# Conference Abstracts

# AN1: Land Degradation and Restoration. Problems and solutions

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# An1: Land Degradation and Restoration. Problems and Solutions

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PENDING

## Abstract

Land degradation is a multifaceted challenge that requires coordinated global, national, and local action. Addressing it is essential not only for environmental sustainability but also for social and economic development. With effective policies, community involvement, and sustainable practices, it is possible to reverse degradation and restore land productivity.
Land restoration refers to the process of rehabilitating degraded land to regain its ecological integrity and productivity. It aims to reverse land degradation, restore ecosystem functions, and improve the livelihoods of people dependent on the land. Land restoration promotes the rebuilding soil fertility and structure, improve water retention, reduce soil erosion, restore biodiversity, recover the native vegetation, enhance climate resilience, and support sustainable livelihoods and enhance food security.
The restoration of the land has been classified as i) ecological when focus on re-establishing native ecosystems, including plant and animal species, and restoring natural processes; ii) agroecological when combines ecological principles with agricultural practices to sustainably restore productivity, often using agroforestry, crop rotation, and organic methods; iii) reclamation, aimed at heavily degraded lands (e.g., mines), often requiring soil amendments, grading, and infrastructure for erosion control; and iv) reforestation and afforestation when planting trees to restore forest cover on degraded or deforested lands.
The land restoration techniques require: i) revegetation when planting native or adapted species to stabilize the soil; ii) contour ploughing and terracing to reduce runoff and soil erosion in sloping terrain; iii) agroforestry when combined crops and trees; iv) composting and mulching to improve soil organic matter, water retention and runoff control; v) check dams and swales to reduce surface water flows and recharge aquifers; vi) soil amendments to recover soil properties.
The benefits of land restoration are multiple: i) increase agriculture productivity, improve water availability and quality, sequesters carbon and then mitigate climate change, enhance biodiversity and wildlife habitat, reduce disaster risks (floodings, landslides..), and support economic development and food security. However, the land restoration faces many challenges: i) high cost; ii) long timeframes; iii) land tenure and governance issues; iv) climate variability; v) monitoring and evaluation complexity. The restoration

programs are actives in all over the world. The UN Decade on Ecosystem Restoration (2021–2030), the Bonn Challenge Aims to restore 350 million hectares by 2030, the Great Green Wall (Africa) combats desertification in the Sahel and the Land Degradation Neutrality (SDG Target 15.3). And, although some programs fail, others show very positive results: i) Loess Plateau, China, transformed degraded land into productive farmland through terracing and reforestation; ii) Rwanda's Gishwati Forest that successfully restoration of biodiversity and erosion control through agroforestry; and India's Watershed Development Projects that restored arid and semi-arid lands using water harvesting and soil conservation.
This scientific session welcome research and study cases (stakeholders) on land degradation and land restoration. Information from the problems and solutions on land degradation issues are welcome.

**Keywords:** Land, Degradation, Restoration, Soil, Water, Biota, Humans

PENDING

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# Drivers of Triple Direction (Environmental – Societal – Economic) For Enhanced Forecasting of Future Land Use/Land Cover Transformations: Reviewing the Clue-S Modelling Framework in Mediterranean Settings.

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## Abstract

Precise and robust predictions of Land Use and Land Cover Change (LULCC) are fundamental for achieving sustainable land management, safeguarding ecosystem biodiversity, and ultimately adhering to national/regional policy frameworks. Remote sensing (RS) approaches for Land Use and Land Cover (LULC) mapping, have markedly upgraded our proficiency in understanding and analysing spatial and temporal land change patterns, especially in fragile ecosystems such as the Mediterranean Basin, characterized by complex interactions between human influences and climatic extremes. A wide spectrum of current research demonstrates that land use modifications are majorly determined by a mix of biophysical and anthropogenic determinants, such as topographical features, climatic variables, demographic trends, and proximity to urban areas. Nonetheless, the existing body of literature frequently emphasizes a confined selection of those determinant factors, rather than a pluralistic modelling prediction approach. Analyses that are spatially explicit in Mediterranean contexts demonstrate that historical alterations of LULC are driven by synergistic, non-linear interactions between biophysical constraints and socioeconomic influences. This complexity underscores the need for integrative, multi-dimensional modelling approaches capable of capturing multi-scale change dynamics. In this manuscript, emphasis is placed on the urban and peri-urban zones of Larnaca, Cyprus, as we review the contemporary literature on LULC modelling and critically analyse the extent to which the current applications of the Conversion of Land Use and its Effects at a Small regional extent (CLUE-S) model incorporate a range of determinant factors. Building on this review, the study explores the necessity of integrating additional environmental and sectoral datasets - beyond conventional topographic, climatic, and demographic variables - into future CLUE-S simulations. These include EU and national geospatial prediction datasets such as erosion probability, desertification risk, flood susceptibility, Aquifer Quality Index, and Soil Organic Carbon (SOC) density maps. The manuscript argues that incorporating such multidimensional determinants can substantially enhance model sensitivity to both natural constraints and anthropogenic pressures, leading to more robust and policy-relevant LULC projections under Mediterranean climate conditions. In light of swift global changes in both environmental and socioeconomic spheres, this proposed

framework enhances policy-related decision-making centres with improved and effective awareness and preparedness for future decisions.

**Keywords:** Land Use Land Cover Change, Remote Sensing, CLUE-S model, Multidimensional Drivers, Land Dynamics, Cyprus

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# Securing the Nation’s Water Supply and Livelihoods Using Nature Based Solution

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## Abstract

Water is one of the limited resources in many regions of the world, and poor management of this resource has exacerbated water related challenges in the developing countries. As a water scarce country, South Africa socio-economic development and growth is intertwined with its water security status and risks. This paper is aimed at illustrating the connection and interdependencies existing between water security and the catchment activities. Special focus on the Maloti-Drakensberg water catchment area showed the impact of soil or land management on securing water resources to increase water security in South Africa. Soil erosion studies have warned about the huge amount of top soil removed and mobilized as sediments to rivers and dams or lakes. The eroded soil from upstream catchments don’t only impoverish agricultural fields (and farmers), but also reduce the water storage capacity of river’s pools, dams or lakes located downstream. Dam siltation or sedimentation contributes to dam wall’s degradation which compromise the safety of dams. The demand for water has become higher than the supply in many parts of South Africa due to the increasing population and increasing economic activities. The case studies showed that the best way to improve water security is to protect water at its source. South Africa has delineated and mapped sites that are called Strategic Water Source Areas. In addition, there are research and development projects and programmes implemented to protect these strategic water sources areas, which this paper will present.

**Keywords:** Dams, degradation, siltation, water security, water supply, water quality, water quantity

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# Landscape Connectivity and Multi-Hazard Risk Management in the Zagros Mountains, Iran

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## Abstract

Mountain landscapes are increasingly affected by the combined impacts of natural hazards, environmental degradation, and human pressure, creating complex challenges for sustainable management. The Zagros Mountains, one of the largest mountain systems in Southwest Asia, are characterised by active geomorphological processes, recurrent landslides, flash floods, soil erosion, and extensive land-use change. Previous studies have highlighted the importance of landscape connectivity and resilience for understanding environmental change and hazard propagation in mountain regions (Brierley et al., 2021; Fryirs, 2013), while investigations in the Zagros Mountains have demonstrated the sensitivity of geomorphological systems to climatic and environmental variability (Ghadimi et al., 2015; Ghadimi et al., 2019). This study explores the relationship between landscape connectivity and multi-hazard risk across the Zagros region using an integrated geospatial framework. Topographic, hydrological, ecological, and anthropogenic variables were analysed to identify areas where environmental disturbances can propagate through interconnected landscape systems and amplify hazard impacts. The results reveal that highly connected mountain corridors, particularly along steep catchments and densely utilised valleys, exhibit elevated vulnerability to cascading hazard processes. The analysis highlights the role of landscape structure in controlling the spatial distribution of risk and demonstrates that hazard management strategies focusing solely on individual processes may overlook critical interactions between environmental systems. The proposed approach supports the identification of priority areas for ecosystem restoration, risk reduction, and sustainable land management. By linking geomorphological dynamics with landscape-scale planning, this study provides new perspectives for enhancing resilience and supporting sustainable development in mountain regions exposed to multiple environmental hazards.

**Keywords:** Landscape Connectivity, Multi-Hazard Risk, Sustainable Land Management, Environmental Resilience

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# Impact of Local Environmental Management on the Diversity and Availability of Economically Important Wild Food Plants in the Central Sumatra Traditional Markets

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## Abstract

Wild plants play an important role in the daily practices of local communities. However, modernisation and rapid natural habitat alteration in Central Sumatra (Indonesia) have threatened the local knowledge related to wild plants. Traditional markets serve as important ethnobotanical places where such knowledge is maintained and transmitted. This study examines the distribution patterns of useful wild plants in Riau across 58 traditional markets using semi-structured interviews. We used Canonical Correspondence Analysis (CCA) to assess plant distribution in relation to socio-ecological factors and compare species richness across land-use types. We found that 172 wild plant species are sold in the markets, and most of them are food plants. Our analyses revealed that markets tend to cluster geographically. The distribution of wild plants in the markets is influenced by the socioecological characteristics and ethnic diversity of the area. We also found that Markets located in areas dominated by monoculture plantations have low species richness and high plant homogeneity. Our findings show that the expansion of monocultures plantation in Riau is a threat to biodiversity and traditional knowledge. The result of our study highlights the need to conserve natural habitat for cultural continuity, livelihoods, and food security.

**Keywords:** Biodiversity, Deforestation, Edible plants, Ethnobotany, Monoculture plantation, Useful plant

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# Nitrogen Management For Soil Carbon Stabilization in Arid Agroecosystems: Linking Aggregates, Microbes and Functional Carbon Pools

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## Abstract

Soil aggregate stability is a key control of soil organic carbon (SOC) protection, nutrient cycling and soil resilience, particularly in arid and semi-arid agroecosystems. Nitrogen (N) inputs can increase plant productivity and carbon inputs, but their effects on SOC storage are strongly dependent on application rate, soil conditions and microbial responses. This review synthesizes evidence from PubMed, Web of Science and Scopus on N-mediated changes in soil aggregation, aggregate-associated carbon fractions, microbial communities, functional genes and carbon-stabilization pathways in arid agricultural systems. The synthesis shows that N effects on SOC and soil structure are nonlinear. Moderate N inputs, commonly reported around 50–200 kg N $ha^{-1}$ $yr^{-1}$, generally promote plant-derived carbon inputs, macroaggregate formation, microbial biomass and glomalin-related aggregation. In contrast, excessive N inputs, often above approximately 200–300 kg N $ha^{-1}$ $yr^{-1}$, may increase microbial decomposition, soil acidification and SOC turnover, although thresholds vary with soil texture, climate and management. Nitrogen tends to stimulate labile carbon pools such as particulate organic carbon (POC), dissolved organic carbon and microbial biomass carbon more rapidly than stable mineral-associated organic carbon (MAOC). Long-term carbon sequestration therefore depends on the transfer of plant-derived and microbial-processed carbon into physically and mineral-protected pools. The review further identifies microorganisms as a central link between N management, aggregate formation and SOC stabilization. Nitrogen alters microbial community composition, enzyme activities, interaction

networks and carbon-cycle functional genes, while microbial residues contribute to stable SOC formation. Integrating N management with organic amendments can strengthen microbial functioning and SOC accumulation. We propose an integrated framework in which N availability regulates plant carbon inputs, microbial processing, aggregate formation and mineral protection. The findings support balanced, site-specific N management as a nature-based pathway for improving soil health, carbon sequestration and climate resilience in dryland agriculture.

**Keywords:** Soil aggregate stability, nitrogen management, soil organic carbon, microbial functions, arid agroecosystems

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# Relative Cost-Effectiveness of Nature-Based Systems For Mitigation of Diffuse Agricultural Pollution Across Diverse Landscapes in New Zealand

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## Abstract

Pastoral agricultural landscapes vary widely in their topography, soils, and hydrological characteristics, requiring tailored approaches that target the dominant flow pathways of diffuse contaminant export. We examine how the cost-effectiveness of nature-based interceptive mitigation systems varies across farm typologies and hydrologic landscape types (HLTs) in New Zealand. Using a national-scale modelling framework, we build on previous work by incorporating detailed farm typology data, stream network characteristics, and hydrologic flow paths to assess the performance and cost of riparian buffers, constructed wetlands, detainment bunds, woodchip bioreactors and filamentous algal nutrient scrubbers for reduction of total nitrogen (TN), total phosphorus (TP), and sediment. Each farm typology is matched to a representative landscape classification using the River Environment Classification (REC2), and we estimate cost-effectiveness across a full range of contaminant reduction levels using an improved optimisation algorithm. Rather than focusing on fixed reduction targets, our analysis uses marginal abatement cost curves to illustrate the trade-offs involved in achieving progressively higher levels of mitigation. Results show that landscape permeability, climate, and profitability strongly influence the feasibility and optimal mix of mitigation systems. This farm- and landscape-specific approach enables more targeted and cost-efficient freshwater interventions and provides a decision-support tool to help prioritise investment where it will deliver the greatest environmental benefit.

**Keywords:** grazing, landscapes, pollution

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# Soil Erosion in Citrus Plantations: a State-of-the-Art Review

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## Abstract

Soil erosion constitutes a major environmental and agronomic challenge in citrus plantations, particularly in Mediterranean and subtropical regions where orchards frequently occupy sloping terrain and experience highly variable rainfall. A global systematic review confirms that citrus orchards can exhibit severe soil loss when vegetation is removed and the soil is intensively managed (Niu et al., 2021). Conventional practices commonly maintain bare inter-rows through tillage or herbicide application to control weeds and reduce competition for water and nutrients. However, these practices expose the soil to raindrop impact, decrease surface roughness and organic-matter inputs, promote crust formation and reduce infiltration. Machinery traffic and drip irrigation can further increase soil compaction and spatially concentrate water, runoff and sediment transport (Di Prima et al., 2018; Cerdà et al., 2021). Research in eastern Spain has demonstrated that newly established citrus plantations on slopes can produce high runoff coefficients and erosion rates under intense rainfall, especially following major land levelling and mechanisation (Cerdà et al., 2009). Soil loss is controlled by interactions among rainfall erosivity, slope gradient, soil texture, antecedent moisture, plantation age, vegetation cover and management intensity. Nevertheless, comparison among studies remains difficult because monitoring methods, plot dimensions, rainfall characteristics and observation periods are poorly standardised (Niu et al., 2021). Vegetated inter-rows, spontaneous plant cover, catch crops, organic farming, reduced tillage and organic mulches are among the most promising nature-based solutions. Straw mulch can substantially delay runoff initiation and reduce sediment detachment in glyphosate-treated clementine orchards (Keesstra et al., 2019). Similarly, chipped pruning residues provide soil protection while reusing locally available agricultural waste, although their adoption depends on costs, machinery and policy support (Cerdà et al., 2018). Organic management can also improve soil organic carbon, aggregate stability, porosity and overall physical quality compared with tillage- and herbicide-based systems (Di Prima et al., 2018). Abandonment may promote vegetation recovery and

reduce erosion, but it can also affect water resources, fire risk and landscape management (Cerdà et al., 2019). Future research should prioritise long-term standardised monitoring, extreme rainfall events, rill and gully development, sediment connectivity and nutrient and pesticide transport. Integrating field experiments, UAV surveys, high-resolution modelling, economic assessment and farmer participation will be essential for designing site-specific strategies that conserve soil without compromising citrus productivity, fruit quality or farm profitability.

Measured erosion rates in citrus plantations vary widely according to soil management, slope, rainfall characteristics and monitoring method. Rainfall simulations in newly established citrus orchards on sloping land in eastern Spain recorded soil losses of approximately 2.4 Mg $ha^{-1}$ during a single one-hour storm representing a five-year return period (Cerdà et al., 2009). These event-scale measurements demonstrate the high erodibility of mechanically disturbed and vegetation-free orchard soils, but they should not be directly interpreted as annual erosion rates.

Long-term measurements also reveal substantial differences among management systems. In a drip-irrigated citrus plantation in the eastern Iberian Peninsula, conventional tillage produced a cumulative soil loss of 6.87 Mg $ha^{-1}$, whereas plots with a grass cover lost only 0.0092 Mg $ha^{-1}$. Soil loss under tillage was therefore approximately 745 times greater than under permanent vegetation (Cerdà et al., 2021).

Rainfall-simulation experiments in glyphosate-treated clementine orchards measured an average soil loss of 439 g per 0.28-$m^2$ plot under bare-soil conditions. Applying straw mulch reduced this value to 73 g per plot and lowered sediment concentrations from 16.7 to 3.6 g $L^{-1}$ (Keesstra et al., 2019). The wide range of recorded values confirms that soil cover is a dominant control on erosion. Nevertheless, differences in plot dimensions, rainfall intensity and measurement duration require caution when comparing experimental and long-term field rates (Niu et al., 2021).

**Keywords:** Citrus, erosion, soil, sustainable, land, degradation, desertification, hydrology, sediments.

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# A Comprehensive Bibliometric Review of Land Degradation in Africa

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## Abstract

Land degradation is a major but underprioritized environmental challenge in Africa, yet the field's overall literature has rarely been mapped systematically to reveal how research has grown, clustered, and evolved. This study presents the first continent-wide bibliometric review of African land degradation research, characterizing its growth, structure, and thematic evolution, and examining reported drivers. A focused search in OpenAlex yielded 143 English-language articles and reviews (2006–2026), analyzed using Bibliometrix/Biblioshiny for annual production trends, citation performance, collaboration networks, and thematic mapping. This quantitative analysis was complemented by qualitative content analysis of the 18 most globally cited publications and 7 representative emerging-topic publications (2022–2026), coded for reported drivers, consequences, methodological approaches, and research gaps. Publication output grew modestly but unevenly (annual growth rate of 2.59%), led by South African institutions within a broadly collaborative, internationally connected research network. Climatic variability (94%) and overgrazing/livestock pressure (67%) dominated as reported drivers, while soil organic carbon loss and vegetation/biodiversity decline (56% each) dominated as reported consequences. Soil microbial responses were addressed in 11% of the high-impact literature and were absent entirely from the emerging-topic sample. These findings indicate that African land degradation research remains thematically imbalanced, disproportionately favoring climatic and vegetation-based indicators over soil-biological processes. The consistent neglect of soil microbial responses across both samples represents a genuine, structural evidentiary gap rather than an artefact of citation bias, leaving a critical mechanistic link in the degradation-to-productivity pathway empirically unexamined. Future primary research that directly pairs remote-sensing, survey, or productivity-based degradation assessment with soil-biological sampling is needed to close this gap and support a more evidence-based foundation for land restoration policy across the continent.

**Keywords:** Soils, Africa, Desertification, Salinization, Deforestation, Research, Bibliography.

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# Vegetation Cover as a Nature-Based Solution to Reduce Soil Erosion in Citrus Plantations

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## Abstract

Soil erosion is a major environmental challenge in Mediterranean citrus plantations, where intensive management, tillage, herbicide application, and the consequent reduction of vegetation cover frequently expose the soil surface to rainfall and overland flow (Cerdà et al., 2009; Keesstra et al., 2019). High-intensity Mediterranean rainfall can generate substantial runoff and sediment losses, particularly in recently established orchards on sloping terrain (Cerdà et al., 2009). Vegetation and ground cover can substantially reduce these losses by protecting the soil against raindrop impact, increasing surface roughness and infiltration, and reducing runoff connectivity (Liu et al., 2012; Cerdà et al., 2018; Rodrigo-Comino et al., 2018). Consequently, maintaining vegetation cover represents a promising nature-based strategy for improving the sustainability of Mediterranean citrus production. Rainfall simulation experiments were carried out following the methodology developed by Cerdà for the assessment of soil hydrological and erosional responses under Mediterranean conditions. Rainfall was applied at an intensity of 55 mm $h^{-1}$ for 60 min over a 1 $m^2$ surface, while runoff and

sediment were collected from a 0.25 $m^2$ plot located in the central part of the wetted area. The simulator was positioned approximately 2 m above the soil surface to reproduce natural raindrop characteristics. Runoff was collected at one-minute intervals, and sediment concentration was determined from runoff samples to calculate soil loss. Prior to each experiment, vegetation cover, soil surface characteristics and antecedent soil moisture were recorded. This standardized experimental design allowed direct comparison of runoff generation, infiltration and soil erosion between citrus plots with contrasting vegetation cover. The system is also characterized by droplets of approximately 2.5 mm, a fall velocity of about 3.4 m $s^{-1}$ and kinetic energy of approximately 7.1 J $m^{-2}$ $mm^{-1}$ which has a 5 year return period in the study area The results shows a reduction in the soil losses as a consequence of the vegetation cover. Plots with less than 5 % plant cover results in soil erosion larger than 3 Mg ha-1 y-1. And plots with more than 50 % plant cover the soil losses were reduced to 0.2 Mg ha-1 y-1.

**Keywords:** Soil, Erosion, Citrus, Plant, Nature-based Solution, Runoff.

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# The Importance of Agricultural Terraces in Runoff Generation and Soil Loss Control

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## Abstract

The Importance of Agricultural Terraces in Runoff Generation and Soil Loss Control Agricultural terraces are among the oldest and most widespread strategies for cultivating sloping land while conserving soil and water resources. By shortening slope length and reducing its gradient, terraces modify the movement of water across hillslopes, promote infiltration, decrease runoff velocity and limit sediment transport (Arnáez et al., 2015; Wei et al., 2016; de Paula et al., 2026). Nevertheless, their hydrological and geomorphological effects vary considerably according to terrace design, soil properties, rainfall intensity, vegetation cover, cultivation practices and maintenance conditions. This course examines the role of agricultural terraces in runoff generation, hydrological connectivity and soil erosion, with particular attention to Mediterranean and other mountainous landscapes, such as agricultural landscapes in Paraná, Brazil.. Properly designed and maintained terraces generally reduce surface runoff and soil loss, improve soil-water retention and limit sediment delivery to downstream areas (Ran et al., 2020; Zhao et al., 2021). Conversely, the deterioration of terrace walls and drainage structures may concentrate runoff, reconnect natural drainage pathways and initiate rilling, gullying, piping, mass movements or cascading terrace failures (Moreno-de-las-Heras et al., 2019). The programme will introduce the principal methods used to investigate these processes, including rainfall simulations, runoff plots, sediment monitoring, soil-property assessment, remote sensing, unmanned aerial vehicle surveys and hydrological modelling. Comparative case studies will demonstrate how climate, topography, lithology, land use and vegetation interact to determine the hydrological response and erosional stability of terraced landscapes. Particular attention will be paid to agricultural abandonment. Its effects are not uniform: vegetation recovery may decrease runoff and surface erosion, whereas insufficient plant cover and the deterioration of terrace structures can increase hydrological connectivity and erosion risk (García-Ruiz & Lana-Renault, 2011; Rodrigo-Comino et al., 2018). In Mediterranean environments, the stability of abandoned terraces depends particularly on vegetation development, lithology, rainfall regime and the structural condition of walls and drainage systems (Moreno-de-las-Heras et al., 2019). Finally, the course will examine how increasingly extreme rainfall, rural depopulation and insufficient maintenance threaten traditional

terraced landscapes. Participants will assess management options ranging from continued cultivation and structural rehabilitation to vegetation restoration and managed rewilding. Terraces will therefore be considered multifunctional landscapes whose conservation contributes to sustainable agriculture, water regulation, erosion control, climate adaptation, biodiversity and cultural heritage.

**Keywords:** : Agricultural terraces, runoff, Soil erosion, Soil loss, Hydrological connectivity, Land abandonment, Mediterranean landscapes, Soil and water conservation.

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# Biochar as a Soil Amendment to Mitigate the Impacts of Land Degradation

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## Abstract

Land degradation is a major global environmental challenge that reduces soil productivity, threatens food security, diminishes biodiversity and weakens the capacity of terrestrial ecosystems to regulate water and climate. It results from interacting processes such as soil erosion, organic-matter depletion, compaction, acidification, salinisation, nutrient loss and contamination. Conventional restoration practices often require repeated applications of fertilisers, lime, compost or other materials whose effectiveness and economic viability may decline over time. Biochar has therefore attracted attention as a potentially long-lasting soil amendment capable of addressing several forms of degradation simultaneously.

Biochar is a carbon-rich, porous material produced through the thermochemical conversion of biomass under oxygen-limited conditions. Feedstocks may include crop residues, forestry waste, manure and selected organic by-products. Pyrolysis converts part of the original biomass carbon into relatively stable aromatic structures, allowing biochar to remain in soil longer than most uncharred organic amendments. When biochar production uses sustainably sourced residues and controls emissions, it can contribute to climate-change mitigation while returning carbon and nutrients to soils (Woolf et al., 2010). Nevertheless, biochar is not a uniform product: feedstock composition, pyrolysis temperature, residence time and post-production treatment determine its pH, porosity, surface chemistry, nutrient content and potential contaminants.

One of biochar's most relevant contributions to restoring degraded soils is the improvement of physical structure. Many degraded soils exhibit high bulk density, weak aggregation, surface crusting and restricted root penetration. Because biochar generally has a lower density and greater porosity than mineral soil, its incorporation can reduce bulk density and increase total porosity. It may also improve aggregate stability by modifying particle associations and stimulating biological binding processes. A broad review found that biochar frequently improves soil physical conditions, although responses are generally stronger in coarse-textured soils than in fine-textured soils and

vary substantially with particle size and application rate (Blanco-Canqui, 2017).

These structural changes influence water storage and movement. Biochar particles contain internal pores that may retain water, while their incorporation changes the size and connectivity of pores between soil particles. A systematic review and meta-analysis found that biochar reduced bulk density and increased plant-available water, with the greatest improvements occurring in coarse-textured soils. Effects were smaller and less consistent in fine-textured soils, demonstrating that biochar should be matched to the properties of the receiving soil (Li et al., 2020). Improved water retention may enhance drought resilience and plant establishment on dry or disturbed land. However, inappropriate particle sizes or application rates may alter hydraulic conductivity unpredictably, while some highly hydrophobic fresh biochars can initially repel water.

Soil erosion is another central process linking land degradation, declining fertility and sediment pollution. Biochar may reduce erosion by improving aggregation, infiltration, surface roughness and vegetation development. A global meta-analysis reported average reductions of approximately 25% in runoff and 16% in water-driven soil erosion following biochar application. The effect was stronger when biochar was combined with vegetation, indicating that biochar should complement rather than replace plant cover and other conservation measures (Bekchanova et al., 2024). Effective restoration should therefore integrate biochar with cover crops, mulching, contour planting, reduced tillage or agroforestry.

Chemically degraded soils may benefit from biochar's liming capacity, surface charge and nutrient-retention properties. Many biochars increase soil pH and cation-exchange capacity, particularly in acidic and sandy soils. Their surfaces can retain ammonium, potassium, calcium and other nutrients, potentially reducing leaching and improving fertiliser-use efficiency. A global meta-analysis found positive effects on soil organic carbon, total carbon, pH and cation-exchange capacity, but identified application rate, initial soil pH and sand content as major controls over the magnitude of these responses (Sun et al., 2022).

**Keywords:** Biochar, soil amendment, land degradation, soil restoration, erosion, soil carbon, water retention, nutrient cycling, contaminated soil, climate mitigation.

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# Vegetation and Evapotranspiration Response to Watershed Restoration: a Case Study of Vardij Watershed, Iran

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## Abstract

Vegetation restoration is an important component of watershed management in semi-arid regions, where vegetation dynamics are closely linked to water availability and land-surface conditions. This study evaluated long-term changes in vegetation and actual evapotranspiration following watershed restoration measures in the 328-ha Vardij Watershed, Iran. Annual NDVI, actual evapotranspiration (ET), and precipitation were analyzed for the period 2001–2025, with 2013 considered as the reference year for the implementation of biological and mechanical soil and water conservation measures. The results showed a clear improvement in vegetation conditions after the interventions. Mean NDVI increased by about 11% compared with the pre-restoration period, while the rate of NDVI increase was more than three times higher than before the interventions. In contrast, mean annual precipitation decreased by about 9%, whereas mean annual ET increased by approximately 5%. Spatial analysis also indicated a greater presence of higher NDVI classes, particularly in the central and southern parts of the watershed after restoration. The simultaneous increase in vegetation greenness and ET under lower mean precipitation suggests that the response of the watershed was not controlled by rainfall alone. Improved infiltration, greater retention of rainfall within the soil–vegetation system, and better availability of stored water following soil and water conservation measures may have contributed to sustaining vegetation growth and increasing water use by vegetation. Overall, the results indicate a positive long-term response of the Vardij Watershed to restoration measures and demonstrate the value of multi-temporal remote sensing for assessing vegetation and hydrological responses to watershed management in semi-arid environments.

**Keywords:** Watershed restoration, NDVI, Actual evapotranspiration, Remote sensing, Iran

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# Land Restoration in Africa: a Systematic Thematic Review

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## Abstract

Land degradation affects a large share of Africa's croplands, rangelands, and forests, prompting continental initiatives such as AFR100 and the Great Green Wall, yet the rapidly expanding body of African land-restoration research has not been systematically synthesized across approaches, contexts, and outcomes. This study addresses that gap by characterizing the research landscape, thematic focus, and evidence gaps of land-restoration research in Africa.
Bibliometric analysis (Bibliometrix/Biblioshiny) was combined with Text-Analysis-for-All (TALL)-assisted thematic coding of 131 peer-reviewed articles and reviews on land restoration in Africa (2006–2026), retrieved from OpenAlex following a PRISMA-adapted screening process, to characterize the field's research landscape, restoration themes, geographical and ecological contexts, outcomes, temporal trends, and governance dimensions.
Annual publication output rose from single articles before 2010 to 10–14 articles annually after 2019, concentrated in Ethiopia (34.9%) and Egypt (17.1%). Agroforestry-based (29.0%) and engineering-based reclamation (28.2%) approaches dominated, while erosion/landform rehabilitation and soil-microbial outcomes remained near-absent (under 2%). Socioeconomic outcomes were reported nearly twice as often as any biophysical outcome (32.6%), and only 19.1% of studies combined multiple restoration themes. Ecosystem/landscape restoration, governance/adoption assessment, and soil-and-water conservation emerged as growing themes after 2016, while stakeholder-participation reporting rose from 5% to 33% across periods, even as institutional-mechanism and policy-barrier documentation remained rare.
African land-restoration research is expanding and diversifying thematically, but remains geographically concentrated, methodologically fragmented, and weak in ecological-outcome verification, particularly for reclamation and mine-rehabilitation approaches. Closing these gaps requires paired ecological–socioeconomic evaluation, multi-country monitoring matched to programme scale, and expanded research coverage of underrepresented regions and ecosystems.

**Keywords:** land restoration, land degradation, sub-Saharan Africa, agroforestry, ecosystem

restoration, governance

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# Land Restoration in Africa: a Systematic Thematic Review

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## Abstract

Land degradation affects a large share of Africa's croplands, rangelands, and forests, prompting continental initiatives such as AFR100 and the Great Green Wall, yet the rapidly expanding body of African land-restoration research has not been systematically synthesized across approaches, contexts, and outcomes. This study addresses that gap by characterizing the research landscape, thematic focus, and evidence gaps of land-restoration research in Africa. Bibliometric analysis (Bibliometrix/Biblioshiny) was combined with Text-Analysis-for-All (TALL)-assisted thematic coding of 131 peer-reviewed articles and reviews on land restoration in Africa (2006–2026), retrieved from OpenAlex following a PRISMA-adapted screening process, to characterize the field's research landscape, restoration themes, geographical and ecological contexts, outcomes, temporal trends, and governance dimensions. Annual publication output rose from single articles before 2010 to 10–14 articles annually after 2019, concentrated in Ethiopia (34.9%) and Egypt (17.1%). Agroforestry-based (29.0%) and engineering-based reclamation (28.2%) approaches dominated, while erosion/landform rehabilitation and soil-microbial outcomes remained near-absent (under 2%). Socioeconomic outcomes were reported nearly twice as often as any biophysical outcome (32.6%), and only 19.1% of studies combined multiple restoration themes. Ecosystem/landscape restoration, governance/adoption assessment, and soil-and-water conservation emerged as growing themes after 2016, while stakeholder-participation reporting rose from 5% to 33% across periods, even as institutional-mechanism and policy-barrier documentation remained rare. African land-restoration research is expanding and diversifying thematically, but remains geographically concentrated, methodologically fragmented, and weak in ecological-outcome verification, particularly for reclamation and mine-rehabilitation approaches. Closing these gaps requires paired ecological–socioeconomic evaluation, multi-country monitoring matched to programme scale, and expanded research coverage of underrepresented regions and ecosystems.

**Keywords:** land restoration, land degradation, sub-Saharan Africa, agroforestry, ecosystem restoration, governance

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# Agrivoltaics and Extensive Livestock Farming: Soil, Thermal, and Geomorphometric Evaluation of Solar Grazing in Rural Granada

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## Abstract

The shift toward renewable energy and the expansion of solar projects increasingly compete with extensive livestock farming for a vital strategic asset: land. To address this land-use competition, solar grazing has emerged as a novel practice that merges renewable electricity generation with traditional grazing within the same perimeter, maximizing territory utility and mitigating friction between industries. This research communication highlights early findings from an ongoing study based in Granada province, an administrative territory experiencing rapid solar development that raises critical questions regarding agricultural, territorial, and visual impacts. The core objective is to evaluate the spatial scale of photovoltaic facilities across the province and assess their direct effect on pasture availability and functionality for livestock producers. Furthermore, the project captures the viewpoints, goals, and expectations of local stakeholders to determine the conditions under which solar grazing fosters sustainable energy and farming management.

The initial phase documented in this paper relies on drone-based measurements using the DJI Mavic 3M and Matrice T4 platforms to generate detailed geomorphometric and thermal maps and evaluate direct soil impacts. Field methodology further incorporates penetrometer testing and laboratory analysis to measure differences in soil water retention capacity alongside key properties such as organic matter, pH, electrical conductivity, and aggregate stability. This integrated spatial and edaphic evaluation helps clarify how solar installations influence forage accessibility for extensive herds. Anticipated outcomes point toward notable environmental advantages—such as enhanced soil conservation and lower ecological disruption—alongside financial gains driven by revenue diversification and reduced operating expenses. Ultimately, the study sheds light on perceived obstacles and catalysts among participants, promoting the scalability of this practice to achieve a socially equitable ecological transition.

**Keywords:** Agricoltaics, geomorphology, regional studies, UAV

# AN2: Innovative means for sustainable disposal of animal farming liquid manure

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# An2: Innovative Means For Sustainable Disposal of Animal Farming Liquid Manure

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PENDING

## Abstract

The management of liquid manure from intensive animal farming poses a major environmental and agronomic challenge due to the risk of nitrogen leaching, greenhouse gas emissions, odors, and long-term soil degradation. As livestock production expands and environmental standards become stricter, there is an urgent need for sustainable and practical solutions that close the nutrient loop between animal waste and crop production systems. This session focuses on innovative strategies that transform liquid manure from an environmental liability into a valuable resource for soil and crop productivity.
Key topics include emerging technologies for manure stabilization, treatment, and precision application, such as anaerobic co-digestion, ammonia recovery, nitrification-denitrification systems, and controlled-rate fertigation. Research findings on improving nitrogen use efficiency (NUE) in crops through optimized timing, placement, and chemical or biological amendments will be highlighted. These methods aim to maximize nutrient recycling while minimizing nitrate leaching to groundwater and reducing gaseous nitrogen losses in the form of ammonia and nitrous oxide. The role of additives and filtration systems in odor mitigation and pathogen reduction will also be discussed, emphasizing their contribution to improving air quality and worker health in farming communities.
The session will further address the importance of maintaining soil health under repeated manure applications. Presentations will explore soil physical and chemical responses to long-term manure use, including effects on microbial activity, organic matter dynamics, and nutrient balance. Integrating these insights can guide the design of adaptive management frameworks that harmonize productive agriculture with environmental protection.
By bringing together researchers, policymakers, and industry innovators, this session seeks to stimulate dialogue on scalable, evidence-based approaches for sustainable liquid manure management. The shared goal is to develop systems that reduce pollution, recover valuable nutrients, maintain healthy soils, and support a more circular and resilient agricultural economy.

**Keywords:** sustainability, Nitrogen, effluents, animal farming, soil health

# AN3: Plant biostimulants for a more sustainable agriculture

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# An3: Plant Biostimulants For a More Sustainable Agriculture

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PENDING

## Abstract

Plant biostimulants are emerging as a key pillar in the transition toward more sustainable and resilient agricultural systems. Unlike fertilizers, which supply nutrients, or pesticides, which protect against pests and diseases, biostimulants enhance the natural processes within plants and soils to improve nutrient efficiency, stress tolerance, and overall crop vitality. They include a diverse group of substances and microorganisms such as humic and fulvic acids, seaweed extracts, protein hydrolysates, beneficial fungi like Trichoderma, plant-growth–promoting rhizobacteria, and silicon-based products. Their strength lies not in replacing existing practices outright but in complementing them to improve performance while reducing environmental pressures.

Sustainability in agriculture demands solutions that maintain high productivity while minimizing the ecological footprint. Biostimulants contribute to this goal by enhancing nutrient uptake, thereby enabling farmers to reduce fertiliser inputs without compromising yield. This reduction helps limit nutrient runoff—a significant contributor to water pollution and eutrophication. Moreover, biostimulants enhance root development and soil structure, increasing water-holding capacity and promoting more efficient water use, a critical benefit under increasing drought frequency and irregular rainfall patterns driven by climate change.

Another major challenge for modern agriculture is plant stress, whether caused by salinity, heat, drought, or transplant shock. Biostimulants help plants regulate stress-related physiological pathways, stabilising membranes, improving antioxidant activity, and supporting faster recovery. As a result, crops become more resilient, reducing losses and decreasing reliance on chemical inputs aimed at mitigating stress symptoms.

From an ecological perspective, many biostimulants support the soil microbiome—an essential component of soil health. Enhanced microbial activity improves nutrient cycling and organic matter formation, promoting long-term fertility and reducing soil degradation. Over time, this fosters regenerative agricultural practices, where soil functions are restored rather than depleted.

Economically, biostimulants can help farmers optimize resource use, reducing input costs while increasing quality traits such as fruit size, colour, uniformity, or shelf life. These improvements can enhance marketability and overall profitability, particularly in high-value crops.

As climate pressures intensify and regulatory frameworks push for reduced chemical use, plant biostimulants offer a highly promising, science-based strategy for achieving sustainable agriculture. They bridge productivity with environmental stewardship,

helping build resilient agroecosystems capable of feeding a growing global population.

**Keywords:** resource use efficiency, tolerance to abiotic stress, beneficial microbes, nature-based solutions

PENDING

# AN4: Nature-Based Solutions in Agriculture: Innovations, Evidence, and Practice

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# An4: Nature-Based Solutions in Agriculture: Innovations, Evidence, and Practice

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PENDING

## Abstract

Agricultural systems are increasingly challenged by climate variability, soil degradation, and rising demands for food production. In this context, Nature-Based Solutions (NBS) have emerged as effective approaches that work with ecological processes to strengthen farm resilience, sustain productivity, and protect biodiversity. Practices such as agroforestry, soil-health–oriented management, nature-based water regulation, and landscape-scale restoration demonstrate how leveraging natural functions can generate multiple benefits across environmental, social, and economic dimensions.
This session welcomes studies, research findings, and practical experiences that advance our understanding and implementation of NBS in sustainable agriculture. We invite contributions that explore innovative practices, evaluate their multifunctional benefits, and examine strategies for scaling NBS in diverse agricultural contexts. Case studies, experimental research, modeling approaches, and participatory methods that link scientific knowledge with real-world applications are particularly encouraged.
The session will focus on:
• The scientific basis and hydrological, ecological, social, and economic benefits of NBS in agriculture context.
• Practical case studies demonstrating successful implementation and measurable outcomes.
• Policy, governance, and stakeholder engagement approaches that support adoption and scaling of NBS.
• Innovative methods for monitoring, evaluating, and optimizing NBS interventions.
The session will take the shape of oral presentations (15 minutes each), followed by 5–10 minutes of questions and discussion, allowing in-depth exchange between presenters and the audience.

**Keywords:** Sustainable Agriculture, Climate-Smart Agriculture, Integrated Land Management, Soil and Water Conservation

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# Canopy Microclimate Modification and Plant–Soil Interactions in Basil Under Manti Shading

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## Abstract

The microclimate within the plant canopy is a key factor in horticultural production systems because radiation load and temperature conditions directly influence leaf energy balance, transpiration and photosynthetic performance. During summer periods, high irradiance and heat waves often occur simultaneously and create stress conditions that can constrain plant growth and biomass accumulation. For this reason, shading technologies are widely used in protected cultivation to mitigate radiation and heat stress. However, conventional shading systems frequently reduce photosynthetically active radiation together with heat load, which in some cases may limit plant growth. In recent years, increasing attention has been directed towards nano-modified covering systems that regulate the optical properties of surfaces. These materials can influence radiation reflection and scattering, allowing modification of the canopy microclimate while maintaining similar levels of light transmission.
The aim of the present study was to examine how a nano-material–modified shading system (MANTI) affects growth responses and biomass allocation patterns in basil (*Ocimum basilicum* L.), and how these plant responses relate to processes occurring in the root zone. The experiment was conducted at the experimental horticultural station of the Hungarian University of Agriculture and Life Sciences in Budapest. Basil plants were cultivated in a raised-bed system under two canopy environments: an uncovered control and a nano-modified shading treatment. During the cultivation period, canopy microclimate conditions were continuously monitored, and plant growth parameters, root traits and selected soil biological indicators were evaluated.
The results indicated that technological modification of the radiation environment can significantly influence basil development. Plants grown under the MANTI covering exhibited altered vegetative growth patterns, reflected in differences in leaf formation and biomass distribution within the plant. These findings suggest that canopy microclimate conditions may affect plant growth strategy rather than simply increasing or decreasing total biomass production. Differences observed in root traits further indicate that changes in canopy environment can influence carbon allocation to the root zone. Because root-derived carbon inputs regulate microbial activity in the rhizosphere, these shifts may also affect soil biological processes. The results therefore suggest that the evaluation of microclimate regulation technologies can be improved when plant growth responses and rhizosphere processes are analysed together in horticultural

production systems.

**Keywords:** basil, microclimate regulation, nano-modified shading, biomass allocation, rhizosphere

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# Biochar Suspension as a Nature-Based Solution to Enhance Phosphorus Efficiency in Agroecosystems

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## Abstract

Biochar (BC) is a promising nature-based solution for improving the sustainability and resilience of agricultural systems. Derived from agricultural residues, it supports circular economy principles while contributing to carbon sequestration and resource efficiency. When used as a suspension, BC can be co-applied with liquid phosphorus (P) fertilisers to stimulate microbial activity, enhance P cycling, and improve plant P nutrition. The localized co-application of BC and P is a practical, nature-based approach that is particularly suited to degraded soils, reduced tillage systems, and drought-prone conditions. It reduces operational costs and supports broader adoption. However, interactions within localized ‘charosphere’ hotspots remain poorly understood.
Our study aimed to identify the potential synergistic effects of applying a corncob BC suspension (300 kg dry BC ha-1) and a liquid P fertiliser (30 kg P ha-1, 33P-labelled), as a localized band near maize seeds. Specifically, we targeted to clarify the underlying mechanisms of soil P transformation and plant nutrition by examining shifts in soil and microbial C:P stoichiometry, microbial responses, P (im)mobilization, and early maize P uptake in a rhizobox experiment. The treatments included sole BC, sole P, BC+P, and an unfertilised Control.
Joint BC and P application balanced soil-microbial C:P stoichiometry compared to sole P or BC, maintained high microbial biomass, and reduced both C- and P-acquiring enzyme activities, indicating more efficient microbial resource use. In contrast, sole BC increased dissolved organic C and stimulated C-acquiring enzyme activity without affecting microbial biomass, whereas sole P increased soil P availability, but also induced a strong soil-microbial C:P imbalance, potentially increasing P loss and abiotic immobilization.
Soil zymography-based enzyme imaging showed that root-associated enzymatic activity was primarily regulated by P availability rather than BC addition. $^{33}P$ labelling and imaging confirmed that BC did not restrict P movement from the fertiliser band. Up to 25% of the applied P remained in the available soil P pool after 38 days, regardless of BC.

Furthermore, BC increased P recovery in young maize (5-leaf stage) from 15% to 18%, indicating improved P use efficiency.
Overall, the localized co-application of BC suspension and mineral P fertiliser increases P use efficiency and promotes more efficient microbial resource use, supporting soil microbial functioning and plant nutrition. Applied at low, economically viable rates (< 1 t ha-1), BC suspension offers a practical, nature-based solution that restores soil fertility and supports the sustainable recovery of agricultural productivity.

**Keywords:** band application, biochar suspension, 33P labelling, P nutrition, soil imaging

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# Assessing the Performance of a Reactive Ditch Treating Agricultural Drainage Water in Northern Germany

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## Abstract

Agricultural drainage is a major source of nutrient pollution, particularly nitrogen (N), in aquatic ecosystems (Burbery et al., 2022). This problem requires treatment systems that decrease the nutrients, and other agrochemical contents of agricultural drainage water before entering surface water bodies. At the same time, they have to be cost-effective, low maintenance and user-friendly. Reactive ditches (RDs) also referred to in the literature as denitrifying bioreactors, woodchip bioreactors, and denitrification beds are a nature-based technology (Rivas et al., 2020). This study evaluated the treatment performance and internal process dynamics of a RD with a volume of 44.4 $m^3$, treating agricultural drainage water in Kiel, northern Germany, during the winter in 2025. Daily inlet and outlet samples were collected and analyzed for ammonia ($NH_4^+$-N), nitrite ($NO_2^-$-N), nitrate ($NO_3^-$-N), phosphate ($PO_4^{3-}$-P), total phosphorus (TP), and sulphate ($SO_4^{2-}$) over 27 days. Continuous hourly measurements of dissolved oxygen (DO), redox potential, pH, and temperature were recorded at three internal sensors positioned at 2 m, 18 m, and 37 m from the inlet. Three functional zones in RD were identified as oxic (near inlet), denitrifying (middle) and sulphate reducing (near outlet) with mean redox potential of 517±35, -23±69 and -265±141 mV respectively. Similarly, DO also showed same pattern, decreasing from 1.6±1.5 to 0.1±0.5 mg/L along the RD length. Temperature varied in between 6.0–6.8 °C and pH remained stable along the length. The RD received a sum of $NH_4^+$-N, $NO_2^-$-N and $NO_3^-$-N of 357.1±138.0 g N/day and removed 5.2 kg over the monitoring period at volumetric removal rates of 5.2-14.6 g N/$m^3$/day. A linear relationship between loading rate and removal rate (slope = 0.996, $R^2$ = 0.9998) suggested the RD was operating below its maximum treatment capacity, with further removal potential at higher loading rates. The removal was statistically significant for $PO_4^{3-}$-P (p = 0.001) and $SO_4^{2-}$ (p = 0.021), with positive removal observed on the majority of monitoring days. However, TP exhibited net release on most days. These results confirm that RDs can achieve near-complete N removal under cold winter conditions without reaching treatment capacity, while providing practical guidance for the design and application of nature-based treatment systems for agricultural drainage water.

**Keywords:** Woodchip bioreactor, Denitrification bed, Nitrogen removal, Nature-based solution

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# Composting Suitability of Aged Woodchips From Reactive Ditches

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## Abstract

Reactive Ditches (RDs) are nature-based treatment systems generally implemented for agricultural water management. Though, disposal of aged woodchips after a long-term operation represents a considerable challenge to farmers. This study evaluated whether aged woodchips from a RD operated for three years could be reused as compost, directly assessed against German BioAbfV composting standards. Thirty-six aged woodchip samples from six locations along the RD length with replicate depths (top and bottom) at each location were collected. Physical parameters (ash content, moisture content, pH, electrical conductivity (EC), chemical composition (phosphorous (P), potassium (K), ammonia (NH4+-N), sulphate (SO42-), chloride (Cl-), nitrite (NO3--N), and heavy metals (Pb, Cd, Cr, Cu, Zn) were quantified. Data was analyzed statistically to evaluate the location and depth effects on woodchip quality, spatial trends and assessed the compliance against German BioAbfV composting standards. Ash content increased significantly from inlet to outlet ($R^2=0.212$, $p=0.005$), indicating increasing woodchip degradation. Conversely, other parameters declined towards the outlet, with Cl- showing the strongest trend ($R^2=0.333$, $p<0.001$). Importantly, ash content did not correlate with chemical parameters, indicating that woodchip degradation and change in chemical composition are independent mechanisms. Two-way ANOVA revealed highly significant effects of depth on EC ($F=60.55$, $p<0.001$) and SO42- ($F=29.10$, $p<0.001$), with bottom samples having lower pH due to organic acid accumulation. Ash content ($H=18.97$, $p=0.002$) and Cl- ($H=29.12$, $p<0.001$) varied significantly by location, while NH4+-N and NO3--N remained uniformly along the RD. Heavy metal concentrations were less than the BioAbfV limits, within the range of 0.0002 - 0.0693 mg/kg. Compliance against BioAbfV revealed that all the samples were within the defined limits for heavy metals, pH and NH4+-N. 83% of the samples met the recommended K concentrations while EC and moisture content were not within the range for all the samples. Only a few samples achieved the ash content limits, indicating that woodchips require more degradation before they use for composting. Nevertheless, this study suggests that woodchips can be used for composting with only minor post treatment.

**Keywords:** BioAbfV compliance, reusing woodchips, nature-based solutions

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# A Systematic Review of Runoff and Soil Erosion Control Measures in Agricultural Landscapes

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## Abstract

Control interventions play a critical role in reducing surface runoff and soil erosion in agricultural landscapes, particularly amid increasing climate variability and intensifying land-use pressures. This systematic review, conducted in accordance with PRISMA 2020 standards, synthesizes findings from 380 studies published between 1995 and 2025 across 20 countries. We evaluate the effectiveness of a wide range of control mitigation measures, compares methodological approaches, and identifies geographic and temporal research.

Through the more than 17 measures types investigated and structured measures (e.g., grassed waterways including a small retention basin) provided the greatest peak flow attenuation, with a maximum reported reduction of 69 percent. The majority of measures were highly effective in controlling sediment (e.g., Conservation tillage, buffer strips, mulching and residue management) this performance depended on scale, slope of area drained, rainfall intensity, and texture of soil.

A key methodological insight emerged regarding experimental design: studies employing simulated rainfall tended to underestimate runoff reduction relative to field studies under natural rainfall (e.g., for riparian buffer strips and geotextile-based controls). This discrepancy is attributed to challenges in replicating realistic flow lengths, widths, and hydraulic roughness in experimental plots, all of which influence surface flow and infiltration dynamics. In contrast, erosion reduction metrics were found to be more consistent across methodological approaches.

Upon completion of the remaining datasets currently in progress, our work will provide a comprehensive evidence base for context-appropriate erosion control selection and implementation. Future deliverables include incorporating site characteristics and assessment of measure performance. The completed synthesis will support policymakers, agricultural practitioners, and watershed managers in developing climate-resilient land and water resource management strategies based on scientific evidence

**Keywords:** systematic review, erosion control, agricultural landscapes, surface runoff, soil erosion, terraces, conservation tillage, grass waterways, buffer strips, geotextiles, Europe, PRISMA 2020, meta-analysis, site-specific effectiveness,

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# Freshgraze: Rethinking “Normal” Grazing Behaviour to Enable Nature-Based Farming

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## Abstract

Modern pasture agriculture has often treated grazing behaviour observed within static fields and simplified monocultural swards as “normal”, then sought to optimise production by refining that system through inputs, measurement and control. Freshgraze began within this conventional framework, but on-farm trials produced unexpected changes in animal behaviour when the grazing boundary was continuously moved.
These observations forced us to question an assumption: what is routinely observed is not necessarily biologically normal; it may be behaviour created by the production system itself. If grazing behaviour is shaped by fixed boundaries, simplified plant communities and established management practices, then improving that system may only refine the limitations it has created.
Freshgraze is an autonomous moving-fence and cyber-physical grazing system designed to recreate key features of how animals grazed as mobile herds across open landscapes before fixed field boundaries. By continuously changing access to pasture, it alters how animals encounter and utilise the sward. Early trials indicate that these changes create new possibilities for managing diverse swards and interactions between livestock, plants, roots, soil organisms and the farmer.
This change in understanding led us to ask: how can food production be designed as a nature-based solution, working with animal behaviour, plant diversity and ecological processes rather than simplifying them for operational convenience?
This presentation will share the observable behavioural and early field outcomes that led to this systems hypothesis, discuss their implications for managing complex agroecosystems, and outline priorities for independent evaluation of productivity, soil health, biodiversity, resilience, animal performance and wider applicability.

**Keywords:** , grazing behaviour, diverse swards, agroecosystem management, Soil heath,

**References**

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# An Ecosystem Service-Based Cost-Benefit Framework For Evaluating Environmentally-Technical Areas in Agricultural Landscapes

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## Abstract

Agricultural landscapes increasingly face soil degradation, erosion, and reduced water retention, creating a need for measures that combine productive land use with enhanced ecological functions. Nature-Based Solutions (NBS) can address these challenges while generating multiple ecosystem services. However, their implementation also involves investment and maintenance costs and may reduce agricultural production. A comprehensive assessment therefore requires an evaluation framework that captures both direct economic effects and wider societal benefits.

This study presents an ecosystem service-based cost-benefit framework for evaluating environmentally-technical areas (ETAs) created through the spatial optimization of agricultural land. ETAs represent non-productive or extensively managed areas integrated into agricultural fields to reduce soil erosion and strengthen landscape functions. The framework combines conventional cost-benefit analysis with the ecosystem services concept to systematically identify, quantify, and, where possible, monetize the wider benefits generated by these interventions. Costs include implementation and maintenance expenditure as well as opportunity costs associated with foregone agricultural production. Benefits include avoided erosion-related damages and other ecosystem service improvements that can be incorporated according to data availability and the spatial scale of the assessment.

The framework was applied to alternative ETA scenarios across three agricultural locations. The scenarios differed in the spatial extent and configuration of grassed areas and linear erosion-control measures and were assessed against a baseline without ETAs over 15- and 25-year evaluation periods.

The results show that most evaluated scenarios generated positive net societal benefits, although their economic performance varied substantially across locations. Grassing the 20% of farmland with the steepest slopes generated the highest cumulative benefits and, in two locations, also the highest net present value. However, the scenarios with the highest benefit-cost efficiency differed among locations, while some more investment-intensive linear measures did not recover their societal costs within the evaluated periods.

The findings demonstrate that ecosystem service-based cost-benefit analysis can provide a practical framework for comparing alternative NBS configurations in agricultural landscapes. They also show that maximizing total societal benefits and maximizing benefits per unit of expenditure may lead to different choices, highlighting the importance of local biophysical and economic conditions when selecting and targeting NBS interventions.

**Keywords:** environmentally-technical areas, ecosystem services, cost-benefit analysis, soil erosion

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# Model-Based Planning of Water Retention Measures in the Trierbach Catchment

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## Abstract

Agricultural and forestry areas contribute significantly to rapid runoff generation due to soil crusting, compaction and dense artificial drainage systems. In steep headwater catchments, low-permeability road networks and drainage ditches accelerate the water transport, which exacerbates both flood discharge peaks and climate-induced drought stress. To mitigate these impacts a sustainable, climate-adapted water management strategy for agricultural and forestry landscapes with site-specific measures is required. These include terrain-adapted retention ditches (with or without plantings), road ditch diversions, ditch backfilling, infiltration trenches, and various forms of redistribution channels or decentralized retention basins. Addressing these challenges, this study focuses on the municipal area of Pomster, a typical headwater catchment in the Ahr Valley. It is characterized by a hydraulically “smooth” landscape dominated by flat plateau landscapes under agricultural management and extensive forest stands. These areas are directly connected to the Trierbach stream through steep gully systems, which leads to rapid runoff generation during extreme precipitation events.
As part of the project physical demonstration sites (“demonstrators”) will be constructed across both agricultural and forestry locations and equipped with hydrometric monitoring to evaluate their hydraulic and hydrological effectiveness. Furthermore, digital twins of the demonstrators will be developed to analyse the impact of decentralized retention measures at both local (e.g. municipal) and regional scale (e.g. the entire Ahr catchment). To ensure long-term usability of the results, the parameterization guidelines will be developed for the current modeling frameworks of Rhineland-Palatinate (HydroZwilling RLP and LARSIM), which enables realistic simulations of measure impacts across these different spatial scales. Methodologically, a hydrological model for the Kirmutscheid gauge catchment (Trierbach) is parameterized using the soil-hydrological map of Rhineland-Palatinate to identify critical runoff-generating process areas. In parallel, the LARSIM model will be adapted for comparative baseline modeling. For critical areas, high-resolution Digital Elevation Models (0.5 m grid) are modified to incorporate virtual retention measures. Their hydraulic efficiency is simulated using a 2D hydraulic model (HYDRO_AS 2D). Concurrently, the physical demonstrators will be surveyed alongside field measurements to quantify the retention efficiency of these measures. The resulting parameter adjustments serve to identify and characterize hydraulic alteration signals, which are integrated into LARSIM to refine its parameterization strategies.
Ultimately, the project delivers robust insights into the effectiveness of various water

retention measures based on coupled hydrological-hydraulic modeling, offering a tool to optimize measures prior to physical implementation. Furthermore, spatial assessments of water retention potential will provide actionable recommendations for agricultural and forest planning.

**Keywords:** water retention, 2D hydraulic simulation

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# Mud Carbovino: Advancing Soil Carbon Sequestration and Resilience in German Viticulture

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## Abstract

Viticulture is an important component of German agriculture and cultural landscapes, but climate change is increasing the need for soils that are fertile, water-retentive and resilient. The model and demonstration project MuD CarboVino investigates practical strategies for maintaining and increasing soil organic matter and carbon sequestration in vineyards. Across 36 demonstration farms in the three selected wider regions Mosel, Pfalz/Rheinhessen/Nahe and Baden-Württemberg, the project combines scientific monitoring, agricultural advisory services and the experience of winegrowers in a transdisciplinary and participatory approach.
The participating farms include organic, biodynamic and conventionally managed sustainable vineyards. In collaboration with the farmers, five management strategies were selected: humus-promoting cover crops, biochar application, reduced tillage, sheep grazing and vitiforestry. Depending on the farm, these measures are implemented individually or in combination on defined treatment plots, each paired with a reference plot. The baseline survey conducted in spring 2025 included soil sampling at two depths (0–15 and 15–30 cm) and in different vineyard positions. Soil parameters comprised mineral nitrogen, organic carbon, soil organic matter, total nitrogen, C/N ratio, pH, texture, coarse fragments and bulk density. In the time of highest vegetation cover plant sampling of the vine leaves and cover crops was conducted. Annual monitoring will be complemented by economic assessments, stakeholder surveys, greenhouse-gas accounting and life-cycle assessment.
The initial survey demonstrates considerable variability in soil properties and farm conditions among the regions. Baden-Württemberg tended to show higher soil organic matter and mineral nitrogen values than the Mosel and Pfalz/Rheinhessen/Nahe sites. As expected, substantial changes in soil organic carbon cannot yet be assessed shortly after implementation; measurable effects are likely to emerge only over several years. The experimental design therefore provides a robust basis for distinguishing management effects from natural spatial and temporal variability and for calibrating process-based soil–plant–atmosphere models.

MuD CarboVino demonstrates how participatory, regionally differentiated management trials can support the development of climate-adapted and carbon-conscious strategies for perennial cropping systems. The project will generate practical recommendations for viticulture, advisory services and policy while strengthening knowledge transfer between research and practice.

**Keywords:** Soil organic carbon, Humus formation, Climate-resilient viticulture, Cover cropping, Transdisciplinary research

# AN5: Circular Nutrient Systems for Agricultural Transitions: Integrating Ecology, Governance, and Modelling

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# An5: Circular Nutrient Systems For Agricultural Transitions: Integrating Ecology, Governance, and Modelling

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PENDING

## Abstract

Circular nutrient management is a cornerstone of resilient, productive, and climate-robust agricultural systems, yet analyses often remain fragmented across ecological, economic, and governance domains. This session brings together interdisciplinary research to examine how nature-based, agroecological, and regenerative approaches reconfigure nutrient cycles at farm, landscape, and food-system scales.
We invite contributions that (i) quantify changes in nutrient flows, balances, and use efficiencies using empirical data and modelling approaches; (ii) analyse trade-offs and synergies among environmental, economic, and social outcomes over time; and (iii) investigate institutional, policy, and governance arrangements that enable adoption, scaling, and long-term viability of circular nutrient practices.
The session will combine short invited talks, contributed papers, and a moderated panel discussion to synthesise insights across disciplines and scales. By integrating ecological evidence, systems modelling, and governance analysis, the session aims to generate transferable knowledge and policy-relevant insights to support transitions from linear nutrient inputs toward circular, soil-centred agricultural systems.

**Keywords:** Circular nutrient management, agroecological transitions, soil health, nutrient flow modelling, sustainability trade-offs, governance and policy innovation

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# Scaling Nature-Based Solutions Through Knowledge-Action Networks: Cooperation For Agricultural Transformation

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## Abstract

Nature-Based Solutions (NBS) are increasingly promoted as approaches for agricultural sustainability transitions because of their simultaneous support for biodiversity, soil restoration, nutrient retention, climate mitigation, and water quality improvement. Yet despite growing policy support and technical evidence, the scaling of NBS across European agricultural systems remains limited. This paper argues that the central barrier to NBS scaling is not primarily technological readiness or individual farmer behaviour, but systemic coordination and cooperation failure within agricultural socio-ecological systems (SES). Drawing on the Evolution of Cooperation (EoC) theory and Theory of Change (ToC), the paper attempts to explain how cooperation emerges, stabilises, and breaks down across experimentation, stabilisation, diffusion, and institutionalisation phases, through value-based, trust-based, reputation-based, network-embedded, and institutional cooperation. Comparative qualitative case studies are from Denmark, the Netherlands, Hungary, and the United Kingdom. The findings show that NBS scaling depends on whether different forms of cooperation become aligned across governance levels, markets, advisory systems, and rural actor networks. While shared stewardship values and trust-based learning enabled experimentation and stabilisation, scaling was frequently constrained by fragmented advisory systems, weak market incentives, regulatory incoherence, unequal access to knowledge-action networks, and unstable institutional support. Three cooperation-enabled transformation pathways are identified: regional nutrient circularity, biological substitution of synthetic inputs, and diversification through integrated landscape management. The study proposes a working hypothesis on sustainability transitions that scaling NBS is a coordination and cooperation problem rather than a simple adoption challenge for collective capacity to organise, stabilise, and govern knowledge-action networks, as suggested by the comparative European case studies.

**Keywords:** Nature-Based Solutions, socio-ecological systems, knowledge systems, collective action, evolution of cooperation, sustainability transitions

# AN6: Biophysical Approach to Terroirs

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# An6: Biophysical Approach to Terroirs

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## Abstract

It is well known that grape quality is a major factor determining the quality of the final product in the vitivinicultural sector. However, land degradation processes such as soil erosion, crusting, soil and water contamination/pollution, and biodiversity loss are increasingly affecting terroirs worldwide and reducing their productivity. The degradation of these areas can be observed from the pedon to the catchment scale, but understanding the dominant processes across increasing spatial scales is further complicated by landscape complexity, management practices, and diverse microclimatic conditions. At present, holistic approaches or targeted studies capable of providing new insights into control measures and/or innovative ideas for efficient land management plans are lacking in many regions. Understanding multiscale degradation processes and assessing the impacts of appropriate biological restoration practices, as well as effective management strategies, remain major research challenges and have become indispensable tasks.
This scientific session aims to foster a constructive, interdisciplinary discussion on the current state of the art of terroirs, with the goal of improving their sustainability through both scientific knowledge and traditional farmers' management practices. Hydrologists, geographers, engineers, enologists, agronomists, biologists, economists, environmental scientists, ecologists, geologists, and stakeholders are all welcome. Studies related to soil, plants, water, animals, and microorganisms are particularly relevant and appropriate for this session. We look forward to discussing this important topic with you.

PENDING

**Keywords:** It is well known that grape quality is a major factor determining the quality of the final product in the vitivinicultural sector. However, land degradation processes such as soil erosion, crusting, soil and water contamination/pollution, and biodiversity loss are increasingly affecting terroirs worldwide and reducing their productivity. The degradation of these areas can be observed from the pedon to the catchment scale, but understanding the dominant processes across increasing spatial scales is further complicated by landscape complexity, management practices, and diverse microclimatic conditions. At present, holistic approaches or targeted studies capable of providing new insights into control measures and/or innovative ideas for efficient land management plans are lacking in many regions. Understanding multiscale degradation processes and assessing the impacts of appropriate biological restoration practices, as well as effective management strategies, remain major research challenges and have become indispensable tasks. This scientific session aims to foster a constructive, interdisciplinary discussion on the current state of the art of terroirs, with the goal of improving their sustainability through both scientific knowledge and traditional farmers' management practices. Hydrologists,

geographers, engineers, enologists, agronomists, biologists, economists, environmental scientists, ecologists, geologists, and stakeholders are all welcome. Studies related to soil, plants, water, animals, and microorganisms are particularly relevant and appropriate for this session. We look forward to discussing this important topic with you.

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# Biophysical Approach For Terroir Characterization: Evaluating Structural and Spectral Precision Via Consumer and Rtk-Enabled Uavs in Vineyards

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## Abstract

High-resolution biophysical monitoring is essential for understanding terroir dynamics and optimizing vineyard management under the framework of Nature-based Solutions (NbS). However, technical variability between Unmanned Aerial Vehicle (UAV) platforms poses challenges for the reproducibility of agronomic indicators. This study evaluates and compares the mapping and spectral performance of different UAVs over commercial European vineyards: e.g. a conventional consumer-grade model (Mavic 2 Zoom), a professional Real-Time Kinematic (RTK) enabled system (Mavic 3E RTK) and thermal camera (Matrice t4) . The geometric accuracy of Digital Surface Models (DSMs), effective spatial resolution, and the consistency of three RGB-based vegetation indices (ExG, VARI, and NGRDI) were systematically analyzed. The findings demonstrate that integrating RTK technology eliminates a systematic vertical bias of ~35 m inherent to conventional consumer sensors. After applying a robust Z-shift vertical correction, DSMs from both platforms showed high internal consistency, reducing the root mean square error (RMSE) to ~1.26 m. Furthermore, the RTK sensor provided a 20% higher effective spatial resolution, which is critical for fine canopy delineation. Regarding spectral data, normalized ratio indices (NGRDI and VARI) exhibited strong cross-platform robustness, whereas ExG showed high sensitivity to radiometric discrepancies. Ultimately, using normalized indices alongside vertical geometric harmonization enables reliable multi-temporal biophysical monitoring, providing a standardized workflow to accurately characterize crop structure and soil microclimates for strengthening NbS strategies in precision viticulture.

**Keywords:** UAV, RTK, vineyards, vegetation indexes

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# From Soil Compaction to Erosion: How the Annual Crop Cycle Controls Infiltration and Runoff

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## Abstract

Annual cropping systems are dynamic environments in which soil properties and hydrological processes change substantially throughout the crop cycle (Lebon et al., 2003). Tillage, sowing, machinery traffic, crop development, harvesting and periods of bare soil can modify soil structure, bulk density, surface roughness, aggregate stability and vegetation cover, with important consequences for infiltration, runoff generation and soil erosion (Hamza & Anderson, 2005; Batey, 2009; Blanco-Canqui & Ruis, 2018). Understanding these temporal dynamics is essential for assessing soil degradation and designing more sustainable agricultural management strategies (Ruiz-Colmenero et al., 2011). This study examines how the different stages of the annual crop cycle influence soil compaction, infiltration capacity, runoff generation and soil erosion, with particular attention to the interactions between soil physical properties, agricultural operations and rainfall characteristics. Soil sampling, double-ring infiltrometer measurements and rainfall simulation experiments were conducted throughout 2013 in vineyards of the Celler del Roure winery, located in the eastern Iberian Peninsula and representative of Mediterranean vineyards where tillage is a major management practice. Measurements were carried out in February, April, June, August, October and December to capture temporal changes associated with agricultural operations and climatic conditions. Soil bulk density, infiltration rates, runoff generation and sediment delivery were determined for each sampling period. The results revealed marked seasonal variations in soil physical and hydrological properties throughout the agricultural year. Soil bulk density decreased from April to August following ploughing operations, when infiltration rates reached their highest values and runoff and soil erosion were lowest. These changes indicate that tillage temporarily modified soil structure and substantially affected the partitioning of

rainfall between infiltration and overland flow. However, the effects of agricultural operations were transient and strongly influenced by subsequent rainfall and soil conditions. The annual cycle was therefore controlled by the interaction between agricultural operations, soil physical conditions and climatic variability. Although numerous studies have investigated the effects of agricultural management on soil degradation, less attention has been paid to the temporal role of individual farming operations and their cumulative effects throughout the agricultural year (Darouich et al., 2022; Giffard et al., 2022). This is particularly relevant in vineyards, where seasonal operations such as tillage, harvesting and pest management repeatedly disturb the soil surface. Conservation agriculture, cover crops, residue management and reduced tillage can improve soil structure, enhance infiltration and reduce runoff and erosion, although their effectiveness depends on soil type, climate, crop rotation, management history and the timing of agricultural operations (Lal, 2004; Hobbs et al., 2008). Identifying critical periods of vulnerability can therefore provide a basis for targeted and preventive soil and water conservation measures, contributing to improved soil health, water regulation and the long-term sustainability of Mediterranean vineyard landscapes.

The annual crop production cycle involves a range of agricultural operations that disturb the soil and can substantially modify its physical properties, with subsequent effects on runoff generation and soil erosion. Although many studies have focused on the effects of soil management practices, relatively little attention has been paid to the role of individual agricultural operations carried out throughout the farming year in driving soil degradation (Darouich et al., 2022; Giffard et al., 2022). This issue is particularly relevant for crops requiring intensive seasonal management, such as vineyards, where tillage, harvesting and pest-control operations repeatedly modify soil conditions. The results showed marked seasonal changes in soil physical and hydrological conditions. Lower soil bulk density was observed from April to August following ploughing, coinciding with the highest infiltration rates and the lowest runoff and soil erosion rates.

**Keywords:** Soil, Erosion, Land, Terroir, Degradation, Agriculture, Water, Sediments.

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# Soil Erosion in European Vineyards: Current Knowledge, Management Challenges and Research Priorities

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## Abstract

Soil erosion is one of the principal threats to the environmental and economic sustainability of European vineyards. Vineyards frequently occupy sloping terrain exposed to erosive rainfall, while conventional tillage, herbicide-maintained bare soil and machinery traffic reduce aggregate stability, infiltration and surface roughness (2005; Arnáez et al., 2007). Consequently, erosion rates often exceed soil-formation rates and tolerable soil-loss thresholds, particularly in Mediterranean vineyards, although substantial losses also occur in Atlantic, continental and Alpine regions (Panagos et al., 2015; Biddoccu et al., 2020). Reported values vary considerably according to rainfall erosivity, slope, lithology, vine-row orientation, plantation age, soil management and monitoring methodology (Rodrigo-Comino et al., 2016). Sediment export is accompanied by losses of organic carbon, nitrogen, phosphorus and agrochemicals, reducing soil fertility and affecting downstream water quality. The sustainable management of European vineyards involves balancing soil conservation, grape production, wine quality, economic viability and adaptation to climate change. This balance is particularly difficult because vineyards are perennial systems frequently established on sloping land, shallow soils or landscapes with considerable cultural value. Although management practices such as cover cropping, mulching, reduced tillage and buffer strips can substantially reduce erosion, their implementation is constrained by environmental variability, production objectives, labour requirements and farmers' perceptions of risk. These processes explain why conventionally managed vineyards often display high erosion rates, particularly where rows are oriented downslope (Arnáez et al., 2007; Rodrigo-Comino et al., 2016). Cover crops are among the most effective alternatives, but their management presents important difficulties. Permanent or temporary vegetation protects the soil from raindrop impact, increases surface roughness, traps sediment and improves aggregate stability. Root systems also promote soil porosity and organic-carbon

accumulation. Nevertheless, cover crops consume water, creating potential competition with grapevines in dry Mediterranean environments. This competition may reduce vine vigour, grape yield or berry size during drought. The challenge is therefore not simply to establish vegetation but to determine the appropriate species, density, spatial distribution and termination date. Temporary winter cover, alternate-row vegetation and early spring mowing may provide a compromise between soil protection and water conservation (Ruiz-Colmenero et al., 2013; López-Vicente et al., 2020).

The effectiveness of cover crops is strongly dependent on timing. Removing vegetation too early can leave the soil unprotected during erosive spring storms, while late termination may intensify competition during critical vine-development stages. Climate variability makes fixed calendars increasingly unreliable. Adaptive management based on soil moisture, weather forecasts, vine water status and cover-crop biomass is therefore required. However, such management demands technical knowledge, monitoring equipment and rapid access to machinery, which may be unavailable to small farms (Novara et al. 2011).

Mulching provides an alternative where competition for water is a major concern. Straw, chipped pruning residues and other organic materials protect the surface, reduce crust formation and contribute organic matter. Barley-straw mulch, for example, can rapidly reduce runoff and soil erodibility in Mediterranean vineyards. Nevertheless, obtaining, transporting and applying sufficient material may be costly. Mulches can be displaced by wind or runoff, interfere with vineyard operations and create concerns regarding fire risk, pests or disease. The origin and quality of the material must also be controlled to avoid introducing weed seeds, contaminants or pathogens.

Topography and vineyard design constitute another major challenge. Row orientation, slope length, terrace configuration and drainage networks strongly influence runoff concentration. Downslope rows facilitate mechanisation but act as preferential flow paths during storms. Contour planting can interrupt runoff, although it may be difficult or unsafe for machinery on steep slopes. Terraces reduce effective slope length but require careful maintenance.

**Keywords:** Terroir, Erosion, Soil, Vineyards, Agriculture, Europe

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# Beyond Wine Production: Nature-Based Soil Management and the Social Value of Vineyards in Spain and the Netherlands

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PENDING

## Abstract

Sustainable soil management in vineyards is important not only for maintaining productive soils but also for supporting biodiversity, climate resilience and wider landscape functions. The Horizon Europe MSCA Staff Exchange project SOSVITI – Sustainable Soil Management Decision Support System in Viticulture addresses soil degradation and erosion in European vineyards by combining field research, stakeholder engagement, modelling and technological innovation to support sustainable vineyard management. (sosviti.egemap.eu)
Within SOSVITI, a secondment in Valencia provided the opportunity to study Nature-based Solutions (NbS) and soil management at Bodegas Los Frailes, an organically and biodynamically managed vineyard in Fontanars dels Alforins. The estate has been certified organic since 2002 and applies management adapted to dry Mediterranean conditions and calcareous soils. Spontaneous vegetation cover in parts of the vineyard provides grazing resources for sheep while also supporting beneficial insects and birds. (bodegaslosfrailes.com) The work is now being complemented by observations of vineyard soil management in Wageningen, the Netherlands, providing a contrasting setting in terms of climate, landscape and societal context.
This comparison is used to explore vineyard soil management from a broader perspective than soil conservation and agricultural production alone. It considers how NbS and sustainable management can contribute simultaneously to soil health, vegetation management, biodiversity and the character and attractiveness of agricultural landscapes. Particular attention is given to the social functions of vineyard landscapes. In Spain, organically managed vineyard soils form part of a multifunctional agricultural landscape in which vegetation provides resources for grazing and contributes to landscape quality. In Wageningen, the vineyard additionally functions as a place where local people can meet, thereby connecting agricultural production with community and landscape values.
The comparison highlights the importance of recognising vineyards as multifunctional landscapes. Sustainable soil management decisions can therefore generate benefits extending beyond grape production and erosion control. Understanding these environmental and social co-benefits can help broaden the assessment of NbS in viticulture and contribute to the SOSVITI ambition of supporting more sustainable and context-sensitive soil management.

**Keywords:** Nature-based Solutions, sustainable viticulture, soil management, multifunctional

landscapes

PENDING

# AN7: Open session on Nature-Based Solutions in Agricultural and Natural Landscapes

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# An7: Open Session on Nature-Based Solutions in Agricultural and Natural Landscapes

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PENDING

## Abstract

Nature-based solutions (NbS) are increasingly recognized as essential strategies for addressing the intertwined challenges of climate change, biodiversity loss, and sustainable food production. This session explores the role of NbS in enhancing resilience and ecosystem functioning across agricultural and natural landscapes. Contributions will examine how approaches such as agroforestry, wetland restoration, regenerative farming, and landscape-scale habitat connectivity can support both productive agriculture and biodiversity conservation.
We welcome interdisciplinary perspectives spanning ecology, agronomy, hydrology, social sciences, and policy studies. Topics may include ecosystem service optimization, carbon sequestration, soil health improvement, water regulation, and socio-economic outcomes for rural communities. Special attention will be given to implementation challenges, monitoring frameworks, and evidence-based evaluation of NbS effectiveness across different climatic and land-use contexts.
The session aims to foster dialogue between researchers, practitioners, and policymakers to accelerate the translation of scientific knowledge into scalable, real-world applications. By highlighting case studies, innovative methodologies, and governance models, this session will contribute to advancing sustainable land management strategies that balance agricultural productivity with ecosystem integrity.
Ultimately, this session seeks to strengthen the scientific foundation and practical deployment of nature-based solutions for resilient agricultural and natural systems.

**Keywords:** sustainable agriculture, land and water management, biodiversity protection

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# Regenerative Homestead Agroforestry For Restoration of Degraded Dryland: a Nature-Based Solution From Tribal India

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## Abstract

Monoculture farming reduces biodiversity, degrades soil, and weakens rural livelihoods. To address this, we tested a Regenerative Homestead Agroforestry (RHA) model with the Lodha tribal community in Jhargram, West Bengal, over eight years (2017-18 to 2024-15). The aim was to design a system-based integration of local need, ITK and ecological principle that is culturally acceptable, ecologically resilient, and economically viable. The RHA model combined multi-layer polyculture, companion crops that support mycorrhiza, no-till practices, and organic nutrient recycling. Livelihood options included beekeeping, poultry, and perennial crops. Social activities included school enrolment drives, arts-based training, documentation of Indigenous Technical Knowledge (ITK), and a community eco-tourism guesthouse. Annual monitoring recorded soil carbon, microbial activity, mycorrhizal colonization, pollinator diversity, school enrolment, income, and participation, compared with conventional farming, horticulture, and forestry. Soil organic carbon in RHA rose by over 25% in comparison to conventional farming. Microbial activity and earthworm density improved, and more than 80% of fruit trees showed mycorrhizal colonization. Pollinator diversity increased, improving crop yields. The RHA system produced 13.37 t $ha^{-1}$ $yr^{-1}$ of recyclable biomass and enhanced soil carbon, dehydrogenase activity, water-holding capacity, and biodiversity. Economically, it gave 5.6, 3.9-, and 2.1-times higher net present value than agriculture, forestry, and horticulture, respectively. Social outcomes included higher school enrolment, diversified household income, and more than 80% family participation in decision-making. The composite evaluation index demonstrated that RHA offers the highest level of multifunctionality of multiple ecosystem services. The RHA model shows that community-led agroforestry can restore ecosystems, reduce poverty, and strengthen cultural identity. It offers a scalable pathway for climate-resilient rural development and supports several SDGs.

**Keywords:** Regenerative agroforestry, tribal livelihoods, ecosystem services, multifunctionality, evaluation index

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# A Catchment-Scale Digital Twin For Nature-Based Solutions: Integrating Hydrology, Indigenous Knowledge, and Customary Practices in Aotearoa New Zealand

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## Abstract

Nature-based solutions (NbS) are increasingly recognised as critical for enhancing climate resilience while delivering multiple economic, environmental and cultural co-benefits; although successful implementation is context dependent (Seddon et al., 2020; Chausson et al., 2020; Nesshöver et al., 2017). This paper presents the development and application of a catchment-scale environmental digital twin that integrates hydrological, land-use, and climate projection data to simulate how different wetland and forest ecosystem reconstruction scenarios influence flood attenuation within catchments in Aotearoa New Zealand. While digital twins are emerging as integrated, data-driven infrastructures for environmental modelling and decision support in water systems and hydrology (Ghorbani Bam et al., 2025), their application to NbS at a catchment scale is relatively new. Scenario modelling indicates that flood attenuation varies with both the extent and spatial configuration of reconstructed wetlands and forests. These findings are consistent with empirical studies that relate existing land-cover patterns to hydrological outcomes (NIWA 2024; Cooper et al., 2021; Dadson et al., 2017; Herath et al., 2025). An additional innovation of this work is the embedding of Indigenous knowledge and governance within the modelling framework through an ongoing partnership with Ngāi Tahu - the Indigenous people of Te Waipounamu (the South Island). The digital twin is not only a technical tool but also a platform for co-production of knowledge, supporting Indigenous-led environmental decision-making - an approach recognized for supporting equitable and legitimate outcomes (MacFarlane et. al., 2024; Bartlett et al., 2012; Tengö et al., 2014; Norström et al., 2020). In particular, the model incorporates methodologies (Townsend et. al., 2004) for representing mahinga kai abundance - customary food resources and harvesting practices - through the integration of local knowledge enabling holistic assessments of ecosystem health and cultural wellbeing. Beyond the focus on flood mitigation, the model will be progressively expanded to capture widely recognized additional co-benefits of NbS including: nitrate retention (Lyu et al., 2021; Hill, 2019; Land et al., 2016); biodiversity uplift (Rey Benayas et al., 2009; Crouzeilles et al., 2016); and carbon sequestration (Griscom et al., 2017; Xu et al., 2019; Pan et al., 2011), as well as costs associated with the loss of farm production landscapes (Miralles-Wilhelm 2023). By integrating these dimensions, the digital twin will, in time, provide a multi-criteria decision-support tool capable of evaluating trade-

offs and synergies across environmental, cultural, and economic objectives, which are recognized as important factors in the successful implementation of NbS at scale (Nesshöver et al., 2017; Albert et al., 2021).

**Keywords:** Nature-based solutions, digital twin, catchment-scale modelling, flood attenuation, ecosystem services, Indigenous knowledge, customary practices, co-production

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# Nature-Based Evolution: Traditional Ecological Practices in the Application of Blue-Green Infrastructure For Climate Resilience

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## Abstract

Climate hazards continue to escalate due to the impacts of a changing climate and pose a growing risk to both ecosystems and human populations. Urban resilience depends on the capacity of cities to respond to climate-related pressures such as rising temperatures, extreme flooding and food insecurity. Traditional ecological practices and historic blue-green infrastructure (BGI) can provide climate-proof strategies to increase urban climate resilience. This study evaluates the effectiveness of traditional BGI practices by mapping a common form of historical BGI – floating agricultural gardens – across geographies to examine 1) historic and contemporary functions in climate resilience, 2) modern challenges and threats to these heritage landscapes through Koppen analysis, 3) land cover and land use change observations, and 4) comparative analysis of site characteristics over time using archival maps and satellite imaging. Floating gardens are examined at seven locations on three continents and the impact of climate change on local floating garden climates is examined by using the time evolution of the Koppen climate classification for each location. Results of land cover and land use observation and the comparative analysis of site characteristics indicate urban encroachment is a significant threat to the viability and climate resilience of floating garden sites. This study is novel because it examines historic BGI in a contemporary context as a means of working with local landscape conditions to increase climate resilience and explores the synergies between floating garden agricultural practices across continents. Integration of traditional blue-green infrastructure practices in modern urban planning and design could provide a pathway forward.

**Keywords:** Nature-based solutions, floating gardens, floating agriculture, urban resilience, heritage landscapes

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# Impacts of Land-Use Diversity on Watershed Resilience: an Introduction to Hydrological Resilience

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## Abstract

Modern food systems have become increasingly homogeneous due to industrialization and globalization, leading to reduced resilience against environmental stressors and shocks. Within the interdisciplinary Research Training Group Diversilience (DIVERSification for Food Systems ResILIENCE), we explore how increasing land-use diversity, such as integrating flower strips and varied land-use patterns, affects watershed resilience. In this study we investigate how hydrological resilience can be defined and quantified at catchment scale. Grounded in the physical-hydrological framework of Newton & Spence (2023), we define hydrological resilience as a watershed's capacity to maintain its hydrological functions under climate and land-use change while remaining within its current regime. This definition combines resistance (the system's sensitivity to a stressor) and latitude (the possible range of recovery), focusing specifically on ecohydrological interactions between vegetation (crops) and the water cycle. We will establish an indicator framework spanning three primary hydrological functions: collection, storage (including vegetation storage), and release of water. To test this framework, the ecohydrological model SWAT+ will be applied to a Northern Germany catchment (Kielstau river) to simulate the effects of diversified land-use scenarios on different hydrological components. This research aims to develop a robust indicator set to quantify ecohydrological resilience and identify how land-use diversification can strengthen watershed capacity against environmental changes.

**Keywords:** hydrological resilience, land-use diversity, land-use change

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# Nbs Rapid Assessment (Ras): Maximum Impact Operationalising the Iucn Global Standard For Landscape Restoration

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## Abstract

Breaching critical planetary boundaries has intensified land degradation worldwide, calling for rigorous, evidence-based approaches to regain ecological integrity and foster resilient communities. Restoration projects lacking standardised design are at higher risk of long-term failure, offering fragmented intervention rather than lasting ecosystem recovery. This preliminary study introduces the NbS Rapid Assessment (RAS), serving as a rapid diagnostic check to rigorously vet project concepts, identify critical operational baselines, and assess compliance with the IUCN Global Standard for Nature-based Solutions™ (IUCN GS NbS). Rather than replacing full-scale planning, this rapid diagnostic tool provides vital guidance and tailored recommendations to optimise project design before large-scale execution and identify breaches to ensure solutions remain sustainable over time. Its efficacy is tested across three Spanish case studies transitioning degraded territories into functional natural infrastructure. In La Veguilla Crypto-wetland (Toledo), a sensitive temporary Mediterranean wetland lacking permanent surface water, RAS guided hydrogeological characterisation and biofiltration restoration following extreme rainfall (the September 2023 DANA) and associated post-flood contamination risks, supporting ecosystem services such as flood buffering and aquifer recharge. Ongoing work includes creating a climate shelter to propagate endemic protected species (e.g., Sisymbrium cavanillesianum, Limonium toletanum) while integrating community-oriented educational and recreational spaces within a peri-urban landscape. In the Cañada Real Conquense Corridor, RAS supported the use of the IUCN Standard to scale a local intervention into a regional ecological corridor, reviving traditional transhumance routes that enhance seed dispersal, soil fertility, rural livelihoods, pastoral heritage, plus an active work on fire prevention. Critically, the RAS identified the need for a context-adapted biodiversity and connectivity monitoring framework as the most critical gap for the NbS design phase. In La Chanta Quarry-Wetland, RAS evaluated the transformation of a former limestone quarry into a protected wetland addressing land degradation and water scarcity, confirming its role as a

biodiversity stepping-stone in an arid landscape while highlighting the need for long-term funding and stronger integration into regional spatial planning. Across all cases, the RAS proved effective as a rapid diagnostic filter, surfacing not only the strengths of each intervention but also the specific, closeable gaps (financial sustainability, governance protocols, adaptive management and monitoring design) that must still be resolved for these projects to qualify as genuine, high-performing Nature-based Solutions under the IUCN Standard. Embedding these recommendations ensures isolated interventions successfully evolve into self-sustaining, high-performing ecological networks delivering measurable benefits for climate adaptation, biodiversity connectivity, cultural heritage endurance and human well-being.

**Keywords:** Nature-based Solutions, Rapid Assessment, IUCN Global Standard, Crypto wetland, Transhumance and Quarry-Wetland.

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# AN8: Agro Building Carbon: Bridging Agriculture and Construction for Carbon Climate Solutions (Panel)

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# An8: Agro Building Carbon: Bridging Agriculture and Construction For Carbon Climate Solutions (Panel)

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PENDING

## Abstract

The future of climate action may lie where agriculture meets construction. Agro Building Carbon (ABC) explores this frontier by promoting the use of construction crops—like straw and bamboo—in bio-based buildings, creating long-term carbon storage while supporting circular economy principles.
A partnership of 11 organizations across Europe (from Netherlands, to Greece and Ukraine) work together to strengthen regional policies and funding programs that encourage carbon uptake in agriculture and building. By aligning local practices with the EU Green Deal and the upcoming Carbon Removal Certification Framework (CRCF), ABC helps regions unlock the climate potential of nature-based solutions.
The project focuses on policy improvement and certification systems, exchanging best practices to make carbon storage measurable, verifiable, and financially rewarding. ABC empowers farmers with new income streams while supporting sustainable construction practices, creating a win-win for both sectors.
Through regional collaboration, ABC demonstrates how innovative policies, strategic planning, and practical tools can transform agricultural residues into climate assets, fostering resilient rural economies and a low-carbon building sector.
ABC is proof that carbon-smart agriculture and construction can work together—turning crops into climate solutions for Europe’s sustainable future.
What are our lessons learned from working together on carbon uptake with different countries? What are our best practices and how do we inspire our stakeholders?

**Keywords:** natural building materials, circular economy, nature inclusive agriculture, nature based carbon storage

# NH1: Fire in the Earth System. Understanding fire and society

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# Nh1: Fire in the Earth System. Understanding Fire and Society

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## Abstract

Fire has been part of the Earth System for the last 400 million years and humans are the sole species that controls and manages fire. We have used fire for over a million years, both, as hunter gatherers managing the landscape with fire, and as farmers using fire as a low-cost, efficient and ecological tool for clearing and maintaining the productivity of land. Fire has been highlighted as the most influential element in the development of human societies. However, fire has also always been a threat to humans, and despite accompanying human evolution, our understanding of fire remains very limited.
In general, fires are more present in the European forest, grasslands and scrublands due to four key factors: i) the expansion of forests due to land abandonment: ii) the increase of fuel load and fuel continuity due to the lack of forest management; iii) the high number of ignitions and climate change induced higher temperatures; and, iv) a reduction in precipitation of some climatic belts such as the Mediterranean, and an increase in the evapotranspiration rate. These conditions cause the potential for catastrophic fires as we saw in many regions of the world along the last four decades. This calls for a new approach in fire fighting, instead of fire suppression, to focus on long term fire prevention through forest management by reducing fuel load and fuel continuity at a landscape level. To be able to accomplish these new strategies many questions need to be answered both from a scientific as well as from a policy and socio-economic point of view. There are multiple aspects in fire research (prevention, fire dynamics, fire effects on soils, hydrology and vegetation and fire risk), however, even tough these aspects of fire are all interlinked they are researched mostly separately and therefore are unable to answer the holistic questions needed to come to implementable management strategies and coherent policies The scientific questions are not solved due to the lack of exchanges, interaction and collaboration within research teams. There is a clear lack of communication within the scientific community, and the reduce connectivity in exchange of knowledge and data within the fire research teams ends in a slow advance of science that can be speeded up with more communication.
This scientific session wish to allow networking and scientific exchange to scientific discovery and coordinate efforts among research institutions, scientists and stakeholders. Without a better understanding of fire, safety technologies needed to protect our citizens we cannot provide a safer environment to the citizens. The final objective is to built a safer world for citizens, their economic resources and promote the scientific knowledge exchange.

PENDING

**Keywords:** FIre, Planet, Ecosystems, Soils, Water, Humans

PENDING

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# A Proposed Framework For Multi-Temporal Uav-Based Analysis of Post-Wildfire Agroecosystem Recovery in Mediterranean Vineyards Using Object-Based Classification

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## Abstract

Mediterranean agroecosystems are increasingly exposed to the effects of climate change and recurrent wildfire events, which can severely alter vegetation structure, crop condition, and land cover dynamics. In vineyard landscapes, post-fire monitoring is needed not only to describe recovery processes, but also to identify which land cover types are most vulnerable, which recover faster, and how spatial configuration influences fire propagation. This ongoing study proposes a methodological framework to investigate post-wildfire dynamics in a vineyard area near Patras, Greece, using multi-temporal unmanned aerial vehicle (UAV) imagery acquired between August 2025 and February 2026. The aerial surveys were conducted with a DJI Mavic 3 Enterprise drone, providing ultra-high-resolution RGB imagery with a Ground Sampling Distance (GSD) ranging from 1.5 to 2.5 cm per pixel. Orthomosaics and surface models were generated through photogrammetric processing, using Pix4Dmapper for the first two campaigns and ArcGIS Drone2Map for the subsequent acquisitions. Covering the period immediately after the fire and the first stages of recovery, the study site includes vineyards, olive trees, bare soil, and burned surfaces, providing a heterogeneous Mediterranean test area for analysing class-specific fire effects and regeneration patterns. To ensure temporal comparability, all RGB orthomosaics were co-registered using the AROSICS framework, allowing a pixel-consistent analysis across acquisition dates. Subsequently, an object-based workflow will be applied to segment the imagery into meaningful polygons and classify the first post-fire scene into the main land cover classes: vine, burned vine, olive trees, soil/ground, and burned area. This classification will provide the basis for tracking temporal trajectories of each class and for comparing their spectral and structural responses during the recovery period. Recovery will be assessed using RGB-based vegetation indices, including Excess Green (ExG), Visible Atmospherically Resistant Index (VARI), and Normalised Green-Red Difference Index (NGRDI), together with structural information derived from the digital surface model. By approximating a digital terrain model (DTM) through morphological filtering, a canopy height model (CHM) will be generated to complement the analysis with information on vegetation structure.

Beyond temporal monitoring, the framework aims to analyse how the location and spatial arrangement of land cover entities may have influenced the wildfire impact, identifying highly vulnerable zones where the fire spread unhindered versus areas where specific vegetation structures or land management acted as natural firebreaks. Ultimately, the proposed approach combines high-resolution UAV remote sensing, object-based image analysis, and multi-temporal indicators to assess both post-fire recovery and spatial vulnerability in Mediterranean agricultural landscapes. It contributes to TerraEnvision themes related to natural hazards, climate-resilient land management, and methods to measure environmental processes through remote sensing and deep learning applications.

**Keywords:** UAV remote sensing, wildfire recovery, object-based image analysis, RGB vegetation indices, Mediterranean agroecosystems, vineyards, UAV high-resolution landcover classification

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# Like Water and Fire

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## Abstract

This summer Europe is once again confronted with the impact of climate change. This impact cannot be seen without the linkages with land use, society and economy. The current state, choices made in the past and current developments exacerbate the situation the continent is facing. Wetter winters, prolonged droughts, massive wildfires and extreme weather in terms of concurrent and sequential heatwaves and torrential rains, set the continent for an immediate challenge. While climate mitigation remains key, climate adaptation should be fore fronted in all our decisions. In this adaptation journey natural systems and Nature-based Solutions are pivotal. Recent research outlined Europe does not face a major shortage of Nature-based Solutions or policy ambitions, instead it misses vision, mainstreaming adaptation and, most of all, full-fledged implementation (Parveen et al, 2026; Van Hattum et al, 2023).
Like water and fire, will move from the fire front to the design table and takes the participants along current insights and pressing needs to bridge single solutions to integrative and cross-sectoral perspectives and implementation. Looking back at the severe season of 2025, drawing on current insights from recent major events and bringing in practical experiences from running projects within the framework of the EU Mission on Adaptation to Climate Change, like NBracer and DesirMED. How can we navigate from inspirational desired futures and vision to immediate action and implementation across sectors without losing time? How can we tune in to the max to contextual differences and interdependencies from a systemic and multiscalar perspective? What are enabling and hindering factors and how to unlock these in the short-term to work towards a resilient and prosperous future?

**Keywords:** Landscape approach, fuel management, fire management

# NH2: Flood Recovery - Interdisciplinary Perspectives into Post-Disaster Governance

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# Nh2: Flood Recovery - Interdisciplinary Perspectives Into Post-Disaster Governance

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PENDING

## Abstract

Floods are among the most frequent and devastating natural disasters worldwide, and their impacts often continue long after the water goes down. While flood risk management, especially mitigation and adaptation has received significant academic and policy attention, much less focus has been placed on what happens after a flood event: The recovery phase. This phase is often framed as a return to “normal,” yet this raises the question – what is normal, and for whom? In many cases, recovery decisions risk reproducing existing vulnerabilities or inequalities and foreclosing opportunities for recovery pathways that incorporate nature-based solutions as part of longer-term flood risk reduction and spatial adaptation strategies.
The recovery phase is often treated as a technical or logistical task rather than as a deeply political and multidimensional process. However, recovery is rarely linear; it is shaped by contested negotiations over speed, justice, sustainability, and long-term resilience. It intersects with technical, institutional, legal, financial, ecological, and cultural systems. Besides, it plays a critical role in determining whether nature-based solutions, such as floodplain restoration or hybrid green/grey approaches, are enabled or constrained after flooding.

This special session aims to critically examine the dynamics of flood recovery by drawing on interdisciplinary research and lessons learned from past large-scale flood events. Such events have generated a wealth of practical insights into what facilitates or hinders effective and equitable recovery, including the conditions under which nature-based solutions are considered, implemented, or constrained. The session invites contributions that explore not just how recovery happens, but whose recovery is prioritized, who governs it, and what social, spatial, and ecological futures are made possible or foreclosed in the process. To this end, the session integrates insights from the social sciences, engineering, planning, law, and environmental studies to explore the governance, institutional, and technical dimensions of recovery.
This special session invites contributions from researchers, planners, policy-makers, and practitioners working on flood risk management, post-disaster recovery, and the governance of nature-based solutions. Key questions include:
(1) What roles do civil engineering, insurance, and financial mechanisms play in enabling or constraining recovery, and how do these interact with longer-term nature-based

adaptation strategies?
(2) How do institutional arrangements and property rights shape post-flood recovery processes?
(3) How is responsibility in the recovery phase distributed among different actors?
(4) How do public expectations and societal pressure shape the political dynamics and priorities of flood recovery?
(5) How are environmental and cultural values considered, negotiated, or sidelined during recovery, particularly in relation to nature-based and adaptive strategies?

**Keywords:** floods, recovery, governance, interdisciplinary

PENDING

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# A Gis-Based Planning Workflow For Flood Adaptation and Land Policy in the Araklı District

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## Abstract

Flood-prone settlements require planning approaches that can connect risk evidence with land-use decisions, property rights, and feasible policy instruments. This issue becomes more visible where private parcels are located in areas in which future development may need to be limited for public safety, climate adaptation, and nature-compatible land management. This contribution focuses on the Araklı district of Trabzon, Türkiye, where a severe flood occurred in 2019. It proposes a GIS-based planning workflow to discuss how flood-related spatial evidence could support policy decisions on risk-sensitive urban development and property-right arrangements. The proposed workflow would begin with the identification of flood-affected and flood-susceptible areas. Satellite images, including Sentinel-1 SAR data, topographic information, and existing GIS layers would be used to derive an initial flood footprint and support susceptibility analysis. These outputs would be treated as preliminary spatial evidence and would need to be checked through accuracy assessment, visual interpretation, local knowledge, and available reference information before any parcel-level interpretation. The main policy concern is how flood-related constraints could be translated into fair and implementable planning decisions. Refined flood outputs would therefore be evaluated together with cadastral parcels, land-use data, planning layers, buildings, infrastructure, and ownership information. This spatial evaluation is intended to identify parcels where development restrictions may be required and to clarify whether these areas may need urgent intervention, long-term planning control, or a combined approach. Restricted flood-risk areas would also be considered as possible spaces for nature-based solutions, green infrastructure, and flood attenuation functions. This perspective would connect property-right reconfiguration with wider adaptation agendas, including sustainable urban planning and resilient land-use systems. Value-based land readjustment, transfer of development rights, land exchange, public acquisition, and compensation are discussed as possible policy tools. Particular attention is given to two options: transferring development rights while ownership remains in place, or transferring both ownership and development rights where public safety, environmental sensitivity, or future land-use decisions require stronger intervention. Receiving areas could be assessed through 3D urban modelling to

estimate possible effects on density, building mass, infrastructure demand, and urban form. The proposal seeks to connect flood evidence with spatial restrictions, compensation options, and planned urban growth within a common framework. Although developed around the Araklı pilot area, the workflow may also support discussion on how flood-prone settlements can reduce risk in vulnerable areas while addressing property rights, development pressure, and sustainable land-use transitions.

**Keywords:** Flood adaptation, GIS, land policy, property rights, sustainable urban planning

# NH3: Open session on Nature-Based Solutions for Natural Hazard Mitigation

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# Nh3: Open Session on Nature-Based Solutions For Natural Hazard Mitigation

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PENDING

## Abstract

Nature-based solutions (NbS) are emerging as effective and multifunctional strategies for reducing the impacts of natural hazards while delivering co-benefits for biodiversity, climate adaptation, and human well-being. This session focuses on the role of NbS in mitigating hydro-meteorological hazards, with particular attention to floods, droughts, and wildfires across diverse landscapes and climatic regions.
We invite contributions that explore how ecosystem-based approaches—such as floodplain restoration, wetland conservation, reforestation, peatland protection, soil organic matter enhancement, and green firebreak design—can reduce hazard intensity and exposure. The session will also highlight how NbS can strengthen landscape resilience, improve water retention, regulate microclimates, and support long-term ecosystem stability under changing climate conditions.
Interdisciplinary perspectives are strongly encouraged, including research on modelling hazard risk reduction, monitoring NbS performance, socio-economic co-benefits, governance frameworks, and stakeholder engagement. Particular interest lies in studies demonstrating measurable outcomes, scalable implementation pathways, and integration of NbS into regional risk management and spatial planning strategies.
By bringing together scientists, practitioners, and decision-makers, this session aims to advance the scientific evidence base and promote practical implementation of NbS as cost-effective, sustainable tools for reducing natural hazard risks while enhancing ecosystem and community resilience.

**Keywords:** climate adaptation, close to nature management, soil-water-sediment system

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# Evaluating Sponge Measures' Effectiveness in Mitigating Flood Extremes at Littlestock Brook, Upper Thames, Uk

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## Abstract

Evidence on the effectiveness of sponge measures in mitigating flood extremes continues to grow, but relatively few sites combine catchment-scale storage features, paired land-use soil monitoring, soil hydraulic characterisation, satellite-based Earth Observation (EO) and event-based hydrological response in one place. We present initial findings from Littlestock Brook (16 km$^2$, Upper Thames, UK), a SpongeScapes case study where about 60 sponge measures — leaky woody dams, field-corner bunds, online and offline storage, swales and new woodland — have been installed since 2017 as part of the Evenlode Natural Flood Management (NFM) project. The NFM features occupy less than 1% of the catchment yet drains around 44% of the upper sub-catchments.

We draw on monitoring strands from 2024 to 2026: storm-event response from nine in-stream and pond sensors during the 23 September 2024 event, ‘Storm Bert’ on 24 November 2024, and the consecutive wet sequence of November 2025 to February 2026, contrasting similar rainfall totals on dry versus wet soils; paired soil moisture profiles under arable and adjacent new woodland; monitored measurements of porosity and saturated and unsaturated hydraulic conductivity under different land uses in 2024 and 2025; and initial HEC-RAS 1D–2D modelling of downstream flood response under different events and antecedent conditions.

As a complementary, independent line of evidence, the SpongeWorks project applied a satellite-based Earth Observation (EO) assessment over Littlestock Brook, using Sentinel-2 NDWI and Sentinel-1 SAR water mask to test whether space-based retrieval can detect water retention driven by sponge measures. For Storm Bert, no clear inundation signal was detected in the main downstream area of interest, but clear evidence of water retention was found within upstream sponge measures, suggesting these were activated during the event even though the target reach itself showed no observable inundation. Robust attribution to the sponge measures remains limited by the small number of comparable extreme events analysed so far.

Together, the monitored and EO strands span surface, sub-surface, feature-scale and catchment-scale responses at a single well-instrumented site, and illustrate both the value and the current limits of combining monitored and satellite EO data to inform design, monitoring and maintenance assumptions for sponge measures in similar lowland catchments.

**Keywords:** Flood extremes, catchment monitoring, Sponge measures, Satellite Earth Observation,

SpongeScapes, SpongeWorks

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# Simulation of Water Retention Measures in Forests: a Comparison of Model Approaches

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## Abstract

Climate change is causing longer periods of drought while it also leads to an increase in heavy rainfall events. As a result, efforts are necessary to increase water retention on both agricultural and forested lands. To examine the effectiveness of such measures, two models were developed and compared for a small forest watershed in northern Rhineland-Palatinate. One model is based on the HydroAS hydraulic model and is suitable for simulating surface runoff, while the other model is based on Hydrozwilling, which can also account for aspects of infiltration and interception. Water retention measures such as sheet pile walls, roadside drainage, swales, and other retention structures were incorporated into the models. A precipitation event was then simulated, and the resulting runoff was compared between the baseline condition and the condition after implementing the measures. By combining these measures, a larger proportion of the runoff can be retained and the discharge in the channel reduced, which has a positive effect on water retention and flood protection. Also, pronounced differences between both models can be seen which can be attributed to the differences in the underlying conceptual models.

**Keywords:** water retention, hydraulic simulation

# NH4: Success Factors in Wetland Restoration for Enhancing Natural Water Retention Capacity

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# Nh4: Success Factors in Wetland Restoration For Enhancing Natural Water Retention Capacity

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PENDING

## Abstract

Wetland restoration is increasingly recognised as a key nature-based solution for enhancing natural water retention capacity, supporting climate change adaptation, flood risk reduction, biodiversity conservation, and multiple ecosystem services. Despite its growing relevance in European policies and strategies, the successful implementation of wetland restoration remains highly context-dependent and often constrained by technical, ecological, and socio-economic challenges.
This session focuses on identifying and discussing critical success factors in wetland restoration, with particular attention to the interplay between ecological and hydrological functioning, technical design, and socio-economic conditions. Drawing on good practice examples from across Europe and insights from ongoing research and implementation projects, including the SpongeBoost project, the session aims to move beyond single-discipline perspectives and highlight integrated approaches to restoration.
From an ecological perspective, contributions may address hydrological processes, soil and groundwater interactions, biodiversity outcomes, and the resilience of restored wetlands under changing climatic conditions. The technical dimension includes restoration design, engineering solutions, monitoring approaches, and the integration of wetlands into broader landscape and agricultural systems. The socio-economic perspective covers governance frameworks, policy instruments, land-use planning, stakeholder engagement, landowner acceptance, and economic incentives supporting long-term functionality and maintenance.
The session welcomes contributions from researchers, practitioners, and policy actors presenting empirical case studies, comparative analyses, methodological advances, or lessons learned from implementation. While the session builds on insights from the Horizon Europe SpongeBoost project, it is open to contributions beyond the project, addressing wetland restoration and natural water retention from diverse disciplinary, geographical, and institutional perspectives. By explicitly linking ecological performance, technical feasibility, and socio-economic viability, the session seeks to identify

transferable lessons and practical pathways for scaling up wetland restoration as an effective nature-based solution for enhancing natural water retention capacity across diverse European landscapes.

**Keywords:** Wetland restoration, Success factors, Natural water retention, Ecological performance, Technical design, Socio-economic aspects

PENDING

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# Assessing Policy Instruments For Wetland Restoration: Insights From Stakeholder Interviews Across Europe

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## Abstract

Ecosystem restoration, particularly wetland restoration, plays a key role in enhancing landscape “sponge functions” that support water retention, flood risk reduction, and climate resilience. While European policy frameworks increasingly emphasise scaling up restoration through innovative governance and financing mechanisms, less attention has been paid to how these instruments are perceived by stakeholders involved in their implementation. This contribution examines stakeholder-based assessments of selected policy and market-based instruments supporting wetland restoration across several European case studies. Drawing on semi-structured interviews with landowners, public authorities, NGOs, and practitioners, it explores four types of instruments (voluntary agreements, payments for ecosystem services, biodiversity and carbon offsets, and flood risk pooling schemes) and how they are evaluated in practice. The analysis focuses on four key criteria: environmental effectiveness, cost-efficiency, political feasibility and legitimacy, and equity in the distribution of costs and benefits. It also considers contextual factors shaping these evaluations, such as institutional settings, trust, and stakeholder capacity. The findings reveal differences in perceptions across actor groups and contexts, highlighting key enabling conditions and barriers to wider adoption. They point to trade-offs between efficiency and legitimacy, as well as challenges related to fairness and long-term commitment. By linking stakeholder perspectives with policy design, this study provides insights into how governance and financing mechanisms can be better tailored to local contexts. It contributes to debates on scaling up wetland restoration in Europe by identifying pathways towards more effective, legitimate, and equitable implementation of nature-based solutions.

**Keywords:** Wetland restoration, Policy instrument, Stakeholder perspectives, Innovative financing

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# Assessing Wetland Restoration Effects on Natural Water Retention: Initial Hydrological Modelling Results From the Schneifel Case Study

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## Abstract

Wetland restoration is increasingly promoted as a nature-based solution to improve natural water retention, reduce runoff peaks, and enhance ecosystem resilience. However, quantifying the hydrological effects of restoration measures remains challenging, especially in small headwater catchments where long-term monitoring datasets are often limited. This contribution presents the modelling approach and first intermediate results from the Schneifel case study in western Germany, which is part of the Horizon Europe project SpongeBoost. The study area is a forested ridge landscape with high rainfall, waterlogged clay-schist soils, and valuable fen, wet heath, and wet forest habitats. Restoration measures include the removal of non-native spruce and the blocking of drainage ditches to support a more natural water regime and improve water retention.

To assess the hydrological effects of these interventions, a hydrological model of the catchment is being developed and linked with new field monitoring data. Since early 2026, discharge-related observations at the outlet have been recorded continuously using water level and flow velocity measurements, while precipitation input is derived from a nearby German Weather Service station. Additional soil-moisture monitoring is being integrated into the monitoring concept to improve process understanding and future model calibration. The modelling framework combines monitoring-based calibration with scenario analysis to compare degraded, restored, and more natural catchment states. Initial results focus on the methodological setup, first calibration steps, and the derivation of indicators for sponge potential and runoff retention.

The contribution highlights both the opportunities and limitations of modelling restoration effects under still-developing data availability. It further discusses how intermediate modelling results can already support the evaluation of wetland restoration measures aimed at strengthening natural water retention capacity and improving the hydrological functioning of restored headwater landscapes. The contribution directly addresses the conference session “Success Factors in Wetland Restoration for Enhancing Natural Water Retention Capacity.”

**Keywords:** wetland restoration, natural water retention, hydrological modelling, headwater catchment, SpongeBoost

# UR1: Decentralised Urban Water Systems for Circularity

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# Ur1: Decentralised Urban Water Systems For Circularity

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## Abstract

Decentralised systems are increasingly recognised as essential components of sustainable urban water management, offering cities greater flexibility, resilience, and circularity, especially as climate change, population growth, and supply variability intensify pressure on conventional networks. Enhancing urban water circularity requires advancing sustainable, efficient, and safe management of non-conventional water resources, reducing reliance on traditional water supplies, and integrating decentralised green infrastructure solutions with existing centralised urban systems. Despite the benefits, only a small portion of the vast volume of treated wastewater is reused in urban contexts, while greywater and urban runoffs remain largely untapped due to regulatory, monitoring, acceptance, and implementation barriers.

This session brings together a broad community of researchers and innovators working on decentralised urban water solutions, including those implemented under PRIMA, Horizon Europe, Water4All, LIFE and national programmes, as well as practitioners, SMEs, utilities, municipalities, and international experts. Its aim is to bridge scientific advances with practical experience and real-world deployment.

Areas of focus include nature-based and hybrid solutions of compact and modular treatment that enable greywater reuse, stormwater harvesting, as well as and digital tools for spatial or economic optimisation, and digital monitoring tools for safe and efficient operation. Contributions on long-term operation and maintenance, user acceptance, risk assessment, and of decentralised systems are highly encouraged. Topics related to governance, regulation, and policy interfaces are also welcome, particularly where they connect to and complement other TerraEnVision sessions.

By creating a space for dialogue between science, industry, and public authorities, the session seeks to identify synergies across projects and regions, explore opportunities for joint demonstrations, and connect innovative SMEs with real urban challenges. Participants will gain insights into emerging solutions and collaborative pathways toward circular and resilient urban water management.

**Keywords:** Greywater and stormwater reuse, Nature-based solutions, Hybrid treatment technologies, Resource recovery, Digital monitoring tools, Urban system optimisation

PENDING

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# Green4Grey: Advancing Urban Water Circularity Through Decentralized Nature-Based Solutions

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## Abstract

Urban areas are increasingly challenged by water scarcity, climate variability, and growing pressure on freshwater resources. At the same time, significant volumes of non-conventional water resources, including greywater, rainwater, and urban runoff, remain underutilized despite their potential contribution to more circular and resilient urban water systems. The adoption of decentralized water reuse solutions is often hindered by technical, environmental, regulatory, and social barriers, highlighting the need for integrated approaches that can demonstrate both safety and effectiveness.
The Green4Grey project aims to enhance urban water circularity through the development and validation of decentralized Nature-Based Solutions (NbS) that safely treat, monitor, and reuse non-conventional water resources within urban environments. The project combines green infrastructure, environmental monitoring, digital tools like City Information Model, risk assessment frameworks, and stakeholder engagement to support the transition towards sustainable and resilient urban water management.
Green4Grey brings together complementary pilot systems in Greece, Israel, Czechia, Spain, and Brazil, showcasing different approaches to water reuse and green infrastructure integration. These include greywater reuse systems, rainwater harvesting technologies, green roofs, constructed wetlands, urban runoff management solutions, and digital monitoring platforms. The pilots provide a diverse testing environment for evaluating system performance, resource efficiency, environmental safety, and operational reliability under different climatic and urban conditions.
Expected outcomes include validated pilot applications, monitoring and decision-support tools, risk assessment and mitigation strategies, spatial planning frameworks, and practical guidance for the wider implementation of decentralized water reuse systems. By generating transferable knowledge and demonstrating innovative NbS solutions across multiple international case studies, Green4Grey seeks to support cities, practitioners, and policy makers in accelerating the transition towards climate-resilient and circular urban water systems.

**Keywords:** Nature-Based Solutions, Urban Water Circularity, Greywater Reuse, Decentralized Water Systems, Green Infrastructure, Climate Resilience, Water Reuse

# UR2: Greening Cities for Climate Action: Resilience, Mitigation, and Community Well-Being

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# Ur2: Greening Cities For Climate Action: Resilience, Mitigation, and Community Well-Being

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PENDING

## Abstract

Cities are at the forefront of climate change impacts, facing increasing risks from heatwaves, flooding, air pollution, and biodiversity loss. Urban Green Infrastructure (UGI), such as urban forests, wetlands, green roofs, and other multifunctional green spaces, has emerged as a key nature-based approach to mitigating climate change, enhancing urban resilience, and delivering co-benefits for human well-being and ecosystems. Despite growing policy attention and investment, significant challenges remain in generating robust evidence, identifying effective implementation pathways, and assessing the long-term impacts of UGI interventions.

This session aims to bring together researchers, practitioners, and policymakers to examine the state of the art and future directions of UGI as Nature-Based Solutions (NbS) for climate change mitigation and adaptation. The session is structured around three interlinked dimensions: (1) Evidence, focusing on advances in monitoring, modelling, and evaluation methods to quantify the climatic, ecological, and social impacts of urban NbS; (2) Implementation, addressing governance arrangements, planning instruments, financing mechanisms, and stakeholder engagement processes that enable successful deployment across diverse urban contexts; and (3) Impact, exploring the assessment of co-benefits and trade-offs related to social equity, public health, biodiversity, and long-term urban sustainability. Contributions may include empirical research, comparative and place-based case studies, methodological innovations, and critical reflections on barriers, synergies, and enabling conditions for scaling up NbS in cities. The session particularly welcomes interdisciplinary perspectives that bridge science, policy, and practice, as well as contributions from climate-vulnerable and rapidly urbanizing regions.

By fostering dialogue across disciplines and sectors, this session seeks to advance an integrated, evidence-based understanding of how urban NbS can support the transition towards climate-resilient, inclusive, and sustainable cities. We welcome contributions

addressing, but not limited to, the following topics:
• Climate mitigation and adaptation performance of urban NbS;
• Monitoring, modelling, and indicators for assessing NbS effectiveness in urban environments;
• Governance, policy integration, and urban planning tools for NbS implementation in urban areas;
• Social equity, environmental justice, and community co-creation processes;
• Economic valuation, financing mechanisms, and cost–benefit analysis of urban NbS;
• Scaling up NbS and integrating them into climate-neutral and resilient city strategies.

**Keywords:** Nature-based solutions, Urban Green Infrastructure, Climate change adaptation and mitigation, Urban resilience, Governance, Co-benefits

PENDING

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# Quantifying Ecosystem Services of Urban Community Gardens Using Invest: Implications For Nature-Based Solutions in New York City

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## Abstract

Urban community gardens are widely recognised as nature-based solutions (NBS) that enhance food access, social cohesion, and urban biodiversity. However, their contributions to key ecosystem services—particularly those related to urban climate regulation and water management—are rarely quantified in ways that inform planning and investment decisions.

We apply the InVEST modelling framework to evaluate ecosystem services provided by community gardens across two council districts in New York City. The analysis focuses on gardens participating in the GreenThumb program, which supports more than 500 community-managed sites distributed across highly developed urban landscapes. This project specifically focused on two council districts with changing political personnel and goals. Spatial datasets describing garden extent and land cover were integrated with publicly available land-use/land-cover data to generate model-ready inputs. We classified gardens into one of four different categories, based on tree canopy cover and impervious surface within the garden footprint.

We developed spatial scenarios comparing current conditions, with gardens across the urban landscape, to a hypothetical scenario where gardens were replaced with paved surfaces. These scenarios were used to parameterise the InVEST Carbon Storage and Sequestration, Urban Cooling, and Urban Stormwater Retention models to estimate the marginal contributions of community gardens to carbon storage, urban heat mitigation, and stormwater retention.

In addition to quantifying ecosystem service provision, this work evaluates methodological challenges associated with representing small, heterogeneous green spaces in land-use/land-cover datasets and ecosystem service models. In particular, we assess how classification resolution and parameterisation influence modelled outcomes for dispersed, parcel-scale NBS features.

This study demonstrates how spatially explicit modelling can be used to quantify and communicate the environmental benefits of community gardens, supporting urban planning, climate resilience strategies, and evidence-based investment in distributed green infrastructure.

**Keywords:** urban community gardens, climate resilience, spatial modelling

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# Climate-Induced Displacement and Labour Migration From Somalia: Governance Gaps in Drought and Flood-Driven Mobility.

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## Abstract

Somalia does not experience climate change as an abstract threat. Recurrent droughts and seasonal flooding — particularly across the Shabelle and Juba river basins — have become the primary engine of population displacement, pushing millions into irregular mobility long before formal labour systems can respond. The 2021-2022,2023-2024 drought, the worst in four decades, did not simply kill livestock and crops. It emptied villages.

What follows displacement matters as much as the displacement itself. Somali workers move — toward Gulf states, toward Yemen, toward uncertain corridors — without legal status, without bilateral protection, and without any mechanism that acknowledges why they left. Existing governance frameworks treat them as economic migrants. They are often something more complicated: people displaced by environmental collapse who need work to survive and to send money home.

Between 2022 and 2025, as Minister of Labour and Social Affairs, I negotiated Somalia's Bilateral Labour Agreement (BLA) with the Kingdom of Saudi Arabia, finalised in December 2024. It is a meaningful step. But I am aware of what it does not contain. There is no clause that responds to climate shock — no provision that activates enhanced protections when drought or flooding triggers a surge in outward mobility. That gap was not an oversight unique to Somalia. It reflects a broader failure to connect climate adaptation thinking with bilateral labour diplomacy.

This paper proposes that sending states facing recurrent climate shocks need a different kind of agreement architecture — one where declared environmental emergencies trigger specific worker protections, expedited documentation, and return guarantees. I draw on comparison with Ethiopia's drought-response migration policies and the Philippines' climate-mobility frameworks, neither of which is perfect, but both of which take the connection seriously.

Managed labour migration, in Somalia's context, functions as a de facto climate resilience mechanism. Remittances stabilise households that have lost everything to flood or drought. That reality deserves explicit recognition in the governance structures we

build — not as an afterthought, but as a design principle.

**Keywords:** Climate displacement, labour migration, drought resilience, fragile states, Horn of Africa

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# Insights Into Climate Change Dynamics: a Tourism Climate Index-Based Evaluation of Gilgit-Baltistan, Pakistan

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## Abstract

Background: Tourism is a vital economic sector in Pakistan, yet the country is highly vulnerable to climate change. Gilgit-Baltistan, a major tourist destination in the Himalayan region, faces changing climatic conditions that affect tourist comfort and destination viability. However, limited research has quantitatively assessed climate change impacts on tourism in this region.
Objective: This study applies the Tourism Climate Index (TCI) to evaluate the current and future suitability of climatic conditions for tourism in six key locations of Gilgit-Baltistan (Astore, Bunji, Chillas, Gilgit, Gupis, and Skardu). It also projects TCI changes under three Shared Socioeconomic Pathways (SSP126, SSP370, SSP585) using three climate models.
Methods: TCI was calculated based on five sub-indices: daytime comfort (CID), daily comfort (CIA), precipitation (R), sunshine hours (S), and wind speed (W). Historical climate data (1991–2021) were obtained from the Pakistan Meteorological Department and ERA5 reanalysis. Future projections (up to 2085) were derived from CHELSA 2.1 data using three climate models. Bias correction and regression imputation were applied for missing variables.
Results: Currently, most stations show “excellent” TCI ratings in summer (May–October), with Gilgit and Gupis maintaining favourable conditions for up to six months. Under optimistic scenarios (SSP126), TCI remains stable or slightly improves. Under pessimistic scenarios (SSP370, SSP585), summer TCI declines due to projected temperature rises, shifting peak comfort to spring and autumn. Astore shows the highest resilience, while Chillas and Bunji experience increased summer discomfort. TCI never falls below “acceptable” in any scenario.
Conclusion: Climate change will alter the seasonality of tourism comfort in Gilgit-Baltistan, but the region remains a viable tourist destination for the coming century. Sustainable tourism planning must incorporate climate adaptation strategies. The TCI proves effective for assessing climate–tourism dynamics and can be extended to other regions of Pakistan.

**Keywords:** Climate Change, Tourism Climate Index (TCI), Sustainable Tourism, Gilgit-Baltistan, Climate Adaptation, Tourism Planning, Shared Socioeconomic Pathways (SSPs), Bioclimatology.

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# Concept For Climate Change Adaptation in the Trier-Saarburg District (Germany)

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## Abstract

The impacts of climate change can be observed worldwide and are also clearly visible in the District of Trier-Saarburg. In recent decades, the region has experienced a significant increase in the number of hot days, a decline in ice and frost days, and a growing frequency of heavy rainfall events. These developments pose considerable challenges to the environment, infrastructure, public health, and overall quality of life.
Recognizing these challenges and their implications for local communities, the Trier-Saarburg District Administration has taken proactive steps in both climate mitigation and climate adaptation. Within this framework, and with the support of the Federal Ministry for the Environment, Climate Action, Nature Conservation and Nuclear Safety (BMUKN), a climate adaptation project was launched in June 2025.
The objective of the project is to develop a comprehensive climate adaptation concept to identify suitable measures to reduce future climate-related risks and enhance the quality of life for residents.
The project is being implemented by the District Administration of Trier-Saarburg, which has commissioned the Institute for Applied Material Flow Management (IfaS) as an implementing partner.
The aim of this presentation is to illustrate the impacts of climate change on the District of Trier-Saarburg and to present the progress made in developing the regional climate adaptation concept, which is scheduled for completion in 2027.

**Keywords:** climate change, Adaptation strategy, nature-based solutions, Trier-Saarburg

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# Nature-Based Solutions as a Bridge Between Human Health and Climate Adaptive Cities

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## Abstract

The interconnected and interdependent connection between human health and a healthy environment is becoming increasingly clear (EEA, 2026). In the field of One health research, which is originally mainly focused on preventing zoonotic risks, the World Health Organization (WHO), World Organisation for Animal Health (WOAH), Food and Agriculture Organisation of the United Nations (FAO) and United Nations Environment Programme (UNEP) recently emphasized that they would like to integrate the environment more into the One Health approach (WHO, WOAH, FAO and UNEP, 2026). So far, Nature-based solutions (NbS) originate from goals related to climate adaptation or improving biodiversity, while the co-benefits, such as improving health, are increasingly getting more attention (WHO, 2025). However, it is still not easy to bridge the gap between human health and NbS in practice, especially in cities where pressure on space is increasing rapidly. When looking at NbS as practical interventions to improve One Health goals, they become more integrated. In our research we bring these perspectives together by looking at Nature-based solutions and the role they can fulfil in the Nexus between biodiversity, climate, water, and health. The point at which these two promising pathways, NbS and One Health, come together is at the design and maintenance of the NbS. By designing NbS in such a way they do not only improve biodiversity and climate adaptation but provide health benefits as well, the role of NbS in society can grow. If NbS are positioned as a bridge between human health and healthy environments (WHO & IUCN, 2023), NbS can strengthen synergies between both domains and thereby lead to a more efficient use of limited space and resources and a more attractive narrative. Especially in times where people are getting less connected with nature (Richardson, 2025), the number of people living in urban areas is growing and space for nature in cities is limited, it is becoming more important to make smart choices on how to fulfil as many functions as possible on one spot. NbS can substantially add to the solution of this complex puzzle, if policy, resources and knowledge are in place as well.

**Keywords:** Nature-based Solutions, Health, Cities

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# Field Monitoring of Plant Functional Traits and Thermo-Hydric Behaviour to Assess the Multifunctionality of Urban Nature-Based Solutions

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## Abstract

Nature-based Solutions (NbS) are increasingly implemented to mitigate urban heat islands, improve stormwater regulation, and enhance climate resilience in cities. However, assessing the multifunctionality of vegetation remains challenging due to plant functional diversity, complex interactions in the soil–plant–atmosphere continuum (SPAC), and the spatial heterogeneity of urban environments. Field-based monitoring approaches linking plant functional traits, thermo-hydric behaviour and ecosystem service delivery remain limited in urban contexts.

This study presents the experimental setup and integrated monitoring framework developed within the ANR PENATE project to assess the thermo-hydric functioning of urban vegetation. The framework is implemented across different NbS typologies, including two renatured schoolyards, urban stormwater trees and a green roof. The approach combines field monitoring and process-based modelling through a sensor network deployed across pilot sites in Strasbourg and Les Mureaux (France).

The monitoring strategy combines multi-scale measurements to characterise water and energy fluxes within the SPAC, including soil moisture and matric potential, tree sap flow, dendrometric variation, surface temperature, and meteorological and microclimatic conditions. This dataset is complemented by measurements of plant traits at the leaf and canopy levels (e.g., transpiration, stomatal conductance, leaf temperature) using porometry, evapotranspiration chamber and thermography. These observations aim to better quantify water and energy fluxes and plant responses within the studied NbS.

The monitoring strategy is designed to support ecohydrological and process-based modelling frameworks, allowing upscaling from plants to overall NbS performance. Methodological challenges associated with integrating heterogeneous sensor networks are discussed. Linking plant functional traits with transpiration dynamics, drought response and cooling efficiency will improve the predictive capability of NbS under current and future climatic conditions. Within the PENATE project, the resulting data will

contribute to evapotranspiration assessment using plant-based (Radiation Absorption, Transpiration and Photosynthesis-RATP), climato-hydrological (Multi-Hydro, SOLENE) and multi-criteria (HIBOU) modelling approaches.

**Keywords:** Nature-based Solutions, soil–plant–atmosphere continuum, plant functional traits, thermo-hydric behaviour, urban hydrology

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# Towards Climate-Neutral Cities: Preliminary Results From the Greencities Framework For Integrating Nature-Based Solutions Into Urban Planning

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## Abstract

Cities account for more than 70% of global greenhouse gas emissions (GHGs) and are increasingly exposed to climate-related risks such as heatwaves, flooding, and declining environmental quality. Although many European municipalities have committed to achieving climate neutrality, local authorities still lack spatially explicit, evidence-based tools to identify where nature-based solutions (NBS) can deliver the greatest climate benefits. The GreenCities project addresses this challenge by developing an integrated framework that combines urban carbon emission mapping, assessment of carbon sequestration by urban green infrastructure, and GIS-based decision support for climate mitigation planning.

This contribution presents the first results of the GreenCities project, using Coimbra (Portugal) as a case study. A multidisciplinary methodology integrates geospatial datasets, high-resolution remote sensing, field measurements, laboratory analyses, and machine-learning techniques to quantify the climate mitigation potential of urban green infrastructure. Unlike most previous studies, the project considers both vegetation and urban soils as carbon reservoirs, providing a comprehensive assessment of ecosystem carbon storage and carbon flux dynamics.

$CO_2$ emission hotspots were identified by integrating high-resolution spatial emission inventories with GIS analyses to quantify emissions from the residential, commercial, industrial, and transportation sectors. Preliminary results reveal that the transportation sector is the dominant source of urban $CO_2$ emissions, highlighting priority areas for targeted mitigation interventions.

Carbon sequestration potential was assessed by integrating above- and belowground carbon pools. Vegetation carbon stocks were estimated from high-resolution remote sensing, biomass sampling, laboratory analyses, and species-specific allometric equations, while soil carbon stocks were quantified through field sampling and laboratory determination of soil organic carbon and bulk density. To complement carbon stock assessments, soil $CO_2$ emissions were measured in situ using a portable infrared gas analyzer (LI-COR) coupled with a closed dynamic chamber across four representative

urban green infrastructure types. The resulting soil respiration data provide insights into the temporal dynamics of carbon fluxes and contribute to evaluating the net ecosystem carbon balance of different urban green spaces.
The preliminary findings demonstrate the importance of integrating emission hotspot analysis with ecosystem carbon storage and soil carbon flux measurements to identify the most effective locations for NBS implementation. By combining advanced environmental monitoring with spatial decision support, GreenCities provides a replicable framework to guide climate-neutral urban planning, supporting evidence-based policies that maximize carbon sequestration while enhancing the multiple ecosystem services and community benefits delivered by urban green infrastructure.

**Keywords:** Nature-based solutions, Urban green infrastructure, Carbon sequestration, Climate neutrality

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# Evaporation-Oriented Sponge City Roofs: a New Paradigm For Compensating Urban Sealing

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## Abstract

Urban sealing fundamentally alters the natural water balance by reducing evapotranspiration, increasing surface runoff and intensifying the urban heat island effect. Although extensive green roofs are widely recognised as an important nature-based solution, their conventional design is primarily optimised for low maintenance rather than for maximum cooling and water-cycle restoration. Consequently, their contribution to urban climate regulation often remains below its potential.
This presentation introduces a new generation of evaporation-oriented Sponge City Roofs that combines permanent water storage, adaptive water management and high-transpiration vegetation to restore—or even exceed—the natural urban water balance. The concept follows the objectives of the German DWA Guideline M 102-4, which aims to approximate the hydrological conditions of undeveloped landscapes within urban environments.
Hydrological modelling based on the NatUrWB approach and DWA M 102-4 demonstrates that conventional extensive green roofs typically achieve evaporation fractions below those required to recreate natural site conditions. By integrating permanent retention layers, capillary water supply and vegetation with high evapotranspiration capacity, the proposed system substantially increases annual evapotranspiration while simultaneously reducing runoff and improving stormwater retention. Model calculations indicate that evaporation fractions can exceed the target values for natural water balances, thereby overcompensating for the hydrological impacts of urban sealing.
The presentation further discusses the importance of vegetation selection, controlled irrigation strategies and active water management for maximising cooling performance during prolonged dry periods. Experimental investigations and large-scale lysimeter facilities at the University of Applied Sciences Weihenstephan-Triesdorf provide the basis for validating long-term water balances and optimising future system configurations under realistic climatic conditions.
The presented approach represents a paradigm shift from conventional green roofs designed to rapidly drain water towards multifunctional roof systems that intentionally retain, redistribute and evaporate water. Such systems simultaneously contribute to urban cooling, stormwater management and climate resilience while supporting the

transition towards sponge cities and circular urban water management.

**Keywords:** Sponge City Roof, Green Roof, Evapotranspiration, Urban Water Balance, Climate Adaptation

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# From Tree Detection to Climate Action: a Digital Twin For Urban Greening and Heat Adaptation

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## Abstract

Background
Increasingly frequent and intense heatwaves are prompting cities to expand green infrastructure as a key climate-adaptation measure. However, municipal tree cadasters typically document only publicly managed trees, excluding much of the privately owned urban tree stock. Although satellite imagery has been used to map vegetation, its spatial resolution is often insufficient to identify individual trees. Recent advances in high-resolution aerial imagery and deep learning have improved individual-tree detection, but their outputs have rarely been translated into operational planning tools. This study bridges the gap between research and practice by develop tree detection, green-volume estimation algorithms and transfer the output into an interactive urban digital twin.
Methodology
Individual trees were detected using deep-learning methods with high-resolution RGB aerial imagery. Three-dimensional LiDAR data were then used to estimate tree-canopy volume. The resulting public- and private-tree data were integrated into a WebGIS-based digital twin that dynamically visualizes tree-cast shadows for any selected location, date, and time. An interactive scenario tool was also developed to simulate the effects of proposed tree planting on local shade provision.
Results
The resulting digital twin provides a comprehensive representation of shade cast by both public and private trees. By calculating cumulative shade hours, the platform identifies urban areas with insufficient protection during hot periods and supports the prioritization of locations for greening interventions. The scenario tool allows planners to add virtual trees and immediately assess how alternative planting configurations affect shade coverage.
Policy and planning relevance
The platform has been applied by local-government staff and urban planners to support tree-planting decisions and climate-adaptation planning. By transforming remotely sensed tree data into actionable spatial evidence, the approach helps cities target green-infrastructure investment, evaluate planting scenarios, and improve outdoor thermal protection. The study demonstrates how digital twins can connect advances in urban-tree detection with practical, evidence-based strategies for greening cities and adapting to extreme heat.

**Keywords:** Green volume, tree detection, deep learning, urban digital twins, climate adaptation

# UR3: Cross scale approach for NBS integrations in urban ecosystems

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# Co-Designing and Co-Implementation For Climate Resilience: the Adaptwise Model and Pathways For Regional Scaling

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## Abstract

INTRODUCTION
As climate change exacerbates extreme weather events, urban and peri-urban systems face unprecedented challenges, particularly concerning water management and soil degradation. While Nature-Based Solutions (NBS) are widely recognized - among other kinds of adaptation solutions - for their capacity to enhance climate resilience, their long-term success heavily relies on participatory governance and social acceptance. This contribution responds to the UR3 session's call by presenting AdaptWise, an innovative Community-Based Adaptation (CBA) model designed to bridge the gap between technical adaptation to CC planning and local community empowerment. AdaptWise shifts the paradigm from top-down infrastructure delivery to a collaborative approach where citizens, public authorities and stakeholders actively co-design and maintain resilient landscapes.
THE ADAPTWISE METHODOLOGY
The AdaptWise framework is structured around a replicable, step-by-step methodology that places communities at the core of the adaptation process, specifically targeting soil and water vulnerabilities. It has been tested across 8 pilot sites.
1) *Contextual Vulnerability and Asset Mapping*: The process begins with participatory mapping, integrating scientific climate data (e.g., flood-prone zones, urban heat islands) with local ecological knowledge. This step identifies critical environmental vulnerabilities while simultaneously mapping existing social capital and risk tolerance.
2) *Stakeholder Engagement and Co-design*: Through structured workshops and capacity-building sessions, citizens and technical experts collaboratively design adaptation solutions, among which NBS. This phase ensures that the interventions are not only ecologically sound but also socially relevant and culturally integrated.
3) *Shared Implementation and Monitoring*: The final step involves the joint execution of the designed solutions, establishing clear roles for both the municipality and the community in the long-term stewardship of the implemented NBS.
2 CASE STUDIES
1) *Livorno*. In the coastal city of Livorno - an area highly susceptible to climate-induced water extremes and soil sealing - the process has successfully reached the implementation stage. The cornerstone of this operational phase is the establishment of a formal "Collaboration Pact" (Patto di Collaborazione) between the local community, civil society organizations, and the Municipality. This administrative tool is fundamental for

participatory governance: it provides a legal framework for citizens to actively manage public spaces and implement small-to-medium scale adaptation interventions. The Collaboration Pact transforms the signatories into active drivers of urban climate resilience, ensuring ownership and sustainability.
2) *Alghero*. A primary school's grounds and infrastructure were retrofitted utilizing targeted NBS, transforming a traditional educational facility into a climate-resilient community hub. This intervention not only addressed local soil and water management vulnerabilities but also established the school as a "living laboratory." By embedding NBS directly into the educational setting, the Alghero pilot fostered hands-on environmental awareness among younger generations and strengthened broader neighborhood engagement, proving that the methodology can be effectively adapted to institutional assets as well as public municipal spaces.

SCALING UP - A VISION FOR TUSCANY REGION

Having successfully spearheaded the regional integration of the FireWise Communities model for wildfire resilience, Anci Toscana is now advocating for a complementary step: adopting the AdaptWise methodology as a foundational framework for a new, parallel policy tool within the Tuscany Region. Anci Toscana's advocating for an open-call mechanism which would provide continuous financial support and technical accompaniment to local communities across the region upon their request. By institutionalizing the AdaptWise approach alongside its FireWise counterpart, the Tuscany Region can systematically empower local networks to implement localized NBS for soil and water management whenever community readiness aligns with local climate vulnerabilities.

CONCLUSION

Ultimately, AdaptWise illustrates that sustainable urban development requires robust social infrastructure alongside ecological engineering. By showcasing the Livorno and Alghero case studies and outlining a clear pathway for regional policy integration, this presentation provides a practical blueprint for cross-scale, community-led climate adaptation.

**Keywords:** #EverydayAdaptation #RelationalDurability #TransformativeAdaptation #SoftAdaptation #KnowledgeCoproduction #IntersectionalClimateJustice #LocalKnowledge #CommunityResilience #CommunityBasedAdaptation

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# Integrating Participatory Governance Into Urban Planning For Climate Resilience: Evidence From the Prin Urca! Project

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## Abstract

Climate change is increasing the frequency and intensity of urban flood events, requiring planning approaches that integrate risk prevention, adaptation, and stakeholder engagement. This research investigates the role of public authorities in embedding climate risk knowledge within statutory urban planning. It examines how participatory governance can support more effective and inclusive climate resilience strategies at the local level.
The study draws on the experience of the Italian PRIN 2020 project URCA! – Urban Resilience to Climate Change: Activating Participatory Mapping and Decision Support Tools for Enhancing Sustainable Urban Drainage, involving seven Italian universities. The project promoted urban resilience as a key component of sustainable development, contributing to Sustainable Development Goals 11 (Sustainable Cities and Communities) and 13 (Climate Action) through the implementation of Sustainable Urban Drainage Systems (SUDS) and participatory decision-making processes.
This abstract focuses on the comparative case studies of Genoa and Brescia, two cities representing different institutional and environmental contexts. Genoa is highly exposed to hydraulic risk and has an established tradition of participatory governance, although climate adaptation had not previously been addressed through participatory processes. Brescia has developed a long-term climate transition strategy integrating municipal planning instruments with participatory practices and collaborative forms of public space management.
Attention is devoted to the development of the URCA! Policy Brief, conceived as an evidence-based decision-support tool for policymakers and public administrators. Building on participatory mapping activities and stakeholder engagement, the Policy Brief translates research outcomes into operational recommendations for integrating participatory approaches into urban planning and climate adaptation policies.
The findings suggest that participatory governance enhances the capacity of local authorities to address climate-related risks by improving risk awareness, facilitating knowledge exchange among institutional and non-institutional actors, and supporting more informed and legitimate planning decisions. Beyond the specific case studies, the proposed Policy Brief demonstrates how research-based policy tools can bridge the gap between scientific knowledge and planning practice, providing a transferable framework for strengthening urban resilience and promoting more inclusive and climate-responsive

governance.

**Keywords:** climate change, governance, public engagement

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# A Fit-For-Purpose Framework For Ecosystem Service Assessment in Spatial Planning

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## Abstract

The integration of ecosystem services (ES) into spatial planning has become increasingly widespread over the last decade, supporting territorial governance across multiple administrative and ecological scales (Malinga et al., 2015). ES assessments are now employed to inform strategic planning, environmental accounting, participatory governance, and land-use regulation. Despite this growing consensus, the selection of assessment methods often remains weakly justified. As highlighted by Albert et al. (2014), ES assessments should not be conceived as standardized procedures, but designed according to the decision-making context and feasibility conditions, including data availability, technical capacity, institutional settings, resources, and users' needs. These conditions determine the appropriate spatial scale, methods, valuation approaches, and outputs. Accordingly, The Economics of Ecosystems and Biodiversity (TEEB) initiative introduced the fit-for-purpose principle, emphasizing that methodological choices should reflect specific decision objectives.
A decision-support framework for aligning ES assessment approaches with planning objectives is proposed to address this gap. Building upon Albert et al., it develops a hierarchical assessment scheme and tests its application through pilot studies in Italy. The framework includes two levels: preliminary conditions defining objectives and feasibility, and an operational matrix linking methods, spatial scales, and outputs according to planning purposes.
The framework is subsequently interpreted through a simplified version of Lasswell's Policy Cycle (1956) to demonstrate how ES assessments should critically evolve across different stages of public decision-making. In particular, four planning objectives are distinguished.
The first, awareness raising, focuses on increasing the recognition of ES through participatory governance processes capable of incorporating plural and non-use values into territorial decision-making. This case did not produce quantitative assessment outputs: instead, it was developed as an arts-based participatory process of knowledge co-production involving civil society and local administrators, aimed at fostering shared understandings of ES and making plural, relational, and non-use values visible within territorial decision-making.
The second, accounting, supports strategic spatial planning through the construction of a territorial baseline. This objective is illustrated by the biophysical and monetary assessment of ES, following the operational guidelines developed by Italian Institute for

Environmental Protection and Research (ISPRA). Although these guidelines prioritize operational applicability over methodological complexity, they provide a consistent basis for ecosystem accounting at the sub-regional scale.
The third objective, priority setting, aims to identify territorial strategies based on a comprehensive understanding of ES provision. This stage is explored through a cross-scale assessment of cultural ecosystem services using the System of integrated Environmental and Economic Accounting- Ecosystem Accounting (SEEA EA) framework, which integrates the ecological scale of ES production with the administrative scale of spatial planning, supporting place-based strategies for natural capital enhancement.
Finally, instrumental design concerns situations in which ES assessments directly support planning instruments and land transformation decisions. Here, methodological robustness and valuation consistency become essential because assessment results influence regulatory choices and negotiations among multiple stakeholders. The proposed application combines the SEEA EA and the European Integrated system for Natural Capital Accounting (INCA) frameworks at the municipal scale to define a monetary metric for soil ES consistent with land market exchange values. This enables direct comparison between natural capital and real estate values, providing an operational basis for integrating ES into planning instruments such as ecological compensation schemes, Soil Value Capture, Transfer of Development Rights, and future Payments for Ecosystem Services (PES).
The proposed framework provides a transparent, critical, and operational framework for integrating ES into contemporary spatial planning and land governance. It emphasized the pivotal role of ES assessment in supporting the planning and implementation of Nature-Based Solutions (NBS), demonstrating how cross-scale governance approaches, interdisciplinary perspectives, participatory processes and are supported by evidence from concrete pilot applications.

**Keywords:** soil ecosystem services, ecosystem services assessment, spatial scale selection, spatial-planning decision making

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# Integrating the Planetary Boundary For Freshwater Change Into Urban Water Management Through Nature-Based Solutions

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## Abstract

The transgression of global Planetary Boundaries (PBs), particularly concerning freshwater change (blue and green water) and climate stability, is heavily driven by increased urban consumption and land-use change. These Anthropocene changes generate severe societal and environmental risks, including risks for urban dwellers and ecosystems. Navigating the freshwater interface between the Earth system and societies requires a cross-scale approach that connects local socio-ecological needs and basic water security with the stabilization of critical global thresholds.
While Nature-based Solutions (NbS) and Urban Green Infrastructure (UGI) are increasingly implemented for local climate adaptation and water management, their ecosystem services (ES) face a duality: they are actively threatened by global environmental changes, yet they serve as vital local levers to counter PB transgression. Hence, this contribution aims to explore what are the requirements to operationalize the PB for freshwater change within urban water management, and how can NbS actively reduce the transgression of these boundaries? To examine these interlinkages, this study first provides the example of compound drought and heat risks on selected ecosystem services within an urban park in Plauen, Germany. To connect these local dynamics to the Earth system, the study further examines the global freshwater–society interface based on existing evidence from literature. This perspective synthesizes critical water-related interlinkages, planetary boundaries for freshwater change, and societal water needs, pointing toward innovations that reduce societal pressures on freshwater systems and build resilience to hydrometeorological extremes.
The findings demonstrate that while urban ES are highly sensitive to compound drought and heat hazards, safeguarding and adapting these green-blue infrastructures generates systemic, multi-scale benefits. By framing NbS as cross-scale operational tools rather than isolated local interventions, this study highlights how targeted urban water management can simultaneously build local climate resilience and contribute to remaining within Safe and Just Earth System Boundaries.

**Keywords:** Urban Water System, Nature-based Solutions, Ecosystem Services, Planetary Boundaries,

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# Assessing Soil Ecosystem Services From Urban Soils to Engineered Soils

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## Abstract

Urbanisation is increasing the need for sustainable solutions that improve environmental quality while enhancing the resilience of urban areas. In this context, engineered soils can play an important role in Nature-Based Solutions (NBS) and Low Impact Development (LID) systems by supporting multiple soil ecosystem services. This research aims to assess the ecosystem services provided by healthy engineered soils in urban environments and to investigate how environmental conditions may influence their performance. The municipality of Parete, in Campania, Italy, is used as the case study. The current phase of the research combines GIS and remote sensing analyses, field sampling, laboratory soil characterisation and regional climatic assessment. Twenty soil samples were collected within the study area, while Landsat imagery was used to evaluate land-use change between 2006 and 2026. Preliminary analysis indicates rapid urban expansion (+70.8%) accompanied by vegetation loss (-18.5%). A regional temperature analysis was also carried out using meteorological data from selected stations across Campania. Parete shows a warming rate of approximately +0.60 °C per decade and an intermediate thermal regime compared with the other investigated stations. These preliminary results provide the environmental context for the next phase of the research, which will integrate soil, vegetation and atmospheric information to assess soil ecosystem services and support the future evaluation of engineered soils within NBS and LID applications. Particular attention will be given to functions related to stormwater management, infiltration, water regulation and urban climate resilience.

**Keywords:** Soil ecosystem services, Nature-Based Solutions, Low Impact Development, Urban soils, Climate resilience

# UR3: Scaling Urban Nature-Based Solutions: Governance, Trade-Offs and Multi-Stakeholder Action

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# Ur3: Cross Scale Approach For Nbs Integrations in Urban Ecosystems

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PENDING

## Abstract

Urban areas play a critical role in the transition towards living within planetary boundaries, as they concentrate population, resource consumption, and exposure to climate risks. Urban ecosystems can be understood as complex “socio-ecological and technological systems” that extend beyond their physical boundaries through continuous exchanges of matter, energy, and ecosystem services across spatial and administrative scales.These systems depend heavily on soil and water to deliver essential ecosystem services such as flood regulation, water purification, urban cooling, carbon storage, and biodiversity support forming the biophysical foundation of effective Nature-Based Solutions (NBS) for urban resilience and sustainability.

By definition NBS integrate environmental, social, and economic benefits, contributing not only to ecological restoration but also to community well-being and social resilience. Therefore, their effective implementation depends not only on technical design, but also on wide community engagement and governance models that enable coordination among multiple actors, including municipalities, regional and national authorities, water boards, planners, scientists, practitioners, and civil society.

A cross-scale perspective recognizes cities as part of wider socio-ecological systems, linked to surrounding landscapes through hydrological processes, soil functions, and material flows. Addressing urban challenges such as flooding, drought, heat stress, soil sealing, and land degradation therefore requires integrated strategies that cut across sectors, disciplines, and administrative levels and involve local stakeholders.

This session focuses on a cross-scale integrated perspective that connects urban, peri-urban, and rural systems and highlights soil and water as key - yet often underestimated - components of urban NBS and spatial planning.
Contributions from different disciplines and actors are invited, particularly welcoming cities and public authorities to share experiences, lessons learned, and policy approaches for embedding soil and water-based NBS into urban planning, infrastructure development, and long-term management.

We welcome presentations that:

Address soil and water as central elements of urban Nature-Based Solutions;
Explore cross-scale planning and governance approaches linking urban, peri-urban, and regional systems;
Demonstrate interdisciplinary methods integrating environmental science, spatial planning, social science and policy;
Present concrete case studies from cities and public authorities, including implementation challenges, co-benefits, and trade-offs;
Reflect on participatory and multi-actor governance arrangements supporting durable and equitable urban transitions.

By bringing together scientific insights and practical experiences from public authorities and other stakeholders, this session aims to contribute to the development of integrated urban strategies that strengthen soil and water systems, enhance climate resilience, and support sustainable urban development within planetary boundaries.

**Keywords:** Nature-Based Solutions, Cross-scale governance, Urban soil and water systems, Integrated spatial planning

PENDING

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# Ur3: Scaling Urban Nature-Based Solutions: Governance, Trade-Offs and Multi-Stakeholder Action

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## Abstract

Cities are facing interconnected climatic, social, and economic challenges that require integrated adaptation responses. Nature-based Solutions (NbS) have the potential to act as multi-problem solvers, delivering environmental, social, and economic benefits simultaneously. However, scaling NbS in urban contexts could be very complex, requiring long-term processes and interdisciplinary approach.
This session will highlight opportunities, challenges, risks and trade-offs of multi-stakeholder governance models for delivering NbS at scale in cities, with a focus on the practical application of political issues, landscape visions, and scientific challenges.
The session will present the case study of Osservatorio La Goccia, an interdisciplinary, multi-stakeholder initiative involving 11 partners—including SMEs, universities, and associations—designed to address complex challenges such as the application of NbS for natural reclamation in contaminated urban areas.

**Keywords:** Urban Nature-Based Solutions Urban resilience Multi-stakeholder governance Urban regeneration Policy–science interface Scaling NbS

PENDING

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# Phosphorus Accumulation and Leaching in Compost-Amended Urban Soils: Implications For Nutrient Management in Nature-Based Solutions

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## Abstract

Urban agriculture is increasingly promoted as a nature-based solution to enhance food security, recycle nutrients, and improve urban soil function. Compost amendments, in particular, are widely used to build soil fertility and close urban nutrient cycles. However, when compost is applied to meet crop nitrogen (N) demand, it can result in substantial phosphorus (P) over-application, with implications for soil P accumulation and downstream water quality.

We present results from a 10-year field experiment in an urban vegetable production system in which manure-based and municipal composts were applied either at rates designed to meet crop N demand (high-input) or crop P demand (low-input), alongside unfertilized and synthetic fertilizer controls. High-input compost treatments led to progressive accumulation of plant-available soil P and elevated phosphate concentrations in leachate, indicating increased risk of P export from urban soils. Over the first seven years, only ~30% of applied P was recovered in harvested biomass under high-input compost management, compared to >88% under P-based compost application. Leachate losses accounted for ~10% of total P inputs in manure-based compost treatments and ~4% in municipal compost treatments. Despite exceeding estimated crop N demand, high-input compost plots also showed evidence of N limitation in the absence of supplemental fertilizer, highlighting mismatches in nutrient stoichiometry.

These findings demonstrate a critical tradeoff in compost-based urban agriculture: while supporting soil health and nutrient recycling, current management practices can compromise water quality through P accumulation and export. We argue that aligning compost application with crop P demand—rather than N demand—is essential for maintaining soil function and minimizing environmental impacts. This work highlights the need for integrated nutrient management strategies within nature-based solutions frameworks to ensure that urban soil systems simultaneously support food production, nutrient retention, and water quality protection.

**Keywords:** urban agriculture, nutrient recycling, ecosystem services

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# Soil (And Water) Steering in Spatial Planning: Spades

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## Abstract

Soil health is a cornerstone of sustainable ecosystems, yet it is under unprecedented pressure from climate change, urbanisation and land degradation. The EU-funded Horizon Europe SPADES project, SPATIAL PLANNING AND DESIGN WITH SOIL, address these challenges by integrating soil health into spatial planning and design. The mission is to support Europe's transition to healthy soils by empowering policy makers, practitioners and communities. By promoting soil literacy and creating adaptable tools, SPADES is putting soil health at the heart of planning for the benefit of current and future generations.

**Keywords:** spatial design, soil literacy

# UR4: Phytomanagement as Nature-Based Solution for sustainable land management

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# Ur4: Phytomanagement as Nature-Based Solution For Sustainable Land Management

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PENDING

## Abstract

Phytomanagement is a land management approach that uses plants and their associated soil microbiota to manage contaminated soils while maintaining or restoring soil functions. Rather than focusing solely on contaminant removal, phytomanagement applies a risk-based and functional perspective, integrating strategies such as phytostabilisation, phytoextraction, rhizodegradation, and biomass valorisation. This approach is recognized as a Nature-Based Solution (NbS), as it combines contamination risk management with ecosystem service provision and long-term land usability.

As a sustainable remediation technology, phytomanagement offers significant advantages over conventional remediation methods. Physical and chemical techniques, including excavation, soil replacement, and ex situ treatments, often generate substantial environmental and social impacts, high costs, and irreversible soil degradation. In contrast, phytomanagement minimizes soil disturbance, reduces energy and material inputs, and preserves soil structure and biodiversity. By integrating remediation objectives with carbon sequestration, soil health improvement, and biomass production, phytomanagement aligns with the principles of sustainable remediation and circular economy.

Phytomanagement is particularly relevant in urban environments, where contaminated soils frequently coexist with strong social, spatial, and regulatory constraints. In cities, conventional remediation can disrupt infrastructure and generate nuisance. Phytomanagement allows contamination risks to be managed while supporting urban greening, climate adaptation, biodiversity enhancement, making it a promising solution for brownfields, public spaces, and multifunctional urban landscapes.

This session will explore phytomanagement as an operational and policy-relevant Nature-Based Solution for sustainable land management. Contributions will address recent scientific advances, field-scale applications, and long-term monitoring of phytomanagement systems, with a particular focus on urban and peri-urban contexts. The session will also cover risk assessment frameworks and biomass management and valorisation strategies, as well as lessons learned from European and national case

studies. In addition, the session will discuss how phytomanagement can be integrated into regulatory and policy frameworks, in line with the EU Soil Strategy for 2030, the European Green Deal, the Zero Pollution Action Plan and the new Soil Monitoring Law. By bringing together researchers, practitioners, and policy actors, the session aims to foster dialogue on the role of phytomanagement in enabling sustainable, socially acceptable, and nature-based solutions for contaminated land management.

**Keywords:** Phytomanagement, sustainability, plants, urban, industrial

PENDING

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# Accounting For Wider Values to Develop Business Cases For Phytomanagement

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## Abstract

Phytomanagement offers a nature-based solution (NbS) to manage risks at contaminated land while maintaining productive land use for biomass production and generating co-benefits, yet deployment at scale is often constrained by weak business cases that limit long-term financial viability. This presentation focuses on how accounting for wider values can strengthen the value proposition of phytomanagement projects and support financially viable, profitable phytomanagement strategies, with particular attention to biomass production and valorisation as a revenue stream. Building on approaches developed in the EU Horizon Soil project, ISLANDR, a practical framework for developing business cases at brownfield sites will be presented with key considerations for designing a phytomanagement strategy. The framework includes the following main steps: (i) identifying relevant wider values  beyond risk reduction and compliance, (ii) quantifying and economically valuing these wider benefits, (iii) demonstrating financial and social viability over the project life, and (iv) selecting financial mechanisms that capture external value into investable revenues or cost savings.

The framework starts with a wider values exploration to identify and prioritize relevant wider values for stakeholders and decision-makers (e.g., reduced contaminant exposure, improved soil functions, urban greening and amenity, carbon storage, biodiversity support, microclimate regulation, and place-based regeneration), many of which are delivered by NbS such as phytomanagement. These are paired with context-appropriate economic valuation methods, including market pricing for biomass outputs, avoided cost and replacement cost methods, value transfer, and stated or revealed preference approaches, so that non-market impacts can be expressed in monetary terms alongside conventional cost items. The resulting monetised costs and benefits can be analysed to assess financial and economic viability as well as distinguishing who pays, who benefits, and when benefits materialise, enabling transparent discussion of distributional effects and risk. To bridge the “financial case” and the “economic case”, internalisation to capture wider values using financial mechanisms such tax incentives, grants, green finance (e.g., payments for ecosystem services, carbon and biodiversity credits), public–private partnerships, etc. are discussed. Central to the phytomanagement business model is biomass handling and valorisation pathways to ensure a profitable and

sustainable land management strategy. Results from a recent study exploring strategies to combine phytomanagement using bioenergy crops with producing biofuels for the maritime industry will be highlighted.

This presentation is expected to contribute to the rapidly developing field of phytomanagement as a nature-based solution by supporting the development of business cases for long-term financial and social viability.

**Keywords:** Economic valuation, Cost-benefit analysis, Business case, Ecosystem services

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# Achieving Natural Reclamation From Spontaneous Forest in Urban Context

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## Abstract

In the face of mounting challenges related to limited availability of urban land and ecological degradation, emerging novel ecosystems offer unique opportunities for ecological regeneration, social redefinition of space, and alternative urban visions.
The study presents the multi-layer analysis of the Goccia Forest in Milan (Italy), a wild urban woodland that has developed over sealed and polluted post-industrial land, aiming to investigate the potential of this novel ecosystem to sustain Nature-based Solutions (NbSs). Using an integrated approach (surveys on fauna, vascular flora, lichens, analysis of forest evolution, mapping of sealed surfaces, and soil characterization) the research looks at the novel ecosystem as a whole, highlighting its ecological dynamics and Ecosystem Services (ES). La Goccia Forest serves as a prime example of how the implementation of NbSs is intricately intertwined with the spontaneous regeneration of urban brownfields. The study also want to offer the opportunity to rethink urban policies, ensuring their alignment with the demands of the population and the latest scientific knowledge.
In fact, cities are facing interconnected climatic, social, and economic challenges that require integrated adaptation responses. Nature-based Solutions (NbS) have the potential to act as multi-problem solvers, delivering environmental, social, and economic benefits simultaneously. However, scaling NbS, specifically in urban remediation sites, could be very complex, requiring long-term vision and interdisciplinary approach.
This session will highlight opportunities, challenges, risks and trade-offs for delivering NbS at scale in urban remediation, with a focus on the practical application of political issues, landscape visions, and scientific challenges.
The session will present the case study of Osservatorio La Goccia, an interdisciplinary, multi-stakeholder initiative involving 11 partners—including SMEs, universities, and

associations—designed to address complex challenges such as the application of NbS for natural reclamation in urban areas. The case study concerns an 18-hectare site with multiple forms of contamination, formerly the Gas Works, on which a novel ecosystem has grown.
The session will present the interdisciplinary approach used to establish the multi-layer baseline analysis and conduct integrative studies on soil, biomass and microbiome, aimed at assessing the phytoremediation potential of the natural forest. Then the results achieved at the policy level, as well as the procedural challenges encountered in implementing innovative Nature-based Solutions, such as rizodegradation, phytostabilization and natural attenuation, will be highlighted.

**Keywords:** Phytoremediation, Interdisciplinary, Urban, Multi-contamination, Novel ecosystems

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# From Total Contamination to Functional Risk: Phytoavailability Indicators For Contaminated Soils

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## Abstract

Managing trace metal contaminated soils requires a shift from static contamination assessment towards functional risk evaluation. Conventional regulatory approaches often rely on total metal concentrations, which remain useful for screening and compliance, but provide limited information on what plants actually experience at the soil root interface, where metal mobility, uptake and ecological risk are dynamically expressed. This presentation proposes a phytoavailability based perspective for improving the management of trace metal contaminated agricultural soils within a Nature Based Solutions framework. Drawing on research on cadmium and lead uptake by plants growing on soils amended with sewage sludge and urban compost (Zarrouk et al., 2014), it argues that contamination should not be assessed only as a stock, but also through the fluxes that determine exposure, including desorption, diffusion through the soil solution, complexation and decomplexation processes, rhizosphere interactions and root uptake. These mechanisms are influenced by soil properties such as pH, organic matter, texture, mineralogy and amendment history. Phytomanagement offers a relevant pathway to address contaminated land without reducing soil to a passive or degraded support. By combining plant based strategies, soil amendments and long term monitoring, it can contribute to risk reduction while preserving or restoring key soil functions. Yet its credibility depends on indicators capable of linking contamination, bioavailability, plant uptake and decision making. Dynamic indicators, including soil plant transfer metrics and diffusive gradients in thin films, can support more operational risk assessment, as recent studies confirm the relevance of DGT for evaluating metal bioavailability to crops (Senila et al., 2024) and show that total soil concentrations alone may be inadequate for assessing cadmium bioavailability in soil crop systems (Cheng et al., 2025). The presentation will examine how such indicators may inform European soil policy, sustainable land management and Nature Based Solutions for contaminated agricultural landscapes. The central argument is that sustainable phytomanagement cannot rely only on measuring how much contamination is present. It must evaluate how contamination behaves, how it becomes available and how it affects living systems. Moving from total concentration to functional risk is therefore essential for designing credible, science based and policy relevant solutions for contaminated soils.

**Keywords:** Phytoavailability, cadmium, contaminated soils, phytomanagement, Nature-Based Solutions, functional risk

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# The Use of Phytoremediation For Removal of Heavy Metals in Urban Soils

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## Abstract

Urbanization is rising globally to fit the demands of the growing population. With an increase in urban centers, urban soil health has become increasingly important. Healthy soils are those that have good biological, chemical, and physical conditions and can therefore provide ecosystem services. These soil ecosystem services include storing carbon, purifying water, cycling nutrients, and contributing to flood mitigation. Healthy urban soils also offer provisioning services, such as the production of food in urban gardens, and cultural services, including the use of green-spaces for physical and mental well-being of residents.
Currently, infrastructure and the acquisition of raw materials are prevalent uses of soils in the European Union (EU). These usages have led to the degradation and continual deterioration of soil health. In Luxembourg, the historical steal industry and urbanization have left polluted soils in its wake. The prevailing approach employed in Luxembourg for addressing polluted soils is the excavation and subsequent disposal in authorized landfills. This method is destructive to the soil structure, limiting its ability to perform ecosystem services. The EU Green Deal, Circular Economy Action Plan, Biodiversity Strategy, and Soil Monitoring Law highlight the importance of addressing soil degradation in a sustainable way. The URSOILL project aims at contributing to urban soil remediation by testing innovative solutions. Specifically, the Urban Living Lab Luxembourg will investigate nature-based solution and new technologies on soil engineering, including phytoremediation, to improve urban soil health.
Phytoremediation harnesses plants and their associated microbes to clean the environment they are apart of. In the case of pollutants like heavy metals, phytoremediation is used to remove them from the soil and store it within the plant's shoot through a process called phytoextraction. As phytoremediation does not require the excavation, washing, or burning of soil like more traditional methods, it keeps the soil intact and offers a more sustainable method for remediating the environment. Additionally, it is less costly than traditional methods that require more labor or tools. For an urban garden and URSOILL experimental site, bio-remediation tools like this hold promise in reaching its goal of improved soil health. Past analyses have shown heavy metal pollution in the soil, namely arsenic and zinc, as well as chromium in certain crops. Based upon the site's baseline, it is recommended to use phytoremediation methods to

improve soil health and ensure safe crops for the community. These implemented methods will be continually monitored to contribute to remediation protocols.

**Keywords:** Soil health, Pollution, Phytoremediation, Urban soils

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# When Is Poplar-Based Phytomanagement of Tph-Contaminated Soils Feasible? a Dynamic Integration of Degradation Kinetics, Tree Growth, Ecosystem Services and Life Cycle Assessment

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## Abstract

The application of phytoremediation is often constrained by the difficulty of predicting when remediation targets will be reached and what benefits the system delivers in the meantime. Without time-explicit estimates of both attenuation and co-benefits, nature-based remediation options are frequently discarded in favour of conventional, more disruptive techniques, despite the greater environmental, economic, and social costs (Drenning et al., 2022).
This work presents a dynamic modelling framework for poplar-based phytomanagement of soils contaminated by total petroleum hydrocarbons (TPH). Rhizodegradation kinetics reported in the literature are coupled to a system dynamics model simulating poplar growth under contaminated conditions. Biomass development and contaminant attenuation are therefore represented as mutually dependent processes: root system development drives rhizosphere degradation, while contaminant-induced stress feeds back on plant growth.
A further feature of the framework is the dynamic quantification of the provided ecosystem services. For instance, CO2 sequestration is computed from simulated above- and below-ground biomass accumulation and from litter-derived soil organic carbon inputs; air contaminant removal and stabilisation are tracked as cumulative mass over time; further regulating services, such as runoff avoidance, are linked to canopy and root development. This highlights the trade-offs between remediation time and the provision of benefits over longer time horizons.
Moreover, the model outputs are integrated with a Life Cycle Assessment, weighing the environmental burdens of the phytomanagement system against the quantified benefits. This covers cuttings production in nurseries, establishment of the phytoremediation plantation, and its management until the legal pollution threshold is reached. Beyond this stage, different scenarios are modelled to describe possible subsequent uses of the area planted with poplars. The net economic impact of phytomanagement, combining environmental costs and benefits, can be eventually calculated across all the considered life cycle phases.
The framework thus provides a decision-support tool for designing and screening

phytomanagement projects, particularly relevant for urban and peri-urban brownfields. While feasibility remains the primary requirement for remediation, weighing life cycle impacts against co-benefits and risk reduction is what could drive a wider and more responsible application of nature-based remediation options.

**Keywords:** phytomanagement, system dynamics, ecosystem services, Populus spp., life cycle assessment

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# From Pollution to Production: Assessing Hemp as a Brownfield Opportunity

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## Abstract

Brownfield soils often present substantial constraints for crop production, including coarse texture, low organic matter, limited water retention, reduced fertility and, in some cases, heavy metal contamination (Oliver et al., 2005). Within a phytomanagement framework, hemp cultivation may offer a promising option to limit pollutant impacts while providing an non-food economically valuable crop. Hemp contributes to carbon sequestration, and its rapid growth suppresses weeds. It requires relatively few inputs, making it well suited to low impact agricultural systems (Parvez et al., 2021). Its deep taproot, reaching up to 2 metres, enables access to large soil volumes and supports resilience under contrasting edaphic conditions (Amaducci et al., 2008). In addition, the recent rise in natural fibre prices strengthens the prospects of this emerging sector (Fagnant, 2025).
This study assessed the feasibility of hemp (Cannabis sativa) cultivation using two cultivars (Santhica 27 (fibre oriented) and Futura 75 (biomass oriented) on three contrasting sites in Wallonia (Belgium) : an agricultural soil, an uncontaminated brownfield and a contaminated brownfield. Across sites, germination, plant survival and vegetative development were not significantly affected by industrial soil characteristics or heavy metal presence. Hemp grown at Sclessin accumulated only low metal levels, confirming its suitability as a safe non food crop on contaminated land. Yield differences were driven mainly by agronomic factors such as water availability, organic matter content, soil texture and C/N ratio. Fibre quality remained stable across soils, reflecting strong genetic control over cellulose, hemicellulose and lignin contents, and shive composition showed no detectable influence of heavy metals.
Overall, the contaminated Sclessin site appears suitable for hemp cultivation, whereas the extremely low organic matter content and high C/N ratio at Ottignies limit its potential without intervention. Achieving viable yields will require targeted improvements such as organic matter amendments, pH correction and enhanced water management. These findings also highlight that brownfield suitability depends not only on soil properties but also on pollutant level and mobility, which govern plant uptake and long term site behaviour.

**Keywords:** hemp, heavy metals, brownfields, production

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# UR5: Open session on NBS in urban environments

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# Ur5: Open Session on Nbs in Urban Environments

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## Abstract

Urban environments are under increasing human pressure and are highly vulnerable to environmental degradation driven by climate change, land sealing, pollution, and population growth. Nature-based solutions (NbS) are increasingly becoming the preferred option for policymakers, urban planners, and environmental professionals seeking to strengthen climate resilience while improving the liveability, health, and sustainability of cities. NbS offer multifunctional benefits, including temperature regulation, flood mitigation, biodiversity enhancement, and improved air and water quality.
This session aims to explore the critical but often overlooked role of soils in urban systems and their interaction with urban water management. We invite contributions addressing soil functions such as water infiltration, carbon storage, pollutant filtering, and support for urban vegetation. Special focus will be given to innovative NbS approaches, including green infrastructure, permeable surfaces, urban wetlands, green roofs, and nature-integrated stormwater management systems.
We welcome interdisciplinary research on methodologies, monitoring approaches, modelling frameworks, and decision-support tools that address urban environmental degradation. Contributions that link scientific evidence with practical implementation, governance frameworks, and stakeholder engagement are particularly encouraged.
By bringing together researchers, practitioners, and policymakers, this session seeks to strengthen the scientific foundation and practical application of NbS to support sustainable urban development and long-term urban resilience in the face of climate and environmental challenges.

**Keywords:** urban resilience, urban agriculture, heat stress, climate mitigation

PENDING

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# Cementitious Permeable Pavement as a Reflective Adsorptive-Filtration Urban Interface For Passive Source Control of Particulates, Chemicals, Rainfall-Runoff and Temperature

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## Abstract

With historical roots across the Roman empire, deployment of permeable pavement as an engineered system can become a modern disruptive technology that are beneficial to the urban climate, water cycle and human health. In the USA, states such as Florida have a growing permeable pavement industry. In the last decade there have been significant technological advances for the manufacture and analysis of permeable pavements. The tools are now available to demonstrate that permeable pavement can provide a durable structural surface for vehicles and provide hydrologic, chemistry and particulate matter (PM) management while reducing thermal pollution, in comparison to conventional impervious asphaltic pavement while reducing the reliance on fossil fuels. Applications of cementitious permeable pavement (CPP) have demonstrated the potential to provide a sustainable and passive green infrastructure that provides unit operations (e.g. filtration) and processes (e.g. surface complexation) mechanisms for management of wet weather urban drainage. Specific aspects of this control have been the subject of significant research from field application and mechanistic elucidation from controlled testing, including filtration, hydrologic restoration and the potential for clogging. This study investigated behavior of CPP subject to PM loadings for a hetero-disperse particle size gradation, a sandy-silt gradation. Tested and monitored at an interstate highway (I-75 Cincinnati, OH USA) catchment, subject to runoff loadings, CPP specimens were examined by x-ray tomography and had similar pore size distributions and effective porosity. Total PM mass removal efficiencies ranged from nearly total removal for medium and coarse sands to greater than 60% for fine silt-size particles. With an engineered surface matrix, total metal and phosphorus reductions exceeded 80%. The commensurate turbidity reductions were significant, and effluent turbidity was reduced by 50 to 90% compared to influent values. Saturated hydraulic conductivity of the clean-bed CPP was in the range of 0.1 to 0.01 cm/s, followed a first-order exponential decline with PM loadings, and restoration of this hydraulic conductivity required pavement cleaning approximately once every six-month period. Cleaning by pavement vacuuming restored up to 95% of clean-bed hydraulic conductivity. In-situ hydrologic restoration was significant, generating peak flow reductions and storage within the pore space that represented approximately 25% of CPP volume. The effluent response from the influent hydrograph was attenuated (peak, volume, duration) as compared to the response of conventional impervious pavement. Regulatory load credits for metals and nutrients

have been provided for over a decade for the implementation and maintenance of such practices that equate to millions of dollars (USD) saved annual by even a small municipality for documentation of such implementation and maintenance.

**Keywords:** Urban drainage, wet weather flow, x-ray tomography, hydraulic conductivity, green infrastructure, urban water cycle, urban heat island

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# Optimizing Urban Water Clarification Systems as Green Infrastructure For Water Reuse

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## Abstract

As a common unit operation within water management systems, volumetric stormwater clarifiers (or as tanks/tunnels below-grade) are widely implemented for hydrologic control, constituent (particulate matter, PM and chemical) load reduction from urban drainage as well as a subsequent reuse water source. Despite ubiquitous applications, optimizing cost-benefit based on planning/design or needed retrofits of such units is often not considered in engineering practice. As a result, basin initial planning/design yield high costs (i.e., total design cost includes land acquisition costs, operation and maintenance costs, and construction costs) from hundreds of thousands to tens of million US dollars (USD) per unit operation system. Many of these clarification units are impaired because of the use of inadequate design/analysis tools such as residence time (RT) indices that only provide presumptive guidance for treatment, lack of regular maintenance or through the non-stationarity of loadings from further imperviousness in urban land uses. Retrofits, if even feasible, yield even higher costs, noting that RT-based solutions require increased unit volume and surface area. The high cost of clarifiers imposes substantial financial burden for stakeholders. Optimized design/retrofit can reduce the cost at a given level of benefit for this common green infrastructure system for reuse water. Recent studies demonstrate using computational fluid dynamics (CFD) simulation to optimize and guide basin design can significantly reduce clarifier costs with even greater reductions (two orders of magnitude) when CFD is coupled with machine learning (ML) for a given level of treatment. Compared to existing tools (RT, CSTR software tools), a CFD-ML model, DeepXtorm can provide a much more robust and significantly improved cost-effective design. From benchmarking with measured data from across Florida clarifiers, DeepXtorm consistently yield much lower cost than existing tools with respect to a range of presumptive design criteria based on PM as total suspended solids (TSS), total phosphorus (TP) and metals; common water chemistry parameters that are regulated. The improved basin cost-benefit in DeepXtorm is fundamentally provided by the constrained non-linear optimization and CFD-ML engine, which allows DeepXtorm to efficiently explore the design parameter space that no current model is able to accomplish. Beyond the research applications, future work is the creation of a web-based user-friendly application interface for engineering practice.

**Keywords:** Computational fluid dynamics, machine learning, unit operations, hydrodynamics, residence time, clarification, cost-benefit, urban drainage, water reuse

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# UR6: Harnessing Indigenous Knowledge for Climate-Resilient Urban Futures in Coastal Cities (Panel)

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# Ur6: Harnessing Indigenous Knowledge For Climate-Resilient Urban Futures in Coastal Cities (Panel)

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PENDING

## Abstract

Rapid urbanisation has increased the vulnerability of coastal cities to natural disasters, such as, flooding and tsunami, highlighting the need for effective resilient measures. Despite advancements in technology including geospatial analysis, the exclusion of local environment knowledge results in limited adaptive capacities, reduced community involvement in risk preparedness and neglect of region-specific ecological indicators undermine resilience strategies. This paper contends that integrating indigenous knowledge with urban planning is a novel approach that can address these gaps and strengthen disaster resilience strategies in coastal cities. Drawing upon an extensive literature review, this study highlights the importance of indigenous knowledge, and the reciprocal benefits of its integration with mainstream urban planning within the framework of disaster management. It argues that integration of traditional environmental knowledge (TEK) enhances resilience, sustainability and liveability in coastal urban areas. Case studies of the Jarawa tribe of Andaman & Nicobar Islands, and the Moken Sea Nomads, demonstrate how knowledge about nature embedded in indigenous knowledge systems enabled these communities to successfully predict and safeguard themselves against the 2004 tsunami in the region, highlighting the potential of integrating NBS and TEK in mitigating the effects of climate-induced disasters. Both communities successfully recognised early environmental cues preceding the 2004 tsunami which even modern hazard systems had not interpreted, thereby safeguarding themselves long before formal alerts were issued. These insights underscore the potential of integrating TEK into NBS, urban planning, and disaster-management systems, particularly in coastal regions where rapid urban expansion intersects with fragile ecosystems. Through its emphasis on the role of indigenous knowledge in augmenting community preparedness and fostering inclusive urban planning, this paper demonstrates that its integration into mainstream initiatives can mitigate climate-induced disasters and empower local communities in urbanising areas.

**Keywords:** urbanisation

# UR7: Nature-Based Solutions for Climate-Resilient Urban Spatial Planning and Sustainable City Development (Panel)

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# Ur7: Nature-Based Solutions For Climate-Resilient Urban Spatial Planning and Sustainable City Development (Panel)

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PENDING

## Abstract

Rapid urbanisation, climate change, and environmental degradation pose significant challenges to contemporary cities, particularly in relation to heat stress, flooding, biodiversity loss, and declining urban liveability. Nature-based solutions (NBS) have emerged as an integrative planning approach that leverages natural processes and ecosystems to address these challenges while delivering multiple environmental, social, and economic co-benefits. This session focuses on the role of NBS in urban spatial planning, examining how green infrastructure, ecosystem-based design, and landscape-led strategies can be systematically embedded into urban development frameworks.
The session aims to explore how spatial planning instruments—such as land-use zoning, master planning, urban design guidelines, and regeneration strategies—can facilitate the effective implementation of NBS at multiple urban scales. Contributions are expected to address both strategic and site-specific applications of NBS, including green corridors, urban forests, blue-green infrastructure, nature-based flood management, and climate-adaptive public spaces. Emphasis will be placed on evidence-based planning approaches that enhance climate resilience, improve ecosystem services, and support social equity in dense urban environments.
In addition, the session will critically examine governance, policy, and institutional dimensions shaping the adoption of NBS, including regulatory frameworks, stakeholder collaboration, financing mechanisms, and community participation. Particular attention will be given to challenges related to implementation, maintenance, and long-term performance, as well as methods for evaluating the spatial, environmental, and socio-economic impacts of NBS interventions.
By bringing together interdisciplinary perspectives from urban planning, architecture, landscape design, environmental science, and policy studies, this session seeks to advance knowledge on how nature-based solutions can move beyond pilot projects to become mainstream components of urban spatial planning. The discussions aim to generate transferable insights and practical recommendations for planners, policymakers, and practitioners working towards resilient, inclusive, and sustainable urban futures.

**Keywords:** Nature-based solutions, Urban spatial planning, Climate resilience, Green infrastructure, Sustainable cities, Ecosystem services

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# Nbs Implementation in Lombardy Region: the Experience of Contratti Di Fiume

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## Abstract

The intensification of extreme atmospheric events, especially stormwater events, due to climate change, combined with soil sealing and green areas reduction, are leading to an increasingly critical and widespread hydraulic risk especially in densely urbanized areas. Lombardy Region is the most densely populated area in Italy and one of the most in Europe. In particular, the area north of Milan has a waterproofing rate exceeding 60 %. The occupation of floodplains, the lack of sewer systems updates and the disappearence of green areas have made the area particularly prone to flooding that occur with high frequency. Furthermore, extreme stormwater events are expected to increase in the coming years according to climate forecast, therefore a change in urban spatial planning and the adoption of strategies to climate change adaptation are now urgently needed. Nature Based-Solutions (NBS) constitute a valid strategy for the reduction of hydraulic risk impacts while simultaneously offering further benefits such as heat islands reduction, biodiversity support, water quality and social and wellness improvement. NBS play a key role in hydrological cycle restoration altered by urbanization, improving the natural processes of storage, evapotranspiration and infiltration. For the successful implementation of NBS, rethinking urban spatial planning, improving public acceptability and enhancing stakeholders involvement are required. ERSAF, the Regional Agency for Agriculture and Forestry Services, supports the Lombardy Region in implementing sustainable water management policies. Specifically, through the promotion of Contratti di Fiume, a voluntary agreement between all stakeholders living and working within a river watershed, as a new process for fluvial territory planning, it aims to build resilient communities based on shared goals and by developing multidisciplinary projects, among which NBS. Contratti di Fiume seek to change the mentality in planning and living urban space according to European Directives, national legislation and sectoral plans but with a deep knowledge of territory needs and potentialities. In particular, in collaboration with the Lombardy Region, ERSAF developed, in 2021-2022, a Call4Ideas for projects concerning public areas re-greening through the introduction of NBS for climate change mitigation and adaptation. It represents the first initiative in Italy to fund projects on this topic, which include the identification of criteria and indicators related not only to hydraulic issues but also to water quality, biodiversity support, fruition and $CO_2$ reduction and absorption. 14 municipal projects have been funded, including solutions such as rain garden, bio-retention areas, infiltration trenches, green roofs, tree boxes, dry and wet ponds and permeable pavements. Currently, the results of the already completed projects

are being monitored. Once they are all completed, they will allow the creation of approximately 13,000 $m^2$ of new green areas, most of which occupied by NBS, the de-sealing of approximately 47,000 $m^2$, and a volume of rainwater diverted from the sewer system of more than 4,000 $m^3$. Moreover, once all the projects have been completed, the goal will be to assess the data more strategically, investigating positive impacts not at site-specific level but at the river watershed scale, defining a standard and replicable method for monitoring and quantifying these benefits and estimating target for each river watershed involved in the River Contract. As a first result of the success of the Call4Ideas and thanks to the dissemination carried out by ERSAF through the Contratti di Fiume, many other municipalities in Seveso and Lambro River watershed, the two most affected by hydraulic risk in Lombardy, have begun to propose further de-sealing interventions through NBS which, once financed and completed, would allow for the de-sealing of an additional 170,000 $m^2$ of land.

**Keywords:** Nature-Based Solutions, Climate Change, Contratti di Fiume, De-sealing

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# Governing Climate Adaptation: Linking Research, Local Government, and Society in Trier-Saarburg.

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## Abstract

Climate change Adaptation has become an urgent priority as communities seek to find options and ways in responding to the far-reaching impacts of a changing climate. Effective adaptation is not solely a technical or environmental challenge; it is a collaborative process that requires sustained interaction, integration, and cooperation among a broad range of stakeholders, including scientific and research institutions, government authorities, policymakers, and civil society.
The district of Trier-Saarburg has embarked on a comprehensive adaptation process through the development of a sustainable climate adaptation concept. Currently under development, the concept aims to provide a strategic framework for understanding and responding to the district's climate-related challenges. The final version is expected to identify areas particularly vulnerable to climate change—the so-called "hotspots"—and to define appropriate measures for reducing associated risks, strengthening resilience, and supporting sustainable adaptation at the local level.

This article examines the key pillars underpinning effective climate change adaptation and considers the distinct yet interconnected roles they play in adaptation process. Drawing on the experience of Trier-Saarburg, it further presents practical examples, lessons learned, and tips into the institutional and collaborative dimensions of adaptation. Particular attention is given to the coordination and management mechanisms established among relevant stakeholders.

**Keywords:** Climate-change adaptation, Research, Society

# MET1: Integrated Methodologies for Measuring Implementation and Impacts of Equitable Nature-Based Solutions and Green-Blue Infrastructures

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# Met1: Integrated Methodologies For Measuring Implementation and Impacts of Equitable Nature-Based Solutions and Green-Blue Infrastructures

Lizzy Moonga[1,*], Chiara C. Iodice-Kraft[1], Kathrin Specht[1], Noriko Otsuka[1] and Virginia Cioncoloni[2]

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PENDING

## Abstract

There is a growing need for a deeper understanding of integrated methodologies for implementing, monitoring, and evaluating nature-based solutions (NBS) and green-blue infrastructure (GBI) to enhance their effectiveness and support upscaling across diverse socio-ecological contexts, particularly in urban and peri-urban areas.
While existing studies and frameworks by international organisations like the IUCN (International Union for Conservation of Nature) Gold Standard provide baseline principles and guidelines for NBS design, implementation, and impact evaluation, there remain significant gaps in operationalising these principles and guidelines through integrated methodologies that capture complex social-ecological interactions, equity, and long-term sustainability of NBS and GBI. For instance, IUCN has developed guidance to ensure NBS effectively address societal challenges and promote transparent and empowering governance processes. However, it does not fully guide on methodologies for implementing, monitoring, and evaluating NBS across multiple social-ecological contexts.
This session aims to explore participatory and co-creation approaches such as stakeholder workshops, empirical surveys, citizen sciences and social media analysis to advance NBS and GBI implementation through a One Health lens embedded within a broader Planetary Health framework. These approaches generate robust evidence on how green and blue spaces enhance human health and well-being, ecosystem health and social equity, while strengthening ecological resilience and reducing environmental drivers of diseases across urban and peri-urban contexts.
By linking local social-ecological interactions with earth system processes and planetary boundaries, the session emphasizes methodological innovations that operationalise One Health and Planetary Health principles by translating theoretical frameworks into practical tools for monitoring, evaluation, and strategic integration of NBS and GBI in urban planning processes. Particular attention is given to co-creation with diverse stakeholders, the development of evaluation frameworks and guidelines, policy strategies that recognise the human and environmental health and well-being and methodologies for measuring mental health impacts and long-term sustainability.
Researchers are invited to submit empirical and conceptual papers advancing methodological approaches for NBS implementation, monitoring, and evaluation.

Contributions should focus on integrated methods that translate theoretical principles into practical experiences, integrate social, ecological, and governance dimensions, and incorporate user's perspectives across diverse contexts. Papers may also address innovative tools for NBS and GBI design and upscaling, and long-term sustainability.
The session aims to foster interactive discussion among researchers, practitioners, and policymakers to exchange methodological experiences on NBS and GBI approaches and identify pathways for equitable NBS and GBI development across regions.

**Keywords:** Methodologies, Nature-Based-Solutions, Green-Blue Infrastructure, Socio-ecological, Participatory Approaches

PENDING

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# Integrated Co-Creation Methodology For Nature-Based Solutions: a Greenme Approach to the Impact of Green Care on Mental Health

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## Abstract

Nature-based Solutions (NbS) and green-blue infrastructure (GBI) are increasingly recognised as essential strategies for addressing interconnected socio-ecological challenges, including climate change, biodiversity loss, and declining mental health and well-being. However, significant gaps remain in translating existing frameworks into integrated, operational methodologies that support implementation, monitoring, and evaluation across diverse contexts.
This paper presents the GreenME project's integrated co-creation methodology as a practical approach to operationalising NbS through participatory, participatory processes. Implemented across seven countries, the methodology combines stakeholder workshops, interdisciplinary collaboration, and user-centred perspectives to co-design context-specific pathways for Green Care "" interventions. Engaging policymakers, practitioners, civil society, and researchers, the process identifies key preconditions, actionable measures funding and governance mechanisms for upscaling Green Care in urban and peri-urban settings.
Aligned with One Health and Planetary Health frameworks, the GreenME approach integrates social, ecological, and governance dimensions, while explicitly addressing equity and inclusion in access to green and blue spaces. It also contributes to the development of evaluation frameworks and methodological tools for assessing mental health outcomes, ecosystem services, and long-term sustainability.
Preliminary findings from the stakeholder's co-creation workshops including overarching actionable measures for implementing and upscaling Green Care. Some of the highly suggested areas by stakeholders across the project countries include:

- Guidelines and Regulation
- Evidence and Research
- Financing and Financial models
- Qualification and Standardisation
- Networks and Coordination
- Pilot & Experimentator

These findings demonstrate how co-creation methodologies can generate robust, context-sensitive evidence, strengthen stakeholder ownership, and support the integration of Green Care into policy and planning processes. By bridging the gap between theoretical

principles and practical implementation, the GreenME approach offers a transferable model for advancing equitable, evidence-based NbS and GBI development across diverse socio-ecological contexts.

**Keywords:** Keywords: Nature-based Solutions, Green-Blue Infrastructure, Green Care, Co-creation, Methodologies, Participatory Approaches

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# Geoai and Self-Supervised Earth Observation Framework For Measuring Nature-Based Solutions and Climate-Resilient Landscape Transitions Across African Socio-Ecological Systems

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## Abstract

Nature-Based Solutions (NbS) are increasingly recognized as transformative approaches for addressing climate change, biodiversity loss, land degradation, and water insecurity while enabling climate-resilient and circular socio-ecological transitions within planetary boundaries. Despite strong policy relevance, a persistent limitation remains: the absence of scalable, transferable, and uncertainty-aware measurement systems capable of quantifying NbS impacts across heterogeneous landscapes.

This study introduces a novel GeoAI framework that advances NbS monitoring by integrating multi-source Earth Observation (EO) data with Self-Supervised Learning (SSL) to enable scalable, label-efficient, and globally transferable ecological representation learning. The framework uniquely fuses Sentinel-1 synthetic aperture radar (SAR), Sentinel-2 multispectral imagery, Landsat 8/9 time series, MODIS vegetation dynamics, and NASA GEDI LiDAR canopy structure data within a cloud-native Google Earth Engine environment.

The key novelty lies in shifting from traditional supervised EO mapping toward self-supervised geospatial foundation representations that learn directly from large-scale unlabeled Earth observation archives. This enables robust cross-biome generalization and reduces dependency on ground-truth data, which is often scarce or inconsistent in African socio-ecological systems.

The framework is designed and evaluated at continental scale across African socio-ecological systems, covering key biomes including the Sahel, East African highlands, Congo Basin, and semi-arid dryland regions.

From learned representations, a suite of NbS-relevant indicators is derived, including ecosystem condition, vegetation recovery trajectories, land degradation risk, restoration suitability, and canopy structure dynamics. These indicators provide a unified and physically interpretable description of ecosystem functioning and landscape transformation processes.

A structured validation strategy is introduced, combining cross-biome transferability assessment, benchmarking against global EO products (ESA WorldCover, MODIS NDVI, Hansen Global Forest Change, and GEDI canopy height), and temporal stability analysis using multi-year satellite observations. Uncertainty is explicitly quantified using ensemble-based variance propagation to support robust decision-making under data-

limited conditions.
By integrating GeoAI, SSL, and multi-sensor EO within a unified operational pipeline, this work advances the measurement science of NbS and supports international policy frameworks including the SDGs, UN climate conventions, and the EU Green Deal. It provides a scalable pathway toward operational monitoring of climate-resilient landscape transitions in data-scarce regions.

**Keywords:** Nature-Based Solutions, GeoAI, Earth Observation, Self-Supervised Learning, Climate Resilience

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# Integrating Nature-Based Solutions and Ecosystem Service Assessment: Evaluating the Contribution of Green Infrastructure in Urban Landscapes

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## Abstract

Nature-based Solutions (NbS), realized by improving Green Infrastructure (GI), are increasingly recognized as effective approaches for addressing climate change, biodiversity loss, and the growing demand for resilient landscapes and urban areas. At the same time, the assessment of ecosystem services (ES) provides valuable information for quantifying the benefits of GI and ecosystems. NbS are one possible solution to current societal challenges. The potential of NbS can substantiated by quantifying ES. Furthermore, NbS with ES assessment can make the multifunctionality of Green Infrastructure more transparent and strengthen decision-making in spatial planning.
This contribution presents a case study from the Ruhr Metropolis, Germany, to demonstrate how ecosystem service assessment can be used to evaluate the effects of Green Infrastructure measures implemented as Nature-based Solution. The analysis focus on ecosystem services, that are particularly relevant in the context of climate adaption and sustainable land management.
The assessment is carried out using the EnhancES Toolbox developed within the IMECOGIP project (BMFTR, FKZ 01LE1805A-B2). The QGIS-based toolbox provides a framework for spatially explicit quantification of ecosystem services offered by different Green Infrastructure elements, based on an understanding of ecosystem functions. By specifically identifying areas that could be transformed and calculating anticipated ecosystem services values in EnhancES optimized Nature-based Solutions can be suggested. By comparing the ES of the area in its existing land cover with scenarios that incorporate additional Green Infrastructure elements, the approach enables an evaluation of the potential contribution of NbS to ES provision.
The presented approach illustrates how combining Nature-based Solutions with quantifying and modelling ecosystem services in an urban area can strengthen planning processes by providing transparent and spatially explicit evidence for the benefits of Green Infrastructure. By combining NbS and ES, plans can be supported with concrete values in order to address societal challenges in urban areas.

**Keywords:** Nature-based Solutions, ecosystem services, Green Infrastructure, spatial planning, climate adaption, biodiversity loss

**References**

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# Invisible Barriers and Perceived Motivations For Green Care in Green and Blue Spaces

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## Abstract

Background:
The Horizon Europe GreenMe project defines green care through three pillars: Nature in Every Life, Nature-Based Promotion, and Nature-Based Therapy. Green care encompasses a broad range of green and blue spaces (GBS), including urban parks, gardens, cemeteries, forests, agricultural landscapes, and green corridors. While this diversity suggests that opportunities for green care are widely available, preliminary findings from stakeholder interviews indicate that many existing GBS are not designed or managed to support green care activities. Furthermore, survey responses show that some GBS are visited much more frequently than others. This study investigates the mismatch between the physical accessibility of GBS and their perceived suitability for green care by exploring the barriers and motivations that influence people's use of nature.
Methodology:
The study combines geospatial analysis, social survey data, and field audits for the case study city of Herne, Germany. An online survey was conducted to identify barriers to engaging with nature and characteristics that motivate visits to green and blue spaces (GBS), yielding more than 1,000 responses. In addition, over 60 GBS were systematically audited during the summer of 2025 to assess their environmental characteristics and quality. Spatial accessibility was evaluated using GIS-based network analysis to calculate the shortest walking distance from residential buildings to the nearest GBS.
Results:
The accessibility analysis indicates that most residents can reach a GBS within a 15-minute walk. However, survey responses reveal that two of the most frequently reported barriers are that "nowhere near me is nice enough to spend my free time" and "there is no natural space close to me." These findings suggest that physical proximity alone does not determine whether a space is perceived as suitable for green care. Many nearby GBS are not considered sufficiently attractive or natural, despite being easily accessible.
Conversely, several rural GBS attract frequent visitors despite requiring longer travel times. Survey respondents identified key qualities that motivate visits, including "the greenery on the site feels diverse and wild" and "good natural features such as trees, flower beds and ponds/lakes/rivers." These findings indicate that perceived naturalness and environmental quality are stronger drivers of visitation than proximity alone. A stronger sense of wilderness, rich vegetation, biodiversity, aesthetic appeal, and

organised activities appear to encourage people to travel further, particularly when seeking mental health and wellbeing benefits.
Conclusions:
The results demonstrate that accessibility, although widely used as a key indicator in GBS research, is insufficient for assessing the potential of green spaces to support green care. Perceived attractiveness and environmental quality play a critical role in shaping visitation behaviour. Future work will develop a gravity-based accessibility model that incorporates both accessibility and destination attractiveness. Attractiveness will be evaluated using factors such as site size, safety, vegetation quality, facilities, aesthetics, biodiversity, and organised activities, while deterrent factors will include noise, overcrowding, and a perceived lack of openness. This integrated approach aims to provide a more realistic assessment of the suitability of green and blue spaces for supporting green care interventions.

**Keywords:** Green care, mental health, Green and blue space, accessibility, nature based solutions

# MET2: Digital transformation for the design, monitoring, and scaling of greenhouse gas mitigation through Nature-Based Solutions

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# Met2: Digital Transformation For the Design, Monitoring, and Scaling of Greenhouse Gas Mitigation Through Nature-Based Solutions

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PENDING

## Abstract

Digital transformation refers to the systematic use of digital data, technologies, and analytical frameworks to improve how evidence is generated, validated, and used in decision-making. In the context of climate change mitigation, this transformation plays a critical role in strengthening the scientific rigor, transparency, and scalability of greenhouse gas (GHG) mitigation strategies. For Nature-Based Solutions (NBS), digital transformation enables the transition from conceptually promising interventions to measurable, verifiable, and decision-ready climate actions.

NBS are increasingly recognized for their potential to contribute to GHG mitigation alongside adaptation, biodiversity conservation, and sustainable resource management. However, their broader deployment remains constrained by persistent challenges: uncertainties in quantifying mitigation outcomes, limited transparency and comparability across projects, gaps between scientific methods and operational implementation, and difficulties in translating complex environmental processes into credible evidence for policy, finance, and compliance frameworks. Addressing these challenges is essential for ensuring that NBS can meaningfully contribute to climate targets and mitigation commitments.

Earth observation provides spatially and temporally consistent data to monitor land use, vegetation dynamics, water availability, and ecosystem change across scales relevant to mitigation accounting. When combined with in situ measurements and contextual data, these observations form the empirical backbone for assessing carbon stocks, fluxes, and land-based mitigation performance. Artificial intelligence and data-driven analytics enable the integration and interpretation of these heterogeneous datasets, supporting robust indicator generation, uncertainty analysis, forecasting, and scenario evaluation. Digital monitoring, reporting, and verification (dMRV) systems further operationalize scientific rigor by enabling continuous, standardized, and auditable tracking of mitigation outcomes, thereby increasing transparency, traceability, and trust. Decision-support systems translate these data and models into actionable insights that inform project design, adaptive management, policy instruments, and investment decisions.

This session focuses on how Earth observation, artificial intelligence, dMRV, and decision-support systems can jointly support the design, implementation, monitoring, and scaling of GHG-focused Nature-Based Solutions across agriculture, natural ecosystems, urban environments, and industrial landscapes. Bringing together perspectives from

science, policy, finance, and industry, the session will highlight practical applications, governance considerations, and lessons learned. Ultimately, it aims to explore how digital transformation can enforce scientific rigor and credibility in NBS-based mitigation, enabling scalable climate action aligned with planetary boundaries and long-term sustainability goals.

**Keywords:** Digital transformationl, dMRV, greenhouse gas, earth observation, decision-suppoty

PENDING

# MET3: Case Studies and Quantitative Methodologies for Nature-based Solutions Integrated into Urban Infrastructure Constraints

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# Met3: Case Studies and Quantitative Methodologies For Nature-Based Solutions Integrated Into Urban Infrastructure Constraints

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PENDING

## Abstract

An uncomfortable legacy for the constructed environments of cities is that urban drainage (rainfall-runoff) transports greater annual loads of particulate matter (PM), metals, organics and chemical oxygen demand (COD) than untreated domestic wastewater discharges from the human population of that same urban environment. Yet, this legacy is chronic and has intensified with increasing urban traffic, pavement area and urban populations.

The built environment has evolved with a predominant focus on individual motor vehicles and trucks, extensive impervious pavements for transport and parking, and spatial configurations that amplify climate change impacts, urban heat island effects, and hydrological alteration. This evolution is no longer sustainable and results, in part, in chronic human health stress associated with anthropogenic chemical and particulate matter generation, cycling and exposure. Conventional urban design produces microclimates that are less supportive of necessary human physical movement and reduces motivation to engage in physical activity. Such conditions highlight the need for a paradigm shift toward nature-based solutions (NBS) that can be integrated within existing urban infrastructure to restore degraded urban water cycles and urban microclimates.

Urban microclimates benefit substantially from vegetation that is proximate to or integrated within infrastructure, including green roofs and wall systems on buildings and interspersed, connected green areas throughout and along transportation corridors and parking land uses. Greener infrastructure systems with mature vegetation re-invigorate the built environment as a sustainable space for both human and ecological habitat. These systems enhance ecosystem services related to stormwater regulation, contaminant sequestration, thermal moderation, urban comfort and environmental quality.

Such nature-based solutions represent both a retrofit and a functional reset for urban microclimates and therefore must be carefully integrated within existing urban infrastructure constraints while preserving operational viability and functionality of all system components. Structural treatment systems commonly referred to as best management practices (BMPs) have not mitigated the existing legacy of urban

contamination and are often neither economically nor ecologically sustainable when compared to mature vegetation systems. Quantitatively, no structural BMP has demonstrated greater combined efficiency and effectiveness than a mature tree for regulating the urban water cycle and sequestering contaminants.
The theme of this session is “Seeing is believing.” The session presents case studies and methodologies focused on nature-based solutions, rather than purely structural BMPs, to disseminate experience with retrofit designs and measured or modeled outcomes. These contributions illustrate cost–benefit relationships, impacts on urban hydrology and contaminant load reduction, and opportunities for recovery and reuse in cities globally.

**Keywords:** Urban drainage, Urban microclimate, Contaminant sequestration, Urban hydrology, Retrofit urban infrastructure

PENDING

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# Restoring the Urban Water Balance: a Proxy-Based Approach to Assess Climate Adaptation Need and Nature-Based Solutions

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## Abstract

Urban areas are increasingly exposed to environmental risks such as heat stress, pluvial flooding, and combined sewer overflows, all of which are intensifying under climate change and growing urbanization. Accurately modelling these processes at city scale is essential for informed planning, yet physically based models remain computationally demanding, data-intensive, and often limited to small pilot areas. In this context, water balance modelling emerges as a powerful and practical alternative, offering a simplified yet robust framework to capture the key hydrological processes governing urban environmental dynamics. This study demonstrates the value of a simplified urban water balance model (ABIMO) as a screening and diagnostic tool to assess multiple environmental risks across the entire city of Berlin. By partitioning precipitation into evapotranspiration, runoff, and groundwater recharge for more than 57,000 spatial units, the model provides a consistent and spatially explicit representation of how water is redistributed in the urban environment.
A central concept is the deviation of the urban water balance from a natural reference state (ΔW), which serves as an integrative indicator of anthropogenic alteration. The results show that this relatively simple metric correlates meaningfully with outputs from more complex physical models describing near-surface air temperature, flood volumes, and sewer overflow discharges. These correlations highlight the fundamental role of hydrological processes in shaping a wide range of environmental risks: reduced evapotranspiration contributes to urban heat islands, increased runoff amplifies flood hazards, and higher effective imperviousness drives sewer system overload.
Beyond predictive capability, the main advantage of water balance modelling lies in its efficiency, scalability, and transparency. Compared to complex model chains, it requires fewer inputs, minimal calibration, and significantly lower computational effort, making it accessible to a wider range of users, including municipalities with limited technical resources. This enables rapid, city-wide assessments that can inform early-stage decision-making, identify priority areas, and guide the allocation of resources before committing to detailed simulations. Furthermore, the conceptual simplicity of water balance components facilitates communication with stakeholders and supports interdisciplinary

planning processes.
The approach is particularly well suited to the planning and evaluation of nature-based solutions, such as green roofs, infiltration systems, and urban greening measures, as changes in ΔW consistently reflect their hydrological effectiveness and co-benefits across multiple risk domains.
Overall, this study underscores the importance of water balance modelling as a unifying and scalable tool in urban environmental assessment. While it does not replace detailed physical models, it effectively bridges the gap between data availability and planning needs, enabling a shift from localized, resource-intensive analyses to comprehensive, city-wide risk screening. By explicitly linking hydrological indicators to the performance of nature-based solutions, the approach supports more integrated and actionable strategies for climate adaptation. As this becomes an increasingly urgent priority, such simplified yet informative methods are essential for advancing resilient and water-sensitive urban planning.

**Keywords:** water-balance, modelling, nbs, water-sensitive urban planning, climate adaptation

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# Cost/Benefit of Sustainable Resource Recovery For Urban Residuals and Chemicals Versus Structural Urban Water Treatment

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## Abstract

Day-to-day maintenance of urban drainage (rainfall-runoff) management systems and pavement can significantly reduce pollutant loads and benefit ecological and human health. The hypothesis that maintenance matters is quantifiable and critical for implementation of the knowledge developed in this Florida-wide (similar to Italy in geographics) data collection and research over the last decade and presented herein. The research results represent a defensible foundation to build the allocation of urban drainage load reduction credits based on maintenance practices. These maintenance practices remove gross solids (detritus), coarse particulate matter (PM) and associated constituents (such as nutrients) from the urban inventory of PM that is transported through and stored in urban drainage systems and can eventually be abraded to fine PM. This PM is a source and sink of nutrients/metals that result from the interaction and imposition of anthropogenic/biogenic activities and urban infrastructure design practices/materials on the hydrologic cycle. The fine abraded PM (< PM2.5) is ubiquitous and at high particle number in the near surface urban atmosphere that is shared by humans; with documentation demonstrating hundred of thousands premature deaths worldwide due to traffic-generated PM and the associated contaminants. This study was designed to create a Florida-based metric for PM recovery and illustrate TN and TP association with particle sizes. This study was designed to provide incentives to Florida municipalities in terms of load credits for quantifiable maintenance practices that are now implemented their regulatory basin management action plans (BMAPs) for nutrients and PM. Germaine to this study, it is noted that the results presented are a function of many variables, and while structural treatment systems (aka BMPs) BMP vendors promote differences between BMPs the reality is that such treatment and cost differences are rarely if ever significant given a lack of BMP maintenance and the benefits of urban maintenance practices. Results reinforce the knowledge that source controls or urban maintenance practices such as street sweeping can be a very cost-effective tool in reducing loads as compared to catchment-based structural BMPs. Of all the maintenance tools available to a municipality, street sweeping dominates load recovery for PM and nutrients as compared to structural treatment systems in the same urban catchments. Florida-based results indicate cost of load recovery for (TN, TP, PM) by street sweeping in $(USD) are (165.00, 257.00, 0.10) compared to structural BMP in $(USD) of (3730.00, 10500.00, 41.00); at least an order of magnitude lower than

structural treatment systems.

**Keywords:** Circular economy, resource recovery, particulate matter, urban maintenance, best management practices, particle size distributions, partitioning, cost-benefit, human health, cardiovascular inflammation, urban drainage

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# MET4: Advancing the assessment of Nature-based Solutions for Agriculture and Food Systems within Planetary Boundaries

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# Met4: Advancing the Assessment of Nature-Based Solutions For Agriculture and Food Systems Within Planetary Boundaries

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PENDING

## Abstract

Nature-based Solutions (NbS) are increasingly recognised as critical components of sustainable agriculture and food systems, with the potential to simultaneously support food production, climate mitigation and adaptation, biodiversity conservation, and freshwater regulation. However, the ability of NbS to effectively contribute to transitions towards living within Planetary Boundaries is constrained by persistent gaps in monitoring, evaluation, and attribution. In particular, scalable and integrative methods for assessing how NbS function in agricultural landscapes and what impacts they deliver across multiple Earth system dimensions remain underdeveloped.

This session aims to explore recent advances in methods and concepts relevant for monitoring NbS in agriculture and food production systems. While particular attention is given to emerging artificial intelligence (AI) applications, the session explicitly remains open to a broad range of approaches. Contributions are invited that employ or critically assess AI-enabled techniques, remote sensing, process-based models, field-based indicators, participatory monitoring, and mixed-methods frameworks integrating biophysical and socio-economic data.

The session will focus on how NbS processes can be measured and linked to impacts on agricultural productivity, resilience, and environmental sustainability, including large-scale effects on the status of Planetary Boundaries. Potential contributions may examine machine-learning methods for time-series analysis, data fusion across optical, radar, and in situ observations from different platforms, as well as non-AI approaches to attribution, causal inference, and counterfactual assessment of NbS interventions.

Explicit links will be made to key Planetary Boundaries, including climate change, biosphere integrity, land-system change, and freshwater use, and to the assessment of trade-offs and synergies in agricultural and food systems. By bringing together methodological advances, applied case studies, and conceptual perspectives, this session seeks to strengthen the evidence base needed to design, scale, and govern NbS in agriculture and food systems, supporting transitions towards sustainable, resilient, and just food production within planetary boundaries.

**Keywords:** Earth observation data, machine learning, spatial modelling, gis, agriculture

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# An Earth System Spheres Perspective on the Integrated Assessment of Multifunctional Nature-Based Solutions

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## Abstract

Integrated assessment is increasingly recognized as essential for capturing the multifunctionality of Nature-Based Solutions (NBS), yet the extent to which current assessments represent interactions among Earth system spheres remains poorly understood. This study presents the results of a systematic review of 84 peer-reviewed studies to examine which natural processes and Earth system spheres are assessed, how these processes are integrated, and the methodological approaches adopted. The review reveals that although many studies consider processes spanning multiple Earth system spheres, genuine process integration remains limited. Nearly half of the reviewed studies (48%) assessed multiple processes without explicitly representing their interactions, highlighting a continued reliance on siloed assessment approaches. A prominent gap was identified in the representation of atmosphere–geosphere interactions. In particular, rainfall–runoff processes are predominantly modeled as a one-way relationship in which atmospheric forcing drives hydrological responses, while potential feedback of NBS on atmospheric moisture recycling and precipitation are largely neglected. These findings point to the need for assessment frameworks that explicitly account for bidirectional interactions between Earth system spheres. A preliminary result of this study explores coupling of the Wflow hydrological model with the WAM2layers atmospheric moisture tracking model to investigate how NBS may influence atmospheric moisture transport and precipitation through land–atmosphere feedback. This work aims to advance an Earth system spheres framework for integrated NBS assessment by moving beyond one-way process representations toward more holistic, process-based assessments that can better support climate adaptation and water resource management.

**Keywords:** Nature-based solutions, Integrated assessment, Earth system spheres, Natural processes, Atmosphere, Geosphere, Ecosphere

# MET5: Nature based solutions and the role of soil life and soil ecosystem services

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# Met5: Nature Based Solutions and the Role of Soil Life and Soil Ecosystem Services

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PENDING

## Abstract

Soil life is an important factor in the delivery of ecosystem services and thereby in creating solutions to stay within the planetary boundaries. But what is the exact role of soil life? What does the presence and populations of soil life tell us about the ability to deliver soil functions? What is the role of climate, soil characteristics eg? Do you know how to measure this? Do you know the relation? Do we have enough data and tools to use that knowledge, and transpose this knowledge into sustainable soil and land management or to contribute to climate measures?
In the Netherlands we do research into these relations, and we try to measure soil life by microscope. Research is being done to speed this up by AI.
During TerraenVision we want to organize a session on this theme. Be welcome to share your research, analyses, tools and practices. Join discussions on how to monitor, measure and translate soil life to ecosystem services and management perspectives. Work together to find ways to exchange knowledge and practices and translate insights in soil life into soil health and soil health management. Send in an abstract of your research or pilot study to give a pitch, presentation or draw up a poster. Serious games or workshop ideas are also welcome.

**Keywords:** AI, soil resilience, climate adaptation, soil health

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# Monitoring Soil Life to Support Nature-Based Solutions Within Planetary Boundaries

Bob Klein Lankhorst

*Antonie*

## Abstract

Soils play a fundamental role in maintaining the Earth system by supporting biodiversity, regulating water, storing carbon and sustaining food production. These functions are central to several planetary boundaries, including biosphere integrity, land-system change, freshwater regulation and climate change. Despite their importance, soil biological processes remain poorly represented in environmental monitoring, limiting our ability to assess the effectiveness of Nature-based Solutions (NbS) and guide transitions towards more resilient landscapes.

Among soil organisms, free-living nematodes are recognised as sensitive indicators of ecosystem functioning because they occupy all trophic levels of the soil food web and respond rapidly to changes in land use and management (Ferris et al., 2001). Nematode-Based Indices (NBIs) provide internationally recognised measures of soil food-web structure, nutrient cycling and ecological resilience, offering practical proxies for soil biodiversity and ecosystem functioning (Du Preez et al., 2022). As such, they have considerable potential to support harmonised assessment of soil condition and to evaluate the ecological outcomes of Nature-based Solutions across different landscapes.

However, widespread application of nematode-based assessment has long been constrained by the time, expertise and cost associated with conventional microscopic analysis. Recent advances in automated microscopy and Artificial Intelligence (AI) now make it possible to generate standardised, reproducible and scalable measurements of soil biological quality. LIFE Monitor is one example of such an approach, enabling rapid assessment of nematode communities while creating permanent digital records that can support long-term biodiversity monitoring and future reanalysis.

By making soil biological assessment more accessible and consistent, these technologies can help bridge the gap between ecological science and practical implementation. They provide an opportunity to integrate biological indicators into monitoring frameworks that evaluate ecosystem recovery, restoration success and sustainable land management. Strengthening our capacity to measure soil biodiversity and ecosystem functioning is essential for understanding whether Nature-based Solutions are delivering their intended outcomes and for supporting evidence-based decisions that enable societies to operate safely within the planetary boundaries.

**Keywords:** Planetary boundaries, Nature-Based Solutions, Soil biodiversity, Ecological monitoring, Soil health, Nematodes

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# MET6: Tracking the ecological value of nature with the help of new technological methods - DNA-based monitoring methods and their biological, legal and economic challenges

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# Met6: Tracking the Ecological Value of Nature With the Help of New Technological Methods - Dna-Based Monitoring Methods and Their Biological, Legal and Economic Challenges

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PENDING

## Abstract

This session focuses on DNA-based methods and their contribution to European biodiversity protection. From an interdisciplinary perspective, we discuss the overall picture and state of biodiversity that the methods are able to paint, and implications for European biodiversity regulation, as well as their disruptive economic potential.
The ecological value of nature can be assessed using a wide range of indicators, such as species diversity or genetic diversity. Technological developments—particularly remote sensing (Frantz et al., 2022), automated image analysis (Zhu et al., 2022), and DNA-based methods (Macher, 2023; Macher et al., 2025; Krehenwinkel, 2017) — can now not only expand existing monitoring approaches but they may also contribute to a new perspective on biodiversity protection. For example, environmental DNA metabarcoding can provide species identification, community composition, functional and taxonomic diversity, environmentally induced changes, and potentially also quantification and age distribution. Still, the methods rely on computational capacity, specialized knowledge and may therefore be too burdensome to establish biodiversity monitoring in the Global South.
In this panel, we therefore concentrate on the pitfalls and potentials that these methods offer for European biodiversity monitoring, regulation and the valorization of nature. On the economic side, due to low costs, low impact, and its non-invasive nature, the research is likely to disrupt traditional approaches to environmental monitoring in Europe. Beyond its scientific importance, the research has significant commercial potential, fostering the development of innovative physical products and the emergence of new service-based enterprises and industries. This leads to questions that concern the commercialization of technology, intellectual property and questions how venture capital, scientific communities, and regulatory frameworks interact to shape this process?
Concerning the regulatory side, in particular, these technologies become relevant in the EU for the restoration of degraded habitats, where they may determine the quality of ecosystems or needs for restoration. However, quantified targets set for restoration must be translated into restoration plans that define areas and measures in a binding and measurable manner (inter alia, CJEU, 2023). Under the new EU restoration law, it is still

unclear what requirements arise for the assessment of ecosystem status, the development of restoration plans, and the implementation of restoration measures? Therefore, we need to address which role the new methods can play in the formulation of those plans. Moreover, we have to address what restoration plans are, and how national authorities can access and use scientifically created information on (degraded) ecosystems.
The panel will turn to the revolutionary potential and some of its downsides, for the wider context of European biodiversity protection. It will feature biological, economic and legal perspectives.
Description of the format
The session will feature short input statements from about 10-15 minutes and a moderated discussion (30 Minutes), in which the overall potential, but also its downsides and impacts on European entrepreneurship and regulation will be discussed, together with the audience.

**Keywords:** Tracking, ecology

PENDING

# MET7: Open session on methodologies for implementation and monitoring of NBS

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# Met7: Open Session on Methodologies For Implementation and Monitoring of Nbs

Manuel Seeger

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## Abstract

NBS must be applied in agriculture, forestry and natural areas to achieve sustainable management. The NBS are usually smaller scaled and based on soil or landscape solutions but they must be applied upon policies that apply strategic solutions for regions and countries. Besides, an accurate assessment of soil sustainability includes the characterization and analysis of a wide range of parameters like soil structure, erosion, quality, biodiversity, degradation, resilience, management, health, use, productivity, etc. Topics like sensors installed in UAVs, in-situ monitoring at high temporal resolution, data mining, machine learning analysis, advanced geo-statistical methods, connectivity of water and sediment, sustainable land management options in intensive and extensive agriculture or social, economic, biophysical and perception constraints are welcome. Next to the biophysical implementation also the socio-economic implementation is a topic we invite to this session.

**Keywords:** Remote sensing, transformation journeys, MRV, machine learning, social acceptance

PENDING

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# Dimensioning Sustainable Project Management in Productive Sectors: Strategic Alignment, Emerging Practices, and Implementation Tensions

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## Abstract

Sustainability has become a central criterion for value creation, organizational legitimacy, and long-term performance in project management. However, despite its growing recognition in academic and professional discourse, a persistent gap remains between its conceptual acceptance and its effective integration into project decision-making. This study aims to dimension sustainable project management in productive sectors by examining its strategic alignment, emerging practices, and implementation tensions. To achieve this purpose, the research adopts a two-phase meta-aggregative literature review based on a corpus of 127 scientific articles. The first phase develops a qualitative meta-aggregation focused on extracting explicit evidence from the literature and organizing it into interpretive categories. The second phase complements this interpretation through quantitative corpus analytics, including bibliometric characterization, principal component analysis, latent Dirichlet allocation topic modeling, semantic network analysis, clustering, and association rule mining.
The qualitative findings show that sustainability is redefining the traditional notion of project success. Rather than being limited by scope, time, and cost, success increasingly depends on projects' capacity to generate economic, social, and environmental value throughout and beyond their life cycle. This transformation requires sustainability to be embedded from early project stages, particularly in formulation, business case development, stakeholder engagement, procurement, monitoring, and post-closure evaluation. The evidence also indicates that sustainability becomes operational only when it is aligned with strategic objectives and governed by mechanisms. In the absence of clear decision criteria, accountability structures, and organizational capabilities, sustainability tends to remain declarative, symbolic, or restricted to compliance and reporting.
The quantitative results confirm the systemic and fragmented nature of the field. The topic model identified twelve latent topics with a moderate-high document-topic entropy of 0.74, indicating that most documents activate several dimensions simultaneously. Similarly, the principal component analysis retained seven components explaining 27.24% of the accumulated variance, reflecting a highly dispersed and multidimensional corpus. Although consolidated thematic nuclei were found around project management,

governance, project success, and organizational capabilities, other domains remain weakly integrated. In particular, risk management, sustainability metrics, financial decision-making, circular economy, and regenerative approaches appear as relevant but underdeveloped areas. The clustering analysis further distinguishes between a more cohesive disciplinary cluster focused on governance, success, and implementation barriers, and a broader applied cluster characterized by sectoral dispersion across agriculture, production systems, digital technologies, and value chains.

The triangulation between qualitative and quantitative results reveals three main insights. First, sustainable project management has achieved high theoretical legitimacy, but its operational integration remains uneven. Second, the field has advanced significantly in measurement, indicators, ESG frameworks, digital traceability, and reporting systems, yet these instruments do not necessarily transform project selection, investment, prioritization, or control decisions. Third, sustainability is not merely a technical issue; it depends on organizational culture, ethical leadership, stakeholder management, communication, learning capabilities, and the capacity to balance competing short- and long-term interests.

The study concludes that the main challenge for sustainable project management is not the absence of tools, frameworks, or conceptual development, but the misalignment between what organizations recognize as important, what they are able to measure, and what they actually incorporate into their decisions. Therefore, future research and practice should strengthen the connection between sustainability metrics, risk analysis, financial evaluation, governance structures, circular economy models, and strategic decision-making. Sustainable project management will only move from an aspirational discourse to a transformative managerial logic when sustainability becomes a binding criterion for value creation, accountability, and project governance across productive sectors. This contribution provides an integrated reading of the field and offers a basis for advancing future empirical studies, managerial models, and sectoral interventions aimed at closing the persistent gap between sustainability discourse and sustainable project practice in complex contemporary productive environments.

**Keywords:** Sustainable project management, Strategic alignment, Project governance, Circular economy, Sustainability metrics.

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# A Decision-Support Workbench For Evidence-Based Siting of Nature-Based Solutions With Integrated Environmental, Economic, and Social Benefit Assessment

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## Abstract

Nature-based Solutions are increasingly central to climate adaptation and biodiversity strategies, yet their on-the-ground deployment remains constrained by ad-hoc siting decisions that lack transparency, reproducibility, and defensible weighting of competing criteria. Equally lacking are frameworks that move beyond biophysical suitability to quantify the bundle of co-benefits such as environmental, economic, and social that justify investment in these interventions. Practitioners need tools that translate the literature on where each Nature-based Solution works, and what it delivers, into spatially explicit recommendations a planner can defend to stakeholders. We present a decision-support automated workbench that integrates the Analytic Hierarchy Process with geospatial multi-criteria decision analysis for thirteen Nature-based Solution types, spanning wetlands, riparian buffers, floodplain restoration, urban green infrastructure, and the Managed Aquifer Recharge family. For each intervention, the tool ingests biophysical and socio-hydrological layers including elevation, land use, soil, groundwater depth, aquifer recharge, precipitation, evapotranspiration, population density, river network proximity, organic carbon, and height-above-nearest-drainage-derived flood depth. There are  reclassified onto a common suitability scale, and combines them through Analytic Hierarchy Process weights whose Consistency Ratio is verified at every run. Each suitable site is then evaluated against a literature-derived benefit profile that quantifies environmental co-benefits (carbon sequestration, biodiversity, water quality, flood regulation), economic returns (avoided damages, ecosystem service valuation, implementation cost), and social outcomes (community access, recreational value, public health). The framework has been demonstrated in Flanders (North of Belgium) and is transferable to any region with comparable input layers, offering a defensible bridge between Nature-based Solution theory and planning practice across diverse climatic and socio-economic contexts.

**Keywords:** Suitability mapping, Socio-economic benefits, Ecosystem co-benefits, Spatial decision-support, digital transformation

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# Evaluating High-Resolution Geomorphometry and Uav-Derived Spectral Indices For Environmental Monitoring and Nature-Based Solutions Diagnosis

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## Abstract

Advanced remote sensing techniques are essential for diagnosing environmental degradation problems and establishing baseline assessments for Nature-based Solutions (NbS) in vulnerable Mediterranean ecosystems. However, the high-resolution performance of Unmanned Aerial Vehicle (UAV) metrics remains sensitive to extreme environmental variations and seasonal crop management practices. This study examines the structural and spectral sensitivity of UAV data under complex agricultural and geomorphological scenarios in southern Spain. First, the operational limits of visible spectral indicators were tested under conditions of severe canopy degradation in a harvested cereal field. Comparing RGB indexes (ExG, ExR, VARI, and GLI) against multispectral NDVI revealed very weak linear correlations (Pearson $r < 0.15$), confirming that visible-band proxies become unreliable for environmental stress assessment when green biomass is minimal and dry soil residue dominates. Second, an integrated geomorphometric and machine learning (Random Forest) approach was utilized to dissect terrain controls on surface spectral variability. Topographic slope (29% importance) and radiative exposure (eastness) emerged as key drivers of soil moisture and microtopographic reorganization. Finally, a GIS-based multivariate framework incorporating Principal Component Analysis (PCA) successfully tracked short-term structural reconfigurations within erosive gully landscapes after high-magnitude convective rainfall events, such as the 2024 DANA. Results demonstrate that while vegetative indices compress under heavy post-harvest or degraded states, multi-scale local relief models combined with AI diagnostic regressions provide an objective workflow to pinpoint landscape connectivity and soil erosion hotspots. This integrated methodology is crucial for designing, monitoring, and validating targeted NbS soil-preservation interventions.

**Keywords:** Cereals, remote sensing, UAV, geomorphometry, geomatics

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# Scale Matters: Key Regional Research and Innovation Needs to Support Soil Health Living Labs

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## Abstract

To support future development of Soil Health Living Labs (LLs) in Europe an assessment of regional research and innovation (R&I) needs was assessed. LLs are collaborative spaces for co-creating solutions to regional soil challenges in a real-life setting, engaging multiple stakeholders in science, policy, and practice. Soil health is vital to tackling climate change and socio-economic challenges, requiring region-specific solutions. The regional R&I needs to elevate soil health group around four areas: (1) scientific research, (2) co-created innovation, (3) data and monitoring, and (4) upscaling practices. These needs are categorized into general European priorities, land-use-specific needs (agriculture, forestry, urban, and mixed-use areas), and regional differences (North-, South-, East-, and West-Europe). Overarching R&I needs include clearer soil health definitions, improved models of soil processes, and cross-sectoral integration. Innovations should provide decision-support tools and secure long-term financing for LLs. Monitoring must use harmonized, cost-effective methods, while upscaling efforts require acknowledgement of regional differences, improved soil literacy and removal of institutional and financial barriers.

In agriculture, challenges range from sustainable cropping systems to soil biology assessments and landscape-level planning. Regional agricultural priorities include water management and peatland restoration in the North, erosion and drought adaptation in the South, regenerative farming in the West, and organic practices in the East. Forestry-focused needs include adapting strategies to long rotation cycles, fostering collaboration between stakeholders, and enhancing data and risk models. Northern forests require better carbon-focused management, the Southeast needs awareness on tourism impacts, Western regions should focus on peatland restoration and biomass, and Eastern areas on mixed forests and soil infrastructure. Urban and (post)industrial regions must address soil sealing, contamination, and restoration. This includes developing pollution maps, improving public awareness, and integrating soil considerations into urban planning. Challenges are largely consistent over the regions, but some points of attention were highlighted: Northern cities face compaction, Eastern regions need

contamination research, Southern areas deal with soil degradation, especially erosion, and Western Europe must align policies for urban growth and nature/soil conservation. Mixed and transitional land use areas, such as abandoned land, peri-urban zones, and touristic regions, require tailored strategies addressing unique pressures on soil health.

Key barriers to LLs implementation include funding, institutional support, technical capacity, and soil literacy. Co-creation is challenged by limited awareness, while practice implementation faces logistical and socio-economic hurdles. Solutions include sustained funding, multi-level policy coherence, and landscape-scale planning. Looking ahead, three strategic directions are recommended: (1) ensuring long-term funding to support the iterative nature of LLs and stakeholder trust-building; (2) enhancing policy coherence across agriculture, environment, and climate sectors, including matching public-private financing; and (3) adopting a landscape and food system approach to address soil health across ecosystems and communities. These strategies aim to foster a shift toward sustainable soil management practices, essential for climate resilience and socio-economic stability across Europe.

**Keywords:** Co-creation, Regional Needs, Sustainable Management, Policy Coherence, Soil Health, ecosystem services Living Labs

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# Nature-Based Solutions For Wildfire Risk Mitigation in Europe: a Comparative Analysis of Northern and Southern Case Studies and Barriers to Scaling

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## Abstract

Wildfire risk is increasing across Europe as climate change interacts with land-use change, ecological degradation, drought, and expanding wildland–urban interfaces. While wildfire governance has historically focused on suppression and emergency response, growing attention is being directed toward preventive and landscape-based approaches that reduce underlying drivers of risk. Nature-Based Solutions (NBS) have emerged as a promising strategy to enhance wildfire resilience by modifying ecological processes, reducing fuel continuity, improving hydrological conditions, and strengthening broader ecosystem functioning. However, comparative evidence on how these approaches operate across different European contexts remains limited.

This paper examines how Nature-Based Solutions contribute to wildfire risk reduction in contrasting bioclimatic and governance settings through a comparative qualitative case study analysis of the Deurnsche Peel in the Netherlands and the Valencian Community in Spain. Drawing on case study reports developed within the ReAdapt project, the analysis combines literature review, stakeholder engagement, field-based insights, and cross-case synthesis to examine NBS effectiveness, governance arrangements, financing mechanisms, and barriers to implementation and scaling.

The findings demonstrate that NBS can support wildfire resilience through multiple pathways, but that their effectiveness is strongly context dependent. In the Valencian case, where wildfire risk has long been recognised, preventive interventions such as prescribed burning, green firebreaks, fuel management, grazing, and landscape mosaics show clearer evidence of reducing fuel loads, fire intensity, and wildfire spread. In contrast, the Deurnsche Peel illustrates an emerging wildfire context in which interventions including peatland restoration, rewetting, compartmentalisation, and vegetation management contribute more indirectly to wildfire prevention through

hydrological restoration and ecosystem resilience.

Despite these regional differences, both cases demonstrate that NBS generate broader co-benefits including climate adaptation, biodiversity enhancement, water regulation, and strengthened territorial resilience. At the same time, implementation remains constrained by fragmented governance, sectoral policy silos, institutional capacity limitations, short-term funding structures, and challenges in translating technical knowledge into long-term institutional commitment.

The paper argues that scaling NBS requires moving beyond isolated pilot projects toward integrated, multi-level governance approaches that embed wildfire prevention within climate adaptation, spatial planning, and landscape management. By comparing northern and southern European experiences, this study contributes to the growing evidence base supporting preventive, landscape-oriented strategies and provides recommendations for strengthening European adaptation policy and long-term wildfire resilience.

**Keywords:** Landscape resilience, Preventive management, Multi-level governance, Climate adaptation, Territorial planning

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# Assessing Performance of Constructed Wetlands With High-Frequency Sensors to Guide Effective Mitigation of Diffuse Agricultural Pollution

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## Abstract

Quantifying field-scale treatment --performance of constructed wetlands (CWs) is essential to guide cost-effective implementation and accurately account for their contaminant load reductions in nutrient budgets and environmental plans for farms and catchments. Following the development of new guidelines for practical application of on-farm CWs in New Zealand in 2022, we sought to assess their real-world performance intercepting mixed surface and groundwater inflows across a range of agricultural landscapes. Working in partnership with councils, industry, and farmers, co-funded by the NZ Ministry for Primary Industries, we undertook comprehensive monitoring of flow and water quality over 2-4 year periods at the inflows and outflows of 4 newly established CWs. The wetlands were sized at 1.2 to 2.7 % of their contributing catchments and constructed in accordance with the new guidelines. Additional groundwater monitoring was undertaken where water balances showed significant anomalies. We used a range of modelling tools to estimate high frequency time-series for nitrogen, phosphorus, sediment and faecal microbes and quantify annual mass loads, load reductions and efficiency for each wetland. The annualised load reductions for TN, TP, SS and E. coli are reported and compared against guideline predictions. We chart the pathway and the challenges in developing and testing the guidelines and demonstrating the potential of CWs as nature-based mitigation tools. This has enabled industry and rural professionals to confidently promote their use and provided assurance for government to reduce regulatory hurdles and allow farmers to claim CW nutrient reductions in their farm environmental plans to achieve catchment nutrient targets.

**Keywords:** wetlands, contaminants

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# From Nature-Based Solutions to Regenerative Landscapes: Assessing Hydrological and Hydraulic Impacts at the Catchment Scale

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PENDING

## Abstract

Nature-Based Solutions (NBS) are increasingly promoted to address the impacts of climate change, soil degradation and water-related risks in agricultural landscapes. Numerous studies have shown that both hydraulic and agronomical measures can effectively reduce runoff and erosion at the plot or field scale. Yet their effectiveness at the scale of whole catchments remains less certain. Understanding how these measures alter hydrological connectivity, flow routing and sediment transport processes is therefore a major challenge for the design of resilient landscapes.

This keynote presents a synthesis of research conducted over the last two decades on the assessment of NBS for the mitigation of Pluvial Muddy Floods (PMFs) in agricultural catchments. Combining field measurements, process understanding and distributed hydrological modelling, this work has focused on quantifying how different categories of NBS modify the generation, transfer and connectivity of water and sediment within landscapes.

Particular attention is given to the translation of field observations into physically meaningful model parameters. Measurements conducted within the GERIHCO programme on hedgerows, vegetative barriers and filter strips provided information on hydraulic roughness, soil surface characteristics and saturated hydraulic conductivity, allowing a more realistic representation of their hydrological functioning. In parallel, studies on conservation tillage and other soil management practices highlighted the importance of measures acting directly on runoff and erosion generation processes.

Catchment-scale simulations (here using the OpenLISEM model) illustrate how modelling can help identify the mechanisms through which NBS reduce hydrological and sediment connectivity. The presentation discusses the importance of representing storage effects, ponding, backwater formation and reinfiltration processes, which are often critical for evaluating the performance of landscape interventions designed to intercept or redistribute overland flow. These impacts cannot be simulated properly with the traditional kinematic wave approximation of flux transfers.

The keynote argues that effective mitigation strategies should not merely focus on

individual measures, but on the organisation of hydrologically functional landscapes. Future developments, including regenerative hydrology and concepts such as Keyline Design, offer promising perspectives for moving from isolated interventions towards integrated management of flow pathways across entire catchments. Advancing this transition will require stronger integration of field monitoring, physically-based modelling and landscape-scale planning in order to quantify, design and optimise the multiple benefits delivered by NBS.

**Keywords:** Nature-Based Solutions, Hydrological Connectivity, Soil Erosion, Catchment Modelling, Regenerative Hydrology

PENDING

# SO1: More than Green - Towards more just, inclusive NBS reflecting socio-cultural and socio-economic aspects

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# So1: More Than Green - Towards More Just, Inclusive Nbs Reflecting Socio-Cultural and Socio-Economic Aspects

Gerd Lupp

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## Abstract

The concept of Nature based solutions (NBS) aims to simultaneously provide environmental, social and economic benefits for more sustainable communities. A key success factor in the implementation, acceptance, and appropriation of NBS is ensuring that interventions address the needs and ambitions of the communities where they are established, while distributing benefits fairly and equitably among stakeholders. In recent years, inclusivity and giving voice to marginalized and underrepresented groups as well as how the needs of nature are articulated in decision making processes are increasingly gaining relevance in both research and practice when co-creating NBS.
For the proposed session for TERRAenVISION 6, the aim is to gather insights and evidence from current research and practical applications on the social-cultural and socio-economic dimensions of NBS. Together, we will reflect about both theoretical foundations why it is relevant to give voice to various stakeholder groups, reflect how the needs of nature are given voice, collect insights about pathways and discuss strategies to make NBS more inclusive.

**Keywords:** NBS, Justice, Inclusivity, socio-cultural, socio-political aspects, governance

PENDING

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# Operationalizing Environmental Justice and Voicing Nature – a Reflexive Ethics Framework For Inclusive Nature-Based Solution Practices in the Trans-Lighthouses Project

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## Abstract

An increasingly important aspect of Nature-Based Solutions (NBS) and nature restoration efforts is seen in their potentials to create “more than green” solutions to address socio-environmental issues, enhance human well-being and support inclusion of stakeholders and citizens in co-creation processes of NBS. In this way, they are cornerstones of ambitious high-level political goals and targets set such as the EU Green Deal and international commitments such as halting the loss of biodiversity or mitigating and adapting to changing climate.
Looking at the challenges related to such goals and meaningful processes to achieve them, ethical questions arise regarding how to support establishing new human–nature relations, to ensure environmental justice and achieve sustainability governance. The ambition of the TRANS-lighthouses project is to meaningfully give voice to nature, foster care for ecosystems, and support a shift in human–nature relations by integrating diverse ethical worldviews and knowledges when co-creating NBS.
Working with a participatory action research approach and epistemologies of co-creation processes, conceptualizing ethics in TRANS-lighthouses is more than just setting a normative framework or a necessity when working with stakeholders. Indeed, it is one of the core elements embedded within the research-in-action practices and co-evolving withing the co-creation process of NBS. The backbone of the ethical framework is structured around the project’s four conceptual dimensions participatory governance, social, human-nature, and economic aspects. Reflecting the co-creation approach from the very beginning along the four dimensions to structure the work, for each dimension, across the consortium, in a series of workshops and reflexive monitoring exercises, we co-formulated key ethical questions that arise and related challenges to them. Based on these reflections, we co-elaborated the corresponding strategies and guiding principles for the work in TRANS-lighthouses.
For the human-nature dimension, we conceptualise ethics as relational, context-dependent, and inherently political. With the ambition of finding pathways for transformation and moving towards a more holistic, beyond human-centric perspective, nature should not be treated as a resource for delivering ecosystem services. Instead, for

the human-nature dimension, the framework centres the intrinsic value of ecosystems and fosters for regenerative, care-oriented human–nature relations. Key ethical issues to be reflected in collaborative efforts is to actively avoid and alway reflect, if, despite well meant ideas, activities and processes, anthropocentric and extractivist paradigms in NBS co-creation processes are unintentionally reinforced, nature and potential NBS might again be judged through a market-oriented NBS lens, or co-creation processes and suggested NBS lead to social exclusion, that would, in consequence, undermine the intended “more than green” approach.

To address these issues, the framework sets up ethical principles and strategies centred around ecological integrity, intergenerational justice, and the recognition of nature as a co-constitutive actor in socio-ecological systems. Thus, co-creating NBS must integrate the EU “Do No Significant Harm” principle and must be aligned with strong sustainability principles, accept ecological limits, and critically reflect growth-oriented paradigms.

Reflecting ethics and creating a structured ethical framework by giving intrinsic value to nature including reflexion and reflexive moments in NBS co-creation approaches can help to support more balanced, more ethical just, more resilient co-creation processes and implementation of mroe meaningful NBS that reconnect people with nature and support environmental citizenship.

**Keywords:** Nature Based Solutions, Ethics, Human-Nature Relation, Environmental Justice

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# Climate Justice in Interventions Within Protected Areas in the Caulim Basin (São Paulo, Brazil): a New Paradigm?

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## Abstract

Since 2010, Brazil's urban planning policies have shifted toward a greater focus on the environmental management of the territory, moving away from the previous reliance on engineering-based standards—particularly regarding drainage and flood control works on urban rivers (Travassos, 2010). Against this backdrop, and considering the concept of climate justice (Torres et al., 2021)—which is gaining traction within social movements and public policy by highlighting the political and ethical dimensions of climate change impacts—this study aims to examine whether a climate justice perspective is present in the urban planning policies of the city of São Paulo, such as the Municipal Climate Action Plan. This analysis is conducted through the monitoring of "Territórios da Água", a Public Policy Research Program established through a partnership between the city of São Paulo, the Federal University of ABC (UFABC), and the National Observatory for the Rights to Water and Sanitation (Ondas). This ongoing doctoral research within the University of São Paulo's Postgraduate Program in Environmental Science, addresses the gap of the dialogue between the use of climate justice in policies and discourses and the lowest level of territorial planning, which are the projects. The projects focused are those of interventions in environmentally protected areas occupied by peripheral populations in the city of São Paulo, in the Caulim River basin. This watershed is situated between the São Paulo Metropolitan Area's two largest water reservoirs: the Guarapiranga and Billings reservoirs. This study analyzes news, public announcements, and conducts a documentary analysis of urban and environmental planning policies from the agencies involved in the Territórios da Água project (including the departments of environment, housing, and urban infrastructure and public works, as well as the São Paulo State Basic Sanitation Company (Sabesp), among others) to investigate their use of the climate justice concept. Content analysis will be performed with the obtained dataset. The central hypothesis is that, although urban and environmental planning policies may establish climate justice as a guiding principle, and interventions in environmentally protected areas occupied by marginalized populations sometimes incorporate climate adaptation techniques—such as Nature-Based Solutions—climate justice is not genuinely considered in terms of the intersections of race, gender, and class, nor across the various dimensions of justice (distributive, procedural, recognition-based, and corrective) (Sultana, 2021; Schlosberg et al., 2024). Preliminary results show that there is a recent use of the climate

justice concept in policies and discourses of the public authorities. Still, the ongoing urban interventions in the Caulim basin perpetuate functionalist paradigms instead of mixed-use interventions that prioritize the environment and integration with the communities' way of life, which contributes to climate injustices.

**Keywords:** climate justice, territorial planning, urban planning, public policy

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# Towards Functional, Just and Scalable Citizen-Led Nature-Based Solutions: an Llm-Assisted Analysis of 707 Support Programme Records

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## Abstract

Cities increasingly rely on support programmes to mobilise citizen-led nature-based solutions (NbS) on (semi)privately and collectively held land, where most of the land sits beyond direct municipal control. Yet it remains unclear whether these programmes are designed to make distributed action functional, just and scalable, partly because the evidence of them is scattered across municipal and utility documentation. Here we assemble 707 programme records from 28 countries through an LLM-assisted search of that documentation and evaluate their documented design against seven conditions required to implement NbS across dispersed sites and actors. We show that programme design converges on a common model built around technical guidance and a capital grant, and that nine in ten programmes fall short on at least one condition. The weaknesses are systematic rather than scattered. They concentrate in three areas: upfront payment requirements, access rules that depend heavily on property ownership and weak post-installation arrangements for maintaining and monitoring. Treating programme architecture rather than the individual measure as the unit of analysis reframes what is required to scale citizen-led adaptation.

**Keywords:** household greening, distributed green infrastructure, climate adaptation governance, property-based resilience, environmental justice, micro-scale, urban retrofit

# SO2: Transforming Agriculture for Climate, People and Planet: Pathways from Demonstration to Systemic Change

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# So2: Transforming Agriculture For Climate, People and Planet: Pathways From Demonstration to Systemic Change

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PENDING

## Abstract

Agriculture stands at a pivotal crossroads, where food security, farm income and environmental integrity all intersects with the urgency for climate action. This session focuses on practical pathways that are both feasible on real farms and scalable across agricultural systems, drawing on large demonstration networks and renewable energy integration

This session will convene leading scientists, practitioners, farmers, and innovators to explore practical and systemic transformation options for agriculture—from on-farm implementation of climate-smart and renewable energy solutions to broader economic and social dimensions that shape whole-system change.

We will bridge insights from two complementary EU initiatives:

· The HarvRESt project, explores how integrating renewable energy systems into farming can enhance sustainability, diversify farm incomes and inform decision-support tools that balance production, emissions reduction and socio-economic impacts.

· The Climate Farm Demo project a pan-European network of 1,500 pilot farms that test and showcase climate-smart farming practices, using peer-to-peer learning, multi-actor engagement and living labs to speed up adoption of mitigation and adaptation measures.

In this session we invite contributions that address:

· On-farm transformations that reduce emissions and increase resilience through climate-smart practices, renewable energy integration, and farmer-mediated knowledge exchange.

· Evaluation frameworks and evidence streams that help compare trade-offs and synergies across environmental, economic and social dimensions of farm transformation.

· Innovative governance, incentive and business models that de-risk transitions for farmers and rural communities while ensuring equitable access to technologies and markets.

· Cross-scale integration, from local demonstration insights to regional, national and EU-level strategies that support climate neutrality, rural livelihoods and ecosystem health.

Through a mix of research presentations, case studies, panel discussion and interactive Q&A, this session will surface actionable insights and pathways that accelerate agricultural transformation—not just towards climate targets, but towards resilient, inclusive and thriving rural systems.

**Keywords:** agricultural resilience, climate adaptation, business models, rural livelyhood

PENDING

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# Between Heritage and Climate Crisis: Agricultural Identity, Adaptive Hybridisation, and Structural Constraints Among Smallholder Farmers in Lower Dir, Khyber Pakhtunkhwa, Pakistan

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## Abstract

Despite growing scholarship on climate change and agriculture in Pakistan, the socio-cultural, psychosocial, and structural dimensions of smallholder adaptation remain underexplored. This qualitative study examines how farmers in Lower Dir, Khyber Pakhtunkhwa (KP), adapt their agricultural practices socially to climate change, taking into account Pakhtun cultural identity, traditional ecological knowledge (TEK), psychosocial wellbeing, and institutional constraints. Guided by an interpretivist paradigm and grounded in Cultural Ecology (Steward, 1955) and Social Adaptation Theory (Bourdieu, 1977, 1984; Adger, 2003), the study employed open-ended, in-depth interviews with 21 purposively selected farmers (minimum 35 years' experience), analysed through Braun and Clarke's (2006) six-phase thematic analysis, yielding nine core themes. Agriculture in Lower Dir is constitutive of Pakhtun social identity, anchored in land ownership, Pakhtunwali, and intergenerational duty, and climate change, manifesting as erratic rainfall, shortened seasons, and destructive floods, disrupts this identity as profoundly as it disrupts production, generating epistemic grief and psychosocial suffering overlooked in existing literature. Adaptation is neither a linear transition to modern farming nor an abandonment of ancestral knowledge; it is a dynamic process of adaptive hybridisation in which TEK and modern tools coexist in productive tension. Structural barriers, financial exclusion, infrastructure deficits, poorly calibrated extension services, and systematic gender exclusion constrain adaptive capacity more severely than knowledge deficits. Three theoretical contributions are made: Bourdieu's habitus and field are extended into climate adaptation; adaptive hybridisation is introduced as a concept distinct from technology diffusion; and structural inequity, through four reinforcing conditions unique to Lower Dir, is identified as the primary adaptive constraint.

**Keywords:** climate change adaptation · TEK · Pakhtunwali · agrarian identity · adaptive hybridisation · psychosocial wellbeing · qualitative research · Khyber Pakhtunkhwa

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# SO3: Open session on science-society: Bridging Science and Society for the Implementation of Nature-Based Solutions

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# So3: Open Session on Science-Society: Bridging Science and Society For the Implementation of Nature-Based Solutions

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PENDING

## Abstract

The successful implementation of nature-based solutions (NbS) depends not only on scientific innovation, but also on strong connections between science, policy, education, and society. While NbS are widely recognized for their potential to address climate change, biodiversity loss, and environmental degradation, their large-scale adoption requires societal understanding, institutional capacity, and effective knowledge exchange. This session focuses on the science–society interface that enables NbS to move from research to real-world practice.
We invite contributions that explore how education systems, science communication, and public engagement can support awareness and acceptance of NbS across different societal groups. Special attention will be given to the role of science policy in creating enabling environments through regulatory frameworks, funding mechanisms, and integration of NbS into national and regional strategies. Contributions addressing interdisciplinary collaboration, co-creation processes, and participatory governance are strongly encouraged.
The session will also highlight capacity building needs, including professional training, knowledge transfer to practitioners, and institutional strengthening in both public and private sectors. Topics may include skills development, transdisciplinary learning approaches, and the role of local and indigenous knowledge in NbS implementation.
By strengthening links between science, policy, education, and society, this session aims to support the long-term, inclusive, and effective deployment of nature-based solutions.

**Keywords:** transition, science-policy, capacity building, education

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# Bridging Science and Landowner Decision-Making Through a Serious Game For Nature-Based Solutions

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## Abstract

The implementation of nature-based solutions (NbS) often depends on decisions made by private landowners. Their willingness to participate is shaped not only by economic incentives, but also by trust, perceived fairness, administrative complexity, local knowledge, property rights and long-term uncertainty. Although scientific evidence on the benefits of NbS is increasingly robust, translating this knowledge into practice requires tools that support dialogue between researchers, public authorities, practitioners and landowners.

This contribution presents a serious game developed within the Horizon Europe project Land4Climate. The game is designed to explore how private landowners perceive different policy and economic instruments supporting NbS implementation. It simulates land-use decision-making in climate adaptation contexts and allows participants to compare instruments such as subsidies, payments for ecosystem services, land swaps, compensation mechanisms and biodiversity offsets. By combining role-based decision-making with structured reflection, the game creates a space for transdisciplinary learning and discussion about barriers, motivations and enabling conditions for NbS.

The presentation builds on results from game sessions conducted in Czechia and Slovakia, including sessions with real landowners in Krásná Lípa and Košice region, as well as previous testing with students at TU Dortmund. The findings indicate that landowners' decisions are influenced by a combination of financial feasibility, clarity of responsibilities, perceived legitimacy of proposed measures, administrative burden and confidence in public institutions. Compared with student-based testing, sessions with landowners brought more attention to practical implementation details, long-term maintenance, ownership constraints and scepticism towards institutional promises.

The serious game demonstrates how participatory and educational tools can strengthen the science-society interface in NbS implementation. Rather than simply communicating scientific knowledge, the game facilitates learning through role reversal, productive conflict and structured reflection. This gives rise to a more entangled relationship between ownership interests, local knowledge and the treatment with environmental risks. Researchers gain a deeper understanding of landowners' concerns, while participants explore the potential benefits, trade-offs and governance challenges of NbS. The contribution therefore highlights the value of serious games as instruments for capacity building, stakeholder engagement and co-creation in climate adaptation

planning.

**Keywords:** nature-based solutions, serious game, private landowners, science-society interface, climate adaptation

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# Bridging the Gap Between Science and Practice: the Role of Practice-Based Education in Accelerating Sustainable Soil Management

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## Abstract

Preserving and improving soil quality is essential for achieving societal goals related to climate, food security and safety, biodiversity, and water quality. The Dutch government aims for all agricultural soils to be managed sustainably by 2030. Achieving this requires action not only from (future) farmers but also from advisors, suppliers, and other stakeholders throughout the agricultural supply chain.
The main threat to soil health on Dutch mineral soils is subsoil compaction. Nearly 50% of fields are affected below the furrow, reducing plant growth, water regulation, carbon sequestration, and soil biodiversity. While many farmers recognize the need to improve soil quality, measuring and interpreting soil health indicators remains challenging. As soil quality, water quality, and climate objectives are closely interconnected, effective soil management requires field-specific advice that accounts for both synergies and trade-offs.
To promote consistent, evidence-based soil management advice, Aeres University of Applied Sciences (UAS), commissioned by the Dutch government and agricultural service providers, developed a training program for soil advisors focusing on integrated, sustainable soil management and nature-based solutions. Participants also contribute to applied research by testing innovative advisory tools and methods for assessing soil health. Several course topics are available online through the NBSoil Academy [1].
Nature-based solutions to improve soil health in general include cover crops, reduced tillage, greater crop diversity, and organic amendments such as compost. Recent studies also demonstrate the potential of adding clay to sandy soils (LIFE CO2SAND [2]), while the combined use of compost, clay, and cover crops producing biological nitrification inhibitors is being investigated in the ClipMicro project [3].
Despite extensive scientific knowledge, adoption in practice remains limited. Farmers may be unaware of soil quality issues, innovations can be difficult or costly to integrate into farm management, and policy-driven innovations increasingly face resistance. In the Netherlands, societal polarization has increased farmers' mistrust of government-funded science, reducing their willingness to participate in research.
This presentation illustrates how Aeres UAS bridges the gap between science and practice through practice-based research involving students. Case studies show how students — many with farming backgrounds and access to farmer networks — often obtain richer insights through informal discussions with farmers than academic

researchers. Their involvement also strengthens their understanding of the value of research and its role in addressing societal challenges.
This approach demonstrates how practice-based education and student involvement can strengthen trust, improve knowledge exchange, and accelerate the adoption of sustainable soil management practices.

**Keywords:** Soil advisors, student research, soil health, nature-based solutions, knowledge exchange

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[1] Link to NBSoil Academy https://nbsoil.eu/soil-academy/ [2] Link to LIFE CO2SAND https://www.gelderland.nl/en/projecten/life-co2sand [3] Link to ClipsMicro project https://nioo.knaw.nl/en/projects/clipsmicro-climate-proof-soils-by-steering-soil-and-residue-microbiomes

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# The Role of Science in Biodiversity Regulation

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## Abstract

It is long established that the natural sciences play a role in the regulation of environmental matters. Biodiversity is no difference. However, in current biodiversity science, high throughput measures and big data create a bulk of insights that biodiversity regulation still needs to process. They allow more holistic views, and predictions of future ecosystem developments. Their inclusion requires standardization processes as well as technological equipment, supplies and relevant know-how. In addition, the methods need to be reconciled with standard biodiversity monitoring as well as insights gained from traditional knowledge. This contribution identifies challenges to the inclusion of new methods, it reviews ways in which biodiversity law has allowed taking new scientific insights on board and identifies procedures that allow dealing with the plethora of insights that result from their combination.

**Keywords:** ecosystems, holistic view, biodiversity monitoring, law

# SO4: Transition towards Circular Land and Soil Management; Building networks, bringing together interests and coping with friction in regulation (Workshop)

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# So4: Transition Towards Circular Land and Soil Management; Building Networks, Bringing Together Interests and Coping With Friction in Regulation (Workshop)

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PENDING

## Abstract

In the Netherlands the executive agency of the Ministry of Infrastructure and Water Management, Rijkswaterstaat, set up a national network with local authorities, industries, farmers and knowledge institutions on circular land and soil management. Within this network partners exchange knowledge and experiences, start projects together and develop tools to communicate and understand the drivers behind collaboration or the inhibitions to collaborate. These instruments help to find pathways towards cooperation fitting all the partners. An example of such a tool is the Social Readiness Level Instrument.
Within this workshop we will share our experiences and show the working of the Social Readiness Level instrument.
We invite you to join us if you want you to learn about building a network with stakeholders, to find out about tools to share interests and prioritize joint activities. You are invited to try out some of the tools we developed and you get to know the do's and don'ts in match making. We want to discuss with you how to overcome differences in interests and frictions in regulation in the field of circular land and soil management.
If you have experiences in circular land and soil management yourself, we invite you to share your results or case study with us in a poster. We will share your insights and discuss your results in this workshop.

**Keywords:** Transition, Circular Land and Soil Management

# SO5: Transforming Society through Social Innovation: Lessons from Practice, Navigating Challenges, and Co-Designing Solutions (Workshop)

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# So5: Transforming Society Through Social Innovation: Lessons From Practice, Navigating Challenges, and Co-Designing Solutions (Workshop)

Klaus Geiselhart[1,*], Birgit Neuer[2], Johanna Mäsgen[3] and Leah Burgard[1]

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PENDING

## Abstract

Given the need to shape social developments within planetary boundaries, nature-based solutions are a promising approach to transformation. Numerous projects demonstrate their potential in this area, but are confronted with the fact that the desired success does not occur or only partially occurs. Therefore, the question arises. What about the barriers? Social, political, or economic dynamics, which must not be overlooked in project design and implementation, frequently shape the extent to which solutions are successfully put into practice.
This is precisely where the workshop takes shape: We invite practitioners, researchers, and policymakers who have encountered challenges in the implementation of measures. Together, we will first identify key practical obstacles: Where do projects stall or lose momentum? What conflicting objectives emerge during implementation? Which assumptions – initially considered plausible – prove to be too optimistic in practice? Building on these insights, we will collaboratively analyze the underlying causes of observed problems – going beyond the scope of nature-based solutions research and development.
The workshop organizers contribute a human geography and social science perspective as a complementary lens, highlighting insights that are often underrepresented. This includes e.g. institutional constraints, asymmetrical cooperation, limited social participation, legal ambiguities, embedded power relations or cultural specificities of local contexts. Far from being in opposition to nature-based solutions, these so-called 'soft' factors are recognized as essential components within a broader agenda for transformative change.
In the final third step, focus shifts to collaborative strategic thinking. We develop and critically evaluate visions for social innovations that could propel societal transformation. Key questions guiding this phase include: How can projects be designed to ensure lasting impact under prevailing social conditions? What potential do multi-professional collaboration formats hold? And how can different disciplinary perspectives contribute to more impactful solutions?
The workshop adopts an interactive, open, and collaborative approach. Rather than relying on traditional lectures, participants engage in mixed-group discussions that bring

together scholars and practitioners from the natural and social sciences, politics, economics, engineering, and planning. The workshop aims to foster a shared understanding of the multifaceted dimensions of social-ecological transformation and to co-develop implementable, scientifially sound, and socially sustainable solutions.

**Keywords:** social innovations, co-designed solutions, transdisciplinary approach, societal transformation

PENDING

PENDING

# Index


## 2

2D hydraulic simulation 53

## 3

33P labelling 44

## A

accessibility 184
Actual evapotranspiration 27
Adaptation strategy 119
Africa 18
Agricoltaics 33
agricultural landscapes 48
agricultural resilience 229

## :

- Agricultural terraces 23

## A

Agriculture 64, 67
agriculture 196
agroecological transitions 57
agroecosystem management 49
agroforestry 29, 31
agronomists 61
AI 199
and biodiversity loss are increasingly affecting terroirs worldwide and reducing their productivity. The degradation of these areas can be observed from the pedon to the catchment scale 60
and diverse microclimatic conditions. At present 60
and microorganisms are particularly relevant and appropriate for this session. We look forward to discussing this important topic with you. 61
and stakeholders are all welcome. Studies related to soil 61
animal farming 35
animals 61
arid agroecosystems 13
as well as effective management strategies 60
Atmosphere 197

## B

band application 44
basil 42
beneficial microbes 38
best management practices 194
Bibliography. 18
BioAbfV compliance 47
Biochar 25
biochar suspension 44
Bioclimatology. 117
Biodiversity 11
biodiversity loss 181
biodiversity monitoring 238
biodiversity protection 72
biologists 61
biomass allocation 42
Biota 5
brownfields 159
buffer strips 48
Business case 150
business models 229
but understanding the dominant processes across increasing spatial scales is further complicated by landscape complexity 60

## C

cadmium 153
capacity building 233
Carbon sequestration 125
cardiovascular inflammation 194
Catchment Modelling 219
catchment monitoring 99
catchment-scale modelling 75
Cereals 211
circular economy 85
Circular economy 194, 208
Circular Land and Soil Management 240
Circular nutrient management 57
Cities 120


PENDING

Citrus 16, 21
clarification 165
climate adaptation 98, 129, 192, 199, 229, 235
Climate Adaptation 117, 127
Climate adaptation 216
climate adaptation governance 226
climate adaption 181
Climate Change 117, 172
climate change 119, 134
Climate-change adaptation 173
Climate change adaptation and mitigation 112
climate change adaptation · TEK · Pakhtunwali · agrarian identity · adaptive hybridisation · psychosocial wellbeing · qualitative research · Khyber Pakhtunkhwa 230
Climate displacement 116
climate justice 225
climate mitigation 162
climate mitigation. 25
Climate neutrality 125
Climate Resilience 109, 180
climate resilience 114
Climate resilience 138, 170
Climate-resilient viticulture 55
Climate-Smart Agriculture 40
close to nature management 98
CLUE-S model 7
Co-benefits 112
Co-creation 178, 214
co-designed solutions 243
collective action 58
Computational fluid dynamics 165
conservation tillage 48
contaminants 217
Contaminant sequestration 190
contaminated soil 25
contaminated soils 153
Contratti di Fiume 172
co-production 75
cost-benefit 165, 194
cost-benefit analysis 51
Cost-benefit analysis 150
Cover cropping 55
Cross-scale governance 141
crusting 60
Crypto wetland 83
customary practices 75
Cyprus 7

# D

Dams 8
Decentralized Water Systems 109
decision-suppoty 187
deep learning 129
Deforestation 11, 18
Degradation 5, 64
degradation 8, 16
Denitrification bed 45
De-sealing 172
desertification 16
Desertification 18
Digital monitoring tools 108
digital transformation 210
Digital transformationl 187
digital twin 75
distributed green infrastructure 226
diverse swards 49
dMRV 187
drought resilience 116

# E

Earth Observation 180
earth observation 187
Earth observation data 196
Earth system spheres 197
Ecological monitoring 200
Ecological performance 104
ecologists 61
ecology 204
Economic valuation 150
economists 61
Ecosphere 197
Ecosystem co-benefits 210
ecosystem restoration 29, 31
Ecosystems 88
ecosystems 238
ecosystem services 51, 73, 75, 143, 158, 181
Ecosystem Services 137
Ecosystem services 150, 170
ecosystem services assessment 136
ecosystem services Living Labs 214
Edible plants 11

PENDING

education 233
effluents 35
engineers 61
enologists 61
Environmental Justice 223
environmental justice 226
environmentally-technical areas 51
Environmental Resilience 9
environmental scientists 61
erosion 16, 25
Erosion 21, 64, 67
erosion control 48
Ethics 223
Ethnobotany 11
Europe 48, 67
evaluation index 73
Evapotranspiration 127

# #

#EverydayAdaptation #RelationalDurability
#TransformativeAdaptation
#SoftAdaptation
#KnowledgeCoproduction
#IntersectionalClimateJustice
#LocalKnowledge
#CommunityResilience
#CommunityBasedAdaptation 132

# E

evolution of cooperation 58

# F

FIre 88
fire management 91
floating agriculture 77
floating gardens 77
Flood adaptation 96
flood attenuation 75
Flood extremes 99
floods 94
fragile states 116
fuel management 91
functional risk 153

# G

GeoAI 180
geographers 60
geologists 61
geomatics 211
geomorphology 33
geomorphometry 211
Geosphere 197
geotextiles 48
Gilgit-Baltistan 117
GIS 96
gis 196
governance 30, 31, 94, 134, 221
Governance 112
governance and policy innovation 57
grass waterways 48
grazing 14
grazing behaviour 49
Green and blue space 184
Green-Blue Infrastructure 176, 178
Green Care 178
Green care 184
greenhouse gas 187
Green Infrastructure 109, 181
green infrastructure 164
Green infrastructure 170
Green Roof 127
Green volume 129
Greywater and stormwater reuse 108
Greywater Reuse 109

# H

headwater catchment 106
Health 120
heat stress 162
heavy metals 159
hemp 159
heritage landscapes 77
holistic approaches or targeted studies capable of providing new insights into control measures and/or innovative ideas for efficient land management plans are lacking in many regions. Understanding multiscale degradation processes and assessing the impacts of appropriate biological restoration practices 60
holistic view 238
Horn of Africa 116
household greening 226
human health 194
Human-Nature Relation 223

PENDING

Humans 5, 88
Humus formation 55
Hybrid treatment technologies 108
hydraulic conductivity 164
hydraulic simulation 101
hydrodynamics 165
Hydrological connectivity 23
Hydrological Connectivity 219
hydrological modelling 106
hydrological resilience 81
hydrology 16

# I

Inclusivity 221
Indigenous knowledge 75
industrial 148
Innovative financing 105
Integrated assessment 197
Integrated Land Management 40
Integrated spatial planning 141
interdisciplinary 94
Interdisciplinary 152
interdisciplinary discussion on the current state of the art of terroirs 60
Iran 27
It is well known that grape quality is a major factor determining the quality of the final product in the vitivinicultural sector. However 60
IUCN Global Standard 83

# J

Justice 221

# K

Keywords
- Nature-based Solutions 178
knowledge exchange 237
knowledge systems 58

# L

labour migration 116
Land 5, 64
land 16
Land abandonment 23
land and water management 72
land degradation 25, 29, 31
land degradation processes such as soil erosion 60
Land Dynamics 7
land policy 96
land restoration 29, 31
Landscape approach 91
Landscape Connectivity 9
Landscape resilience 216
landscapes 14
land-use change 81
land-use diversity 81
Land Use Land Cover Change 7
law 238
life cycle assessment 158
Low Impact Development 138

# M

machine learning 165, 196, 206
management practices 60
Mediterranean agroecosystems 90
Mediterranean landscapes 23
mental health 184
meta-analysis 48
Methodologies 176, 178
microbial functions 13
microclimate regulation 42
micro-scale 226
modelling 192
Monoculture