtration by urban vegetation across Europe
15.05	**Interactive panel discussion** Integration of geodesign with ecosystem service and nature-based solution into planning			
15.25	**Session wrap up**			

III.ABSTRACTS

The first author is the presenting author unless indicated otherwise.

1. Biophysical and monetary modelling of air filtration by urban vegetation across Europe

First authors(s): Javier Babí Almenar

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Poor air quality, especially due to particulate matter (PM), remains a major concern in urban areas due to its impact on premature human deaths. This concern is addressed by the revised Air Quality Directive and amendments to the European Environmental Economic Accounts Regulation, aiming to improve air quality and monitor PM levels and dry deposition by vegetation. In this research, we develop a combined biophysical and monetary method to model air purification by vegetation across European urban areas. PM10 dry deposition is used as a proxy for this ecosystem service. The method is tested for the year 2018. For the biophysical valuation, we use a mechanistic model based on the electrical resistance analogy, along with earth observation data from Copernicus Services, to estimate the flow of PM10 deposited over time. This flow, together with boundary layer height data, allows estimation of changes in atmospheric PM10 levels (µg/m3) attributable to vegetation. Using dose-response functions, changes in PM10 levels estimate annual variation in mean population exposure to PM10 and the risk of premature human deaths across Europe. The economic valuation employs a Value Transfer approach. We use a Meta-analysis function transfer to predict the Value of Statistical Life (VSL) as a measure of willingness to pay for mortality risk reduction. The VSL welfare estimate is adjusted using the cost of illness approach. Initial results illustrate that in some countries (e.g., Austria, Poland), vegetation's capacity to filter PM10 is limited during high pollution periods. In contrast, other countries (e.g., Greece, Spain) show a better match. Notably, southern Nordic areas, with lower atmospheric PM10 levels, exhibit higher air purification capacity and are better equipped to meet future stricter thresholds proposed in the revised EU Air Quality Directive. This method helps to evaluate the effectiveness of urban vegetation as air-purifying nature-based solutions across European urban areas.

Keywords: urban ecosystem; urban sustainability; human health; remote sensing; ecosystem services flow;

2. Measuring and assessing urban green infrastructure with citizens: stories from Urban ReLeaf cities

First authors(s): Gerid Hager

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People living in cities are increasingly exposed to severe environmental stresses exacerbated by the climate crises. Nature-based solutions (NbS) can provide cooling effects, decrease air pollution, and improve mental health, amongst other important ecosystem services (ES) and health-related benefits. Ambitious plans, such as the pledge to plant 3 billion trees in the EU, the European Green Deal, or the Green City Accord support the direction towards NbS and ES implementation in cities. This implementation, however, requires transformative changes to overcome business as usual approaches. The Urban ReLeaf project innovates together with public authorities and local communities to jointly shape green infrastructure actions. Six pilot cities co-create citizen-centric innovations for participatory urban greenspace monitoring and planning in pursuit of urban climate resilience. This presentation showcases data and policy mapping activities to identify opportunities for citizen participation in urban planning and policy as well as illustrating stories of the six Urban ReLeaf cities. Athens is undergoing a greening transformation with a new, citizen-powered tree registry providing critical data for better management of greenspaces. Cascais engages citizens in sharing perceptions and thermal comfort levels while using greenspaces to validate the effectiveness of its parks. In Dundee, a city facing increasing grey infrastructure in deprived areas, actions to enhance the accessibility of greenspaces are co-developed with citizens and stakeholders. Mannheim has a heat action plan to safeguard its most vulnerable residents but has identified critical data gaps for tree infrastructure maintenance. Citizen observations of trees and heat stress aid the delivery of climate adaptation measures. Riga engages diverse audiences to measure and address concerns about air pollution and greenspace usage, to ensure better informed policies. Finally, in Utrecht, data on temperature, humidity and heat stress, collected by and for citizens, will help shape effective mitigation strategies.

https://urbanreleaf.eu/

Keywords: citizen science, participation, greenspace, urban planning, policy

3. Field evidence on multiple ecosystem services in urban green infrastructure. Heat reduction, air remediation, water regulation and biodiversity, do they co-exist?

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Urban environments face significant challenges exacerbated by climate change, in the domains of the Urban Heat Island (UHI), flooding, air quality and biodiversity loss. Several types of Urban green infrastructures have been proposed as a Nature-based Solutions to remediate these problems, by providing cooling, regulating stormwater-runoff, filtering contaminants out of the air and supporting biodiversity. While urban green infrastructure has been shown to be capable of addressing these challenges separately, little research exists on measures delivered simultaneously, leaving uncertainty about the synergies and trade-offs that exist within green infrastructure.

Our research, encompassing over 160 sites in a broad range of green infrastructure types in The Hague (NL), aimed to simultaneously measure ecosystem services provided by green infrastructure. Our findings indicate that green spaces play a vital role as Nature-based Solutions by mitigating the UHI effect, improving air quality and to supporting biodiversity. Our results show that biodiversity and air pollution levels were consistently better in areas with substantial green coverage. Trees were found to significantly reduce ambient temperatures and yet were also associated with a reduction in biodiversity and air quality. Despite these synergies, our research also revealed a trade-off where best practices for heat reductions are not in line with best practices for air quality and biodiversity enhancement. Interestingly, our analysis shows that water infiltration is unaffected by the type of green infrastructure.

To address the multifaceted challenges of UHI, flooding and air quality, cities must integrate diverse and strategically planned green spaces. UHI is reduced best by increasing tree cover. This tree cover also provides the additional benefit of increasing permeable soil, increasing the capacity of soil to let stormwater-runoff infiltrate. In contrast, increasing tree cover is not the best method of improving the air quality, where grassy vegetation seems to be better.

These results highlight the need for a diverse and strategic implementation of different types of urban green infrastructure. The design of green infrastructure in the cities should be adapted to

the needs for ecosystem services, while understanding the synergies and trade-offs between them.

Keywords: Climate adaptation, Nature-based Solutions, Biodiversity, green space design, field data

4. Integrating cultural ecosystem services in Urban Nature Plans through Participatory Approaches: A Case Study of Riga

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With over 70% of Europe's population residing in urban areas, for many people interactions with nature predominantly occur within city environments. This makes urban green spaces essential for the well-being of city dwellers. However, despite their importance, human-nature interactions have been largely overlooked in urban policymaking. The EU Biodiversity Strategy requirement for cities with at least 20,000 inhabitants to develop Urban Greening plans (now called Urban Nature plans) offers a unique window of opportunity to incorporate these interactions into policy frameworks.

Our study utilized participatory approaches, including PGIS surveys and workshops, to assess urban cultural ecosystem services (CES) in Riga, as well as to identify problem areas where climate change related issues such as heat islands and flooding occur. This study is a part of a comprehensive green infrastructure assessment that is being developed for Riga's Greening plan.

Home to over 610,000 people, Riga represents more than 30% of Latvia's population and is the largest city in the Baltic States. Despite being a relatively green city, Riga faces many challenges including pluvial flooding, the heat island effect and uneven accessibility to green spaces.

This presentation will highlight the main results of the assessment, demonstrating how participatory approaches can effectively evaluate urban CES for policy documents. We will also share key lessons learned from our attempt to embed CES into municipal planning, demonstrating the potential and challenges of this integrative approach.

The study is supported by the LIFE LATESTadapt project (101074438).

Keywords: urban cultural ecosystem services, urban nature plans, green infrastructure planning, participatory approaches, Riga

5. Assessing the transformative power of policy strategies towards healthier cities in four European case studies

First authors(s): Thea Wübbelmann
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Urban natural environments are often degraded, facing limited biodiversity, and high sealing rates, while being required to offer opportunities to connect citizens to nature and health-promoting environments with benefits for human health and wellbeing. It is becoming increasingly evident that climate change has a significant impact on human health, which can be reduced by climate mitigation and adaptation measures through the provision of ecosystem services by natural environments such as Nature-based Solutions (NbS). European and national policy frameworks have emerged in recent years to address this challenges, with a range of initiatives to promote mitigation, adaptation and resilience to climate change. However, are local adaptation strategies for cities transformative enough to meet the needs in the context of biodiversity loss and increasing impacts of climate change to support citizens health? To fill this gap, we build on the planetary health framework and operationalize it by focusing on climate, biodiversity and health (CBH) policy goals with particular attention to synergistic effects and trade-off across the CBH nexus.

In four case study cities – Klagenfurt, Cork, Valetta and Lahti –, we examine the strategies, goals, and targets, including NbS, in urban policy and planning documents whether cities' stated goals and targets are transformative enough to meet the global challenges related to climate change and urbanisation. Our integrated appraoch based on textural analysis is used to assess interactions between health, biodiversity, and climate adaptation and mitigation to identify potential synergies and conflicts between policy goals thereby empirically defining sustainability transformations in city governance. The outcomes illuminate the coherence among the policy goals and should provide recommendations to city stakeholders to improve the integration of biodiversity and health and well-being to the adaptation and mitigtation of climate change.

Keywords: Planetary health, urban environmental governance, climate-biodiversity-health nexus, sustainability transformations

6. EnhancES - An Open Source GIS-based Toolbox for Assessing, Mapping and Enhancing Ecosystem Services

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The transfer of ES assessments to real-world decision-making in the public and private spheres is still lagging. In this contribution, we introduce EnhancES, a toolbox for mapping and assessing ES developed with the open-source software QGIS. We demonstrate how biophysical ES modelling can be integrated into a multi-step spatial planning process using EnhancES.

EnhancES can currently assess 10 ES (base flow regulation; flash flood regulation; temperature regulation (cooling intensity); carbon sequestration and storage; particulate matter (PM10)-filtration; visual screening; pollination; activities promoting recuperation through active or passive interactions with nature; aesthetic experiences). EnhancES is being applied and tested in case studies covering a range of scales from building blocks to regions.

The real-world example presented here comes from the city of Bochum, Germany, where a mixed-land-use area shall be transformed into a residential area. We used real information and compared the expected changes of six ES that emerged from three different urban planning designs submitted as part of an official urban planning competition organized by Bochum's Cityhall. The competition's jury selected one of the plans, which was revised according to specific requirements defined by Bochum's planning department.

For each plan EnhancES calculated and produced maps displaying six ES (base flow regulation; flash flood regulation; cooling intensity; carbon sequestration; (PM10)-filtration; pollination). To allow meaningful comparisons between different ES that are expressed in different biophysical units, EnhancES includes a standardization procedure for each ES with the maximum being 1. The gains and losses of standardized ES performances convey clear messages. By averaging all ES, it becomes clear that an overall gain of ES is only possible with the revised plan. Acknowledging ES as a fundamental basis for human well-being should put them at the centre

of decision-making, for what marginal valuations over different development alternatives is the way forward.

Keywords: • urban ecosystem services, real-world example, quantitative assessments, planning and decision-making, marginal valuation

7. Financial exploration of green spaces in and around the city

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There is an urgency to start working on a green built environment - because this is where population growth, biodiversity loss, and climate adaptation converge. Additionally, a new EU regulation on nature restoration requires that by 2030, there should be no net loss of urban green spaces and urban tree canopy cover.

The government wants and needs to invest in a green built environment. The focus lays on increasing biodiversity in urban developments. Linking green spaces to housing development is promising, but the costs and benefits are not yet fully known: this research focuses on the costs and benefits of three scenarios:

Scenario 1 – Compensating for 2,147 hectares of green space and 240,800 trees lost due to urbanization until 2030. The costs are €6.32 billion against €4.61 billion in monetizable benefits;

Scenario 2 – Green grows together with the city by adding 4,477 hectares of public green spaces and ecosystem green for 900,000 homes. The costs are €12.91 billion against €8.91 billion in monetizable benefits; management and maintenance amount to €3.7 billion, making it a significant expense.

Scenario 3 – Green grows towards a healthy and climate-resilient city by planting 23 million trees and over 48 million square meters of pergolas to provide shade for 40% of all major routes in the city. Costs and benefits of this scenario where not calculated.

The largest monetizable benefits are health, climate mitigation, and avoided water damage. Biodiversity and some health benefits are not monetizable but have a significant impact. Therefore investment decisions should not only be based on a comparison of costs and monetizable benefits.

The benefits analysis provides a good overview but contains uncertainties – the assumptions made in the calculations can significantly influence the outcomes. Sensitive assumptions include the time horizon, property value, CO2 price, and water damage.

Keywords: financing, benefits, invest, urban, building

8. Planning for transformative change with nature-based solutions: a geodesign application in Stockholm

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Advancing towards urban futures in which both human communities and ecosystems can thrive requires transformative change (TC). Spatial planning can serve as a backbone for inspiring and fostering the desired transformation of cities. However, at least three key interrelated challenges exist for spatial planning to support this transformation: creating unconventional plans, accounting for the complex trade-offs and interactions of different scenarios, and facilitating participatory procedures. A promising approach for addressing the challenges is Geodesign as it couples spatial co-design with impact simulations. This paper aims to explore how, and with what effects, geodesign can support the co-creation of transformative urban plans. A geodesign process was developed and deployed for a case study neighborhood in Stockholm, Sweden. Fourteen planning stakeholders divided into three groups developed and explored the impacts of two alternative futures. The study findings indicate that the geodesign process enabled participants to develop transformative plans that address housing needs while also promoting biodiversity and ecosystem services through nature-based solutions. Participants showed high perceived desirability of TC but were mostly skeptical regarding the

plausibility and probability of future implementation. The study findings also confirmed that Geodesign may provide effective planning support for managing 'boundaries' between knowledge holders, by integrating data and knowledge, and facilitating effective stakeholder collaboration. All geodesign steps enhanced communication by promoting discussions and collective reasoning, albeit to different degrees. Participants acknowledged contributions to knowledge co-production and decision-making by mediating between different perspectives and opinions. Data quality was identified as critically affecting perceived credibility. Reservations were expressed regarding the translation function. We recommend practical applications of geodesign to strategically involve key stakeholders throughout study conceptualization, scenario development, and model generation for better context consideration. Enhancing geodesign tools for user-friendliness is also crucial. Research should focus on scaling up collaborative geodesign for complex challenges in metropolitan and landscape planning.

Keywords: Boundary management, Impact assessment, Knowledge co-creation, Land use change, Planning support, Scenario planning, Suitability Analysis

9. Geodesigning sponge landscapes to address floods, droughts and biodiversity loss

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Increasing risks for floods and droughts and the rapid decrease in biodiversity values present substantial challenges in Europe. Addressing these challenges will require a paradigm shift in water management and spatial planning away from a focus on rapid water discharge towards the development of sponge landscapes with substantially enhanced water retention capacities in surface water bodies, soils and aquifers. To advance this paradigm shift, knowledge and know-how is needed for how large-scale transformative change of land and water management can be initiated and fostered.

The aim of this contribution is to introduce a novel collaborative geodesign approach and first results for advancing collaborative planning and exploration of sponge landscapes. The approach consists of co-generating systems understanding, co-creating plausible scenarios of how case landscapes might transform in the next three decades, co-exploring potential

scenario impacts on the landscape hydrological cycle, and co-generating sponge strategies for long-term adaptive implementation with actions at local, regional and national levels. Large scales demonstrators in Pinios river basin, Greece, the Lèze basin, France, and the Vecht basin, The Netherlands and Germany, serve as case studies. First results highlight case-specific flood and drought challenges, innovative sponge measures already implemented or envisioned, and sponge scenario archetypes as elaborated with diverse knowledge holders. Finally, lessons-learned and recommendations for future applications are derived.

The presentation builds on insights from the SpongeScapes and SpongeWorks projects, two EU Research and Innovation Actions to demonstrate practical, effective, economically feasible and inclusive approaches and solutions towards enhancing the water retention capacity of interconnected groundwater, soil and surface water systems at regional scale.

Keywords: Water challenges, Biodiversity, Ecosystem Services, Geodesign, Landscape Planning

10. Linking social challenges, spatial planning, and multifunctional green infrastructure design through an ecosystem services lens to enhance urban resilience and health

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Urban areas globally face socio-demographic shifts and tensions among social groups. Climate change exacerbates these challenges by increasing the need to mitigate heat stress and risks from severe weather events. Poor infrastructure, limited green spaces, and inadequate public amenities and programs further intensify these issues. Data-driven analysis can identify strategic locations for interventions to enhance resilience and well-being.

This study presents a framework integrating urban analytics and space syntax network analysis with ecosystem services mapping and modeling for green infrastructure. Understanding spatial configurations and their impact on movement and interactions, together with the benefits provided by urban ecosystems, allows for evaluating current conditions in vulnerable areas, designing evidence-based interventions, and allocating targeted nature-based solutions. Public engagement and participatory processes can expand the socio-demographic demand analysis,

spatial quality assessment of existing urban fabric, preferred intervention design, and help evaluate performance over time to effectively complement the methodology with qualitative data.

The framework's application is illustrated through the Norman Foster Institute's collaborations with the city administrations of Bilbao, Athens, and San Marino. Despite differing contexts and objectives, the ecosystem services concept proves to be an effective common analytical lens that can communicate potential intervention outcomes to diverse stakeholder interests, such as enhanced urban thermal comfort, conservation of peri-urban cultural landscapes, and strengthened social cohesion. The interventions provide various ecosystem services while supporting disadvantaged communities, including habitat provision for urban biodiversity, micro-climate regulation to mitigate urban heat island effects, food provision stimulating local economy and stewardship, and recreational spaces contributing to urban health.

The authors propose an innovative approach to city planning that can actively involve citizens in addressing multiple, often intangible, societal challenges. Jointly designing spatial interventions can deliver a diverse array of ecosystem services simultaneously, thereby redefining community interpretation and expectation of public service and value generation.

Keywords: Urban Resilience, Urban Ecosystem Services, Green Infrastructure, Participatory Planning, Socio-Demographic Changes

11. Collaborative Planning of Sponge Measures for Climate Adaptation at the Landscape Scale: Exploring the Potential of Geodesign

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Rural European landscapes face escalating risks of floods and droughts exacerbated by unsustainable land use practices and climate change. Sponge measures are particularly promising to address such challenges from a participatory and social-ecological perspective. Sponge measures are nature-based solutions (NbS) that preserve, restore, enhance, or create ecosystems to increase landscape and soil water retention while providing co-benefits for people and nature through biodiversity and ecosystem services.

Effective design and planning of NbS require overcoming challenges such as developing a shared understanding of their spatial impacts among stakeholders, considering their co-benefits and trade-offs, and evaluating effectiveness across different scales and future scenarios. Geodesign offers an iterative, multidisciplinary, and stakeholder-driven framework to address these challenges by integrating stakeholder inputs, geospatial data, and technology to generate real-time feedback and inform decision-making. Despite promising applications in urban and landscape planning, knowledge is lacking on how geodesign can best be applied to facilitate the planning of sponge measures at a landscape scale.

As part of ongoing PhD research within the SpongeScapes project (spongescapes.eu), we aim to assess the utility of geodesign to upscale sponge measures on a landscape scale in two European case studies. We present insights from the first workshop conducted in the Netherlands, which focused on co-generating a shared social-ecological system understanding and identifying priority sponge measures. Preparations are ongoing for the second workshop during which sponge measures will be placed in opportunity spaces based on geospatial data and stakeholder input to eventually inform collaborative discussions on future scenario narratives. With increasing NbS implementation in response to climate change across Europe, our research aims to provide insights into the potential of geodesign to optimize the co-design of sponge measures, support policy creation, and inform decision-making.

Keywords: Geodesign; Ecosystem services; Climate change adaptation; Stakeholder engagement; Landscape Planning