BOOK OF ABSTRACTS

I. SESSION DESCRIPTION

ID: T13c

Nature-based solutions with societal nexus as a key for transformative change

Hosts:

	Name	Organisation	E-mail
Host:	Diana Dushkova	Helmholtz Centre for Environmental Research - UFZ, Leipzig, Germany	diana.dushkova@ufz.de
Co-host(s):	Dagmar Haase	Humboldt Universität zu Berlin, Germany; Helmholtz Centre for Environmental Research - UFZ, Leipzig, Germany	dagmar.haase@ufz.de

Abstract:

Ecosystem services provisioning undergoes change as ecosystems undergo transformation due to climate change, urbanization, land use intensification as well as technogenic pollution and disruption. It results in ecosystem fragmentation, the introduction of invasive species, and the expansion of managed land uses into natural ecosystems. Recognizing that the situation is expected to deteriorate and acknowledging that nature is the foundation of human and other life forms' existence and well-being, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) and the Intergovernmental Panel on Climate Change (IPCC) call for proactive, transformative actions to meet both national and international objectives for biodiversity, climate, and sustainable development by 2030 and beyond. As outlined by IPBES in 2019, transformative change refers to a comprehensive restructuring that encompasses technological, economic, and social dimensions. This reorganization involves a shift in paradigms, objectives, and values, aiming to ensure the conservation and sustainable use of ecosystems and their biodiversity, enhance human quality of life, and promote sustainable development. The growing number of studies emphasized that ecosystems, biodiversity and climate are deeply intertwined, underlying the need for a unified approach to address the

interdependent crises of biodiversity loss and climate change. In this regard, the role of Nature-Based Solutions (NBS) in addressing the twin biodiversity and climate crises by providing multiple co-benefits is broadly recognized in both scientific discourse and policy. This is demonstrated by the variety of NBS-related projects supported by the EC Research and Innovation programs. Still, their capacity but also existing trade-offs and conflicts for driving transformative change have yet to be fully investigated.

In this session, we will explore:

- the role(s) of NBS and nature-based adaptation in transformative change,
- successful strategies and examples illustrating the significance of nature-based actions in addressing climate challenges,
- approaches to ensuring climate actions do not harm biodiversity and ecosystem services,
- NBS approaches that combine climate action, biodiversity support and social justice,
- mechanisms fostering sustainable and biodiversity-friendly outcomes for small and large-scale transformative change, and,
- the involvement of decision-makers, stakeholders, and the general public in advancing the dialogue on biodiversity and climate action under fair conditions.

We are inviting scientists, practitioners, decision-makers, and representatives of citizen groups to attend this session and share their experiences by presenting frameworks, conceptual approaches, implementation strategies, social innovations, etc., to collaboratively identify crucial next steps to promoting transformative change for nature.

Goals and objectives of the session:

With this session, we are aiming to address the following questions:

- How NBS and nature-based adaptation can contribute to transformative change?
- What are the successful strategies/practice examples that demonstrate the importance of action for nature in tackling climate challenges?
- How to achieve that climate actions will avoid negative impacts on biodiversity and ecosystem services?
- What are the mechanisms that support more sustainable and biodiversity-friendly outcomes that drive transformative change on both small and large scale?
- What role in this regard play decision-makers and stakeholders from all groups/sectors, especially those seeking active dialogue on biodiversity within their respective domains,

as well as the general public to guarantee social fairness when it comes to NBS implementation?

Planned output / Deliverables:

We are planning to organize a Special Issue in one of the peer-reviewed academic journals or a blog chain in The Nature of Cities (TNOC) based on the selected papers from the session.

Session format:

As we are planning to orginize our session in form of speed talks and long joint talk (5 min, and joint discussion), we would most probably need 1,5-2 h (10 min intro, approx. 1 h of speed talks consisting of in total15 short presentations, 20-30 min discussion)

II. SESSION PROGRAM

Room: Success Avenue 1

Date of session: 19th of November 2024
Time of session: 11:00 – 12:30 & 14:00 – 15:30 & 16:00 – 18:00

Timetable Speakers

Part 1: NBS integrated within BGI and sustainable practices (11:00-12:30)

1) **Introduction to the Session:** *Diana Dushkova, Dagmar Haase.* Nature-based solutions with societal nexus as a key for transformative change
2) *KOUSHIK CHOWDHURY.* Blue infrastructure as nature-based solutions for urban sustainability: Evaluating local perceptions from four Indian megacities
3) *Solen Le Clec'h.* Nature-based Solutions in agriculture: A strategy to transform the sector
4) *Maisam Rafiee.* Mapping Critical Zones of Societal Challenges: A Case Study in Kabul City
5) *Max López-Maciel.* Understanding the adoption of nature-based solutions in urban environments: insights from the diffusion-of-innovation theory
6) *Claudia Parenti.* Urban transformation through phytoremediation for healthier soil and land management. The case of Milan Metropolitan area

Subpart 2: Co-creating NBS for transformative change (14:00-15:30)

7) *Chengcheng Feng.* The Role of Resident Practices in Urban Soil Management and Ecosystem Service Enhancement: A Case Study of Wageningen
8) *Siobhan McQuaid.* Progress towards Nature Positive: national and global initiatives led from Ireland

9) *Diana Dushkova, Olga Ivlieva.* From informing to empowerment: levels of co-creation and roles of stakeholders in development and implementation of nature-based solutions
10) *Gerd Lupp.* Co-creating transformative NBS for inclusive communities – Insights from the EU project TRANS-lighthouses
11) *Gerd Lupp.* Co-creation and Co-Governance of Nature-based solutions
12) *Ina Sieber.* Building Resilient Coastal Communities through Nature-based Solutions and Empowerment Tools

Subpart 3: Integrating NBS in Policy, Planning and Governance processes for transformative change (16:00-18:00)

13) *Andrea Benedini.* Nature-based solutions for pluvial flood adaptation: the role of spatial planning to support transformative change
14) *Anastasia Konstantinova.* Towards Sustainable Urban Ecosystems: Planning and Management Transformation in Russia
15) *Roy Remme.* Aligning urban nature-based solutions with ecosystem services for transformative change
16) *Sabrina Lai.* Strengthening regional resilience in urban and regional planning through nature-based solutions: focus on nutrient retention
17) *Marek Hekrle* Unlocking the Benefits of Nature-Based Solutions: Economic Assessments and Policy Innovations
18) *Mina Di Marino.* Nature-based solutions to climate change adaptation in urban areas: a Norwegian planning perspective
19) *Anna Marín-Puig.* Unpacking the transformative potential of NbS: A focus on vulnerability and justice

Discussion – chairs + presenters + participants (15-20 min)

III.ABSTRACTS

The first author is the presenting author unless indicated otherwise.

1. Nature-based solutions for pluvial flood adaptation: the role of spatial planning to support transformative change

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In recent years, climate changes have increasingly impacted pluvial flooding occurring in our cities. In this context, flood risk management has become a priority for urban planning agendas. There is also a growing advocacy towards a paradigm shift from conventional interventions to nature-based solutions. This has raised awareness of the need for new planning strategies, processes and tools for managing flood risks. Nonetheless, there are very limited studies focusing on how to operationalize the paradigm shift into practice. This research aims to explore emerging planning approaches to flood risk management by conducting a comparative analysis between the two cities of Copenhagen and Oslo. Both cities are indeed vulnerable to pluvial flooding, and they have committed to adopting nature-based solutions to flood risk management. A mixed-method approach was used in this study, consisting of content analysis of municipal policies and planning strategies, interviews with key decision-makers from different city departments, and spatial analysis. The main findings show that, on the one hand, Copenhagen has developed a comprehensive and structural plan that includes more than 300 nature-based interventions, which are being built by public and private stakeholders. On the other hand, Oslo has approved an action plan, the goals of which are primarily to develop knowledge on urban pluvial flooding, as well as provide regulations and guidance for private developers. These two approaches have produced different mechanisms leading to the transformation of the cities (both at small and large scales). Copenhagen has adopted a systematic approach to transform consolidated areas, while Oslo has supported the implementation of nature-based solutions in the transforming city. The study discusses the legislative, financial, policy, and planning limitations and opportunities found in the two cities. There is a further need for the development of adaptive approaches and inter-departmental collaboration to contribute to transformative changes in cities.

Keywords: Urban flooding, Flood risk, Resilience thinking, Climate adaptation, Cloudburst

2. Blue infrastructure as nature-based solutions for urban sustainability: Evaluating local perceptions from four Indian megacities

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Blue infrastructure delivers multiple economic, social and ecological benefits to the residents of the city which can enhance their ability to urban sustainability challenges. However, scientific evidence linking traditional forms of blue infrastructure as nature-based solutions to urban sustainability challenges and in particular localisation of the urban sustainability is limited. Using the perceptions from the 616 urban dwellers in four Indian megacity, this paper used a quantitative methodology to demonstrate how blue infrastructure can be seen as nature-based solutions that can help to mitigate urban sustainability challenges. In doing so this paper used descriptive statistics, spearman correlation and binary logistic regression to analyse the data. Our result showed that nature-based solutions provide multiple ecosystem services to the urban residents with regulating services and biodiversity are prominent. Both neglected and well-maintained nature-based solutions demonstrated significant for urban sustainability but they contribute differently. The socio-cultural characterises of the respondents significantly influence their opinion on the significance of nature-based solutions in urban sustainability. The information presented in this paper will be of interest to practitioners, researchers, and policymakers working to promote nature-based solutions and urban sustainability in developing countries, as well as those interested in restoration of urban blue infrastructure as a strategy for advancing the transformative change in the process of urban development.

Keywords: Nature-based solutions, Urban sustainability, Blue infrastructure, Ecosystem services, India.

3. Nature-based Solutions in agriculture: A strategy to transform the sector

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Transformational change is required to respond to the Anthropocene polycrisis (WEF, 2023). The agricultural sector relies on ecosystems that provide several ecosystem services (ES), while significantly impacting them. Nature-based solutions (NbS) tailored for farming systems have emerged as promising contributions to solving several societal issues. Working within the H2020 MERLIN project, we focus on restoring freshwater ecosystem functions following the IUCN global standard for NbS (2022). We aimed to support the transformation of the European agricultural sector by developing a strategy for the sector to mainstream NbS, using a transformation framework (Carmen et al., under review). The strategy would support field measures (e.g., soil management); farm measures (e.g., smart buffer strips) to catchment measures (e.g., wetlands or flood plain reconnections). The strategy combined a literature review, stakeholder analysis, interviews, and two sectoral round tables with key stakeholders from the European agricultural sector. The strategy offers a vision of the agricultural sector where NbS are part of regular farming practices and enable resilient, productive, and sustainable farming systems that are interconnected. Farmers are recognized and valued by society as providers of multiple ES, resolving several societal issues, at several spatial levels. The strategy relies on six key actions that need to be urgently taken to transform the sector:

1) Engaging and assisting farmers to adopt NbSs;

2) Increasing society's understanding & support;

3) Improving policy and regulatory frameworks;

4) Setting up a network of local NbS coordinators;

5) Accelerating relevant innovations; and

6) Creating financing mechanisms that reward NbS.

These actions require the involvement of many stakeholders groups, beyond farmers and their representatives, e.g. finance institutions, media and policy makers. Recent political events

illustrate that transformations are often resisted, due to vested interests and concern that working with nature will perpetuate uneven allocation of costs and benefits within the agro-food system.

Keywords: Agriculture, Nature-based Solutions, transformation framework, freshwater, multi-scale.

4. From informing to empowerment: levels of co-creation and roles of stakeholders in development and implementation of nature-based solutions

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Nature-based solutions (NBS) are increasingly acknowledged as a systematic, cost-effective and locally-adapted approach that utilizes natural systems and community engagement to address a range of societal challenges. Integrated into blue-green infrastructure, NBS incorporate natural elements and processes into both urban and rural areas through tailored, resource-efficient interventions, thereby enhancing sustainability and resilience of socio-ecological systems. By providing examples from RECONECT* and EmpowerUs** projects, this research examines the transformative potential of NBS and illustrates their significance in tackling triple planetary crisis (climate change, pollution, and biodiversity loss). Along with assessing the effects of NBS in transformative change (e.g. through demonstrating successful strategies and models of NBS), it also focuses on the roles of stakeholders in these processes and the value of co-creation. In particular, we analyse different levels of co-creation used within the NBS co-development and co-implementation processes, starting from stakeholder informing, going through involvement and engagement and reaching empowerment. We present the frameworks for co-monitoring and co-evaluation of NBS impact from the sustainability perspective (to assess the environmental, social, and economic benefits delivered by NBS) as well as provide conceptual approaches and tools to empower stakeholders to become the drivers of sustainability transformations.

Keywords: Nature-based solutions, sustainability transformation, co-creation, stakeholder engagement, community empowerment

5. The Role of Resident Practices in Urban Soil Management and Ecosystem Service Enhancement: A Case Study of Wageningen

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Urbanization increases worldwide, and in the Netherlands, urban areas are projected to cover more than 17% of the territory by 2040. Development of urban ecosystems coincides with constructing Technosols – man-made soils in which “properties and functions are dominated by technical human activity”. The choice of Technosols’ materials, design and management may be crucial for the delivery of ecosystem services and shall be considered to support sustainable development of urban green infrastructures.

A considerable part of urban soils is located in private urban green spaces and is managed by residents, whose soil literacy and maintenance preferences strongly influence soil quality and determine Technosols’ functionality. Therefore, understanding relationships between the soil literacy, personal preferences in green spaces’ maintenance and resulting urban soils’ quality and functions is essential for enhancing the ecosystem services provided by urban green infrastructures.

This study focuses on Wageningen, known as the "City of Life Sciences," as a case study. We conducted a comprehensive questionnaire to examine the green space management practices of Wageningen residents, including aspects such as soil condition and management strategies. The survey aimed to create a group profile of the residents and assess their soil literacy. Besides, interviews with different stakeholders (soil experts, product suppliers, etc) were conducted to understand the current and potential role of soils in sustainable development of urban green infrastructures, the ecosystem services they can provide and indicators to be used for the ecosystem services’ assessment and monitoring.

By analysing the management practices and their effects on soil quality, this study provided insights into the role of residents in maintaining and improving urban soils. The research outcomes will help to identify better practices in soil management to optimize ecosystem services in urban environments, contributing to broader applications in other urban settings and enhancing our understanding of sustainable urban soil management.

Keywords: Urban soils; ecosystem services; urban green space

6. Towards Sustainable Urban Ecosystems: Planning and Management Transformation in Russia

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An application of ecosystem services (ES) and nature-based solutions (NBS) frameworks in decision-making is essential for sustainable urban development. It meets objectives for biodiversity conservation and sustainable use of ecosystems, as well as humans' quality of life and well-being enhancing. This is also true in Russia, where the rich knowledge base on urban ecosystems borders challenges of their implementation into policy and practice, specifics for the urban environment management drastically differ between the cities and decision-making rarely involves different stakeholders. The presented experience of five years of research aimed at supporting decision-making in sustainable urban development in the context of global environmental change includes important steps in assessing and analyzing the social aspects of planning and management of urban blue-green infrastructure (UBGI). For this purpose, various approaches were used including participatory practices and methods (surveys, interviews, document analyses, observations) in different cities of Russia, such as Moscow, Yekaterinburg, Rostov-on-Don, Apatity, St. Petersburg. These studies were aimed at (1) assessing nature values for residents and identifying needs for improving UBGI; (2) understanding the current state of ES and NBS implementation in practice and policy; (3) analyzing of practices in decision-making; (4) developing approaches for sustainable planning of UBGI and translation of the ES concept into environmental governance; (5) engaging various stakeholders in projects on UBGI sustainable development. The analyzes of the obtained experience gives a view on diverse limitations in ecosystem management that exist at different levels including strategic (the lack of regulatory specification of ES and NBS; the lack of public demand and the conflict of interests among stakeholders), conceptual (the lack of methodologies for assessing ES; uninformed stakeholders) and tactical (the lack of guidelines and practical experiences) levels. Addressing these challenges could advance transformative change in the sustainable use of ecosystems in Russia.

Keywords: ecosystem services, sustainable urban development, ecosystem management, participatory approaches, decision-making

7. Strengthening regional resilience in urban and regional planning through nature-based solutions: focus on nutrient retention.

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Nature-based solutions (NbS) are deliberate, strategic, evidence-based interventions that mimic, utilize, or are inspired by natural processes to address societal challenges. They are scientifically designed to emphasize the incorporation of biodiversity, ecosystem services, and sustainable resource management to promote environmental, social, and economic benefits. While NbS have been around in the literature for over fifteen years, only in the last ten years have studies on NbS and urban or regional planning started to emerge. However, only a few concern wetlands, conceived of as NbS that help addressing flood control and disaster mitigation, wastewater management, and nutrient retention. The latter aspects are especially crucial in effectively supporting regional and urban circular economies: by enabling water reuse, the consumption of fresh water is minimized, which contributes to climate adaptation.

In this study, the significance of NbS for nutrient retention is explored by coupling scientific and grey literature review with case-study analysis. A taxonomical classification of NbS to address nutrient retention is hence derived, including, for instance, constructed wetlands, natural wetlands or ponds, riverine buffers, vegetated buffer strips. For each element in the taxonomy, the main features are then outlined, including the most appropriate scale and management level, advantages and limitations, overview of the ecosystem services provided, hence highlighting co-benefits and the multifunctional character of the NbS.

The taxonomical classification here developed serves as a valuable tool for guiding planning decisions aimed at supporting circularity in water management and enhancing the environmental resilience of both urban areas and regions.

The study is developed within the project “e-INS” (Project Code ECS0000038), funded by the European Union – NextGenerationEU through the National Recovery and Resilience Plan (NRRP), Mission 4 Component 2 Investment 1.5 – Call for tender no. 3277 issued by the Italian Ministry of University and Research (MUR).

Keywords: Nature-based solutions, NbS, nutrient regulation, urban and regional resilience

8. Co-creating transformative NBS for inclusive communities – Insights from the EU project TRANS-lighthouses

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Nature-based solutions (NBS) bring together solutions and approaches to simultaneously provide environmental, social and economic benefits towards more sustainable communities. However, there is a lack further scientific evidence especially on the expected socio-cultural benefits and how indirect drivers such as not well conducted participation processes impact a proper and successful implementation. This often hinders that NBS unveil their full potentials and hindering processes to gain momentum or the uptake of NBS in a broader scale.

The EU-funded project TRANS-lighthouses (TRL) aims to unlearn, rethink and reframe the main components of NBS and their co-creation processes to achieve better, more social and more ecologically just NBS. Based on the TRL conceptual framework, we look at the four dimensions (1) transformative participatory governance, (2) enabling new human-nature relations, (3) rethinking economic logics shaping NBS and (4) social aspects. Reviewing literature and the OPPLA project data banks, gaps were identified especially when considering how to successfully create more inclusive co-creation processes and evaluating NBS performance from a community perspective. Together with pilot cases co-creating NBS, evidence is created, best practice as well as lessons learned are drawn from more mature assessment cases sharing their experiences.

We will provide insights in our most recent ongoing work compiling sets of indicators for NBS by critically reflecting and reviewing existing collections such as handbooks especially in terms of socio-ecological analysis along the four dimensions of the TRL conceptual framework. Looking at the reviewed indicators in handbooks and literature, most of them cover technical aspects on NBS, are mainly expert-driven and only a few of them consider socio-ecological aspects and do not take stakeholder perspectives into account. In detail, in several cases scales and how to measure them are missing or difficult to employ in the context co-monitoring.

Keywords: Nature-based solutions, Transformation, Co-Creation, Justice, Human-Nature Relations

9. Co-Creation and Co-Governance of Nature-based solutions

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Successful implementation of Nature-based solutions (NBS) and their social acceptance depend on stakeholder engagement from the very beginning of the co-creation processes. Analysing different EU funded sibling NBS projects following Living Lab approaches, two ways help to structure and guide co-creation processes: Co-Creation Stages/Phases or Building Blocks.

Looking at the different projects, five key co-creation stages or phases can be identified - (1) co-diagnostic, (2) co-design, (3) co-implementation, (4) co-evaluation/ monitoring and (5) co-amplification/ replication. All analysed projects had systematic approaches to identify and map stakeholders to activate co-creation processes. For the co-design phase, similar key principles, guidelines of participatory design models and approaches have proved to be useful. One element is good communication for informing, involving and empowering through sharing knowledge. Governance network typologies and actors' constellations support understanding and guiding towards new governance networks. For the participatory assessment and evaluation of NBS benefits, a number of often similar methodologies and tools were most useful.

While stages support to develop the different phases of the co-creation process of NBS, Building Blocks provide an overview of the different dimensions of co-creation processes. co-creation processes build on a number of Blocks from different categories:

(1) Founding principles blocks are the basis for the co-creation process.

(2) Stakeholder engagement blocks ensure outreach beyond the usual suspect including those who are often neglected or marginalized.

(3) Context specific building blocks are essential to successfully engage stakeholders.

(4) Inclusive approaches to encourage stakeholders to bring their skills to create added value and multiple benefits to NBS.

The understanding of building blocks is useful to reflect upon and plan the co-creation processes before initiating them highlighting important dimensions to be considered. The building blocks approach can support the identification of complementarities and contradictions, common grounds and is an alternative approach for inclusive co-creation process.

Keywords: Nature-based solutions, co-creation, co-governance, building blocks, co-creation phases

10. Unlocking the Benefits of Nature-Based Solutions: Economic Assessments and Policy Innovations

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Nature-based solutions (NBS) have become an integral part of most climate change adaptation strategies. Although the positive effects of a single small-scale NBS are often uncertain, NBS as a whole are generally associated with a wide range of societal benefits. However, implementation of NBS providing sponge function faces numerous barriers, including uncertainties, lack of funding, ownership issues, low awareness of benefits, lack of owner motivation, and spatial differentiation between the implementation site and the areas where benefits are realized (e.g., upstream-downstream relationships in flood risk reduction).

While subsidies are being used to enhance the provision of NBS benefits, supporting tools and policy instruments need to be developed to overcome other barriers. One effective approach is to use economic assessments to establish the economic case for NBS and address the unequal distribution of costs and benefits among different stakeholders (residents, owners, farmers,

decision-makers, etc.). Considering both the positive and negative impacts (in terms of ecosystem services and costs) can help allocate resources efficiently to NBS that combine climate change adaptation, biodiversity support, and social justice. Developing and testing such innovative policy instruments and governance frameworks is one of the main aims of the Horizon Europe project SpongeBoost (2024-2027).

Using the economic assessment of three NBS-supported sponge functions implemented in urban and rural areas, it is possible to demonstrate the wide range of benefits and their beneficiaries. In addition to promoting biodiversity and developing public areas, many exclusively private benefits can also be identified. Based on this, recommendations can be made on how to involve more actors in implementing NBS to drive the transformative change.

Keywords: Awareness, barriers, decision-making, nature-based governance, wetlands

11. Nature-based solutions to climate change adaptation in urban areas: a Norwegian planning perspective

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Over the last decade, scholars and policy makers have recognized the Nature-Based Solutions (NBS) as key-tools to challenge climate change mitigation and adaption Despite the rise and active promotion of NBS in the international and local debates, relatively little is known about what has been effectively done (and not yet done) at the different levels of governance and planning. The main outcomes of this study refer to research conducted by an interdisciplinary group of experts on climate, water and ground water management, urban planning and laws - from NIVA, the Norwegian Institute for Water Research and the Norwegian University of Life Sciences, commissioned by the Norwegian Environment Agency (Miljødirektoratet). The study first focuses on the challenges in implementing NBS in planning, and secondly, the main outcomes from the four selected municipalities of Trondheim (in central Norway), Stavanger (in south-western Norway), Indre Østfold (in south-eastern Norway) and Bodø (in northern Norway) are presented. Document analysis and five focus groups/interviews with the municipal managers (experts on urban planning, climate, environment and water security) were conducted. This study shows that the municipalities have acknowledged the relevance and

need for NBS to tackle the climate changes. A variety of NBS have been identified that contribute to ecosystem restoration, habitat, flood protection and water retention, as well as soil restoration and heat regulation. Nonetheless, other tools and concepts, such as blue-green factor, blue-green structure and ecological compensations, are currently used for integrating climate change adaptation in the municipalities. There are still barriers for implementing NBS (e.g. understanding of the concept itself among practitioners and local private actors and the use of other notions adopted in earlier plans). The study contributes to the current debate on the implementation and upscaling of NBS to further address climate, biodiversity, water and health issues among decision-makers, citizens and practitioners.

Keywords: Nature-Based Solutions, climate changes, practitioners, decision-makers, planning challenges

12. Unpacking the transformative potential of NbS: A focus on vulnerability and justice

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Achieving human adaptation, reducing inequality, and meeting biodiversity goals require societal transformative change, as emphasized in the latest IPES (2019) and IPCC (2022) reports. Nature-based Solutions (NbS) are increasingly recognized as transformative responses to global policy challenges. While some efforts have been made to conceptualise the transformative potential of NbS, less attention has been given to approaches that address the systemic issues underlying vulnerability. This paper presents a conceptual framework based on extensive literature on social vulnerability to climate change adaptation and the justice aspects of ecosystem services. By approaching NbS from context-specific vulnerability perspectives, the framework aims to enhance societal transformative response capacities, incorporate diverse values and knowledge systems, and ensure justice in the upscaling process of NbS.

Keywords: Transformative adaptation, NbS, Vulnerability, Justice, Upscalin

13. Building Resilient Coastal Communities through Nature-based Solutions and Empowerment Tools

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To face escalating coastal challenges from climate change and anthropogenic pressures, there is an urgent need for Nature-based Solutions (NbS) to drive transformative change in coastal social-ecological systems. NbS development offers a promising pathway, particularly when involving and empowering local communities. Responding to a request from the Horizon Europe 'EmpowerUs' project, an Expert Working Group facilitated by Eklipse—a knowledge brokerage mechanism bridging the biodiversity science-policy gap in Europe—explored how NbS can empower coastal communities and foster social-ecological resilience. The EWG conducted a Rapid Evidence Assessment on NbS and so-called Empowerment Tools (ET) applications in European coastlines, including the United Kingdom, EU Outermost Regions, Overseas Countries and Territories, and other OECD states, assessing their role in enhancing empowerment and coastal resilience.

The study highlights the critical nexus between coastal resilience, NbS, and empowerment frameworks. Key results indicate that NbS projects incorporating participatory approaches are more successful in tackling challenges related to social justice, human health, and economic development. However, standardized approaches to measure participation and empowerment outcomes are lacking in the literature. We categorize six distinct groups of ET—Education Tools, Knowledge Tools, Platform/Dialogue Tools, Governance Tools, Co-creation Tools, and Community-led NbS—showcasing their effectiveness in empowering coastal communities. Community-led NbS, designed with engagement and knowledge co-creation processes, act as powerful ET, fostering ownership and sustainable environmental management.

The study underscores the need for systemic approaches, multi-level governance, and consideration of socio-cultural diversity to improve NbS effectiveness and enable social-ecological resilience. We also provide recommendations for researchers and policymakers, such as increasing longitudinal studies to monitor intervention outcomes and funding community-based NbS initiatives, emphasizing adaptive pathways and collaborative governance. These insights offer a valuable resource for planning future NbS projects and coastal Living Labs,

contributing to the broader objective of achieving transformative change for biodiversity, climate, and sustainable development.

Keywords: Nature-based Solutions, Empowerment, Resilience, Europe, Coastal Communities

14. Developing Landscape Metrics for Mapping Societal Challenges: Application to the Kabul Region

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Cities and metropolitan regions face numerous societal challenges that require detailed landscape analysis to support sustainable spatial planning. Nature-based solutions (NBS) represent a cost-effective approach for addressing several of these societal challenges.

This research aims to develop and implement a systematic approach using spatial indicators and landscape metrics to map and prioritize societal challenges in metropolitan regions. The objectives are to identify key issues, assess their spatial distribution, and provide actionable insights for urban planning. Insights on mapping societal challenges are so far rare, especially in the Global South. This study focuses on the Kabul Region (KR), selected due to its rapid urbanization, diverse socio-economic challenges, and limited existing research on urban issues.

The research design involves a systematic approach of literature review, assessment, metric development, mapping, and validation. Firstly, key NBS publications and frameworks identified through snowball analysis are reviewed to assess societal challenges for their feasibility of being addressed through NBS and their relevance to KR. Secondly, landscape metrics and spatial indicators are developed through a targeted literature review. Thirdly, societal challenges are mapped using selected indicators and landscape metrics in KR, involving spatial multi-criteria analysis to weight and combine each indicator's impact, identifying hotspots and cold spots. Finally, findings are validated through Focus Group Discussions (FGD) with community experts.

The results focus on the case study application in the KR, which includes the development of detailed priority maps highlighting areas for intervention. These maps identify specific hotspots and cold spots of societal challenges, providing a clear spatial distribution of issues that need addressing.

This approach enhances decision-making for sustainable development and resource allocation, providing a replicable model for other metropolitan areas to promote urban resilience and sustainability.

Keywords: Landscape metrics, Mapping, Societal challenges, Spatial analysis, Urban planning

15. Aligning urban nature-based solutions with ecosystem services for transformative change

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In an increasingly urbanized world, the concepts of ecosystem services and nature-based solutions are crucial for tackling critical challenges, such as climate change, public health risks, and biodiversity loss. Nature-based solutions and ecosystem services can serve as foundations for creating transformative change that empowers both humans and non-human species. However, ambiguity in definitions and in the relationship between ecosystem services and nature-based solutions complicates comprehensive research efforts as well as their effective application in policy and planning in urban systems. We present a framework to clarify and explicitly relate the two concepts, enhancing their applicability in the management of urban challenges. We explore the role nature-based solutions play alongside social and technological solutions to aid integrative approaches to different types of challenges. Within the framework, addressing urban challenges serves as the starting point for the development and implementation of nature-based solutions. Nature-based solutions alter the flows of ecosystem services that are produced by an ecosystem by altering the performance of the ecosystem or by changing how people engage with the ecosystem. This results both in changes in the target ecosystem services, as well as non-targeted ecosystem services, leading to benefits. Using two illustrative case studies, we show how the framework can be applied to two urban challenges that are expected to increase in intensity in cities across the world: stormwater management

and urban heat stress. Moreover, we highlight key research topics that will benefit from more integrated use of nature-based solutions and ecosystem services. The framework helps emphasize co-benefits, and can be used to help make co-benefits and multifunctionality explicit in urban decision-making and planning processes – aspects that are indispensable for much needed transformations in and around cities.

Keywords: Framework, solution space, cities, social-ecological-technological interaction, biodiversity

16. Understanding the adoption of nature-based solutions in urban environments: insights from the diffusion-of-innovation theory

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The implementation of Nature-Based Solutions (NBS) in urban areas presents significant potential for addressing environmental challenges such as climate change, biodiversity loss, and urban resilience. However, their adoption is often limited by various barriers that can be understood through the lens of Everett Rogers' Diffusion of Innovation (DOI) theory. DOI theory outlines the stages through which innovations are adopted within a social system, categorizing adopters into innovators, early adopters, early majority, late majority, and laggards. By examining these stages, we aim to understand the factors influencing the adoption of NBS, such as innovation characteristics, communication channels, time, and the social system involved. Through DOI theory, we can relate NBS as "innovations" and point the stages for adoption: from initial awareness and understanding (knowledge stage) to forming attitudes and evaluations (persuasion stage), making decisions to adopt (decision stage), implementing NBS in urban settings (implementation stage), and reinforcing adoption decisions based on outcomes (confirmation stage). The theory's application can clarify factors influencing NBS adoption, including innovation characteristics (relative advantage, compatibility, complexity, triability and observability of NBS), communication channels, and the socio-technical contexts of urban environments. The objective of this study is to review empirical insights from previous studies to disentangle through the DOI concepts the actual knowledge, information, and perceptions among potential adopters of NBS. Results underscore the importance of enhancing profit benefits, reducing risk, and improving ease and convenience of installation to significantly

boost green roof adoption rates. These insights can be relevant for urban planners and policymakers aiming to promote sustainable urban development and urban resilience. Future research could explore alternative adoption frameworks to analyse adoption dynamics of NBS complementary to the use of the DOI theory.

Keywords: Nature-based solutions, Adoption, Diffusion, Innovations

17. Progress towards Nature Positive: national and global initiatives led from Ireland

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In this paper we describe two inter-connected projects, working towards nature positive from different perspectives.

The first is built around financing mechanisms for nature restoration at farm level. Through the BiOrbic SFI funded research project (working name ReFarm), the Trinity College Dublin research team is inviting businesses based in Ireland to play a role in financing action for nature restoration at farm level. The research builds on existing successful projects working with farmers (particularly in High Nature Value farming, or HNVf, systems), and natural capital accounting, to help build simple, effective governance structures to deliver and monitor outcomes, as well as ensure effective, timely payments to farmers (for habitat quality and actions to restore habitats). Aligned with other initiatives in Ireland (such as public finance under CAP programmes), the work also aims to support sustainable livelihoods in rural areas. This addresses a number of actions highlighted in the Irish National Biodiversity Action Plan, specifically in relation to exploring ways to combine private and public finance to fund national targets for climate, water and biodiversity action, as well as Just Transition.

The second is taking a global perspective. Go Nature Positive! is a collaborative initiative backed by the European Commission dedicated to accelerating awareness and transformative action towards a nature-positive economy among policymakers, investors, businesses, and wider society. The partners – led by Trinity College Dublin, and including global collaborators / pilots studies of Nature-based Enterprises - have come together to address key systemic challenges

through research, demonstration and transformational leadership. The first output of Go Nature Positive! will be the delivery of a clear EC definition and conceptual framework for the nature-positive economy (NPE). Research will consider valuable existing knowledge from business and insights from other initiatives. Through collaboration the project aims to build pathways and partnerships towards an inclusive nature-positive economy.

Keywords: Nature Positive economy, restoration, payments for habitat quality and ecosystem services, finance for nature

18. Urban transformation through phytoremediation for healthier soil and land management. The case of Milan Metropolitan area

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Contemporary urban systems face the challenge of regenerating a relevant number of areas whose soil health has been compromised by anthropogenic activity. These spaces range from significant dismissed industrial areas to small vacant or agricultural polluted plots, which need remediation to be reintegrated. Urban regeneration and remediation are intertwined processes, primarily market-driven, often resulting in interventions in the more profitable areas and further abandonment of less economically appealing sites.

Reclaiming urban soil conditions is challenging due to the high costs of traditional remediation methods and the bureaucratic complexity. This calls for a more accessible approach to regeneration. In the context of extended biodiversity loss, restoring soils has become a primary area of investigation and intervention. This urgency is reflected in the political actions of national and communitarian bodies, as evidenced by soil management and restoration strategies.

This contribution explores the application feasibility of phytoremediation in Milano's metropolitan context. It develops a methodology to identify suitable sites for this technique, which uses plants to treat soil contamination and contributes to increasing the city's natural capital and urban green spaces. Phytoremediation, as a nature-based solution, offers a more environmentally friendly alternative to traditional reclamation while providing ecosystem

services that improve urban quality by enhancing urban biodiversity, reducing pollution, and improving habitat health.

The research creates guidelines to help decision-makers and public administration identify areas suitable for this remediation approach. This involves mapping abandoned, degraded, and potentially contaminated urban areas that could benefit from phytoremediation intervention. The study also assesses the feasibility of implementing Phyto techniques, prioritizing the polluted sites included in the ecological network or the urban green provision, and develops practical instructions for designing phytoremediation projects in these areas. This new approach has the potential to significantly influence urban development, offering a sustainable solution to the pressing issue of soil restoration.

Keywords: Phytoremediation, contaminated soils, soil restoration, nature-based solutions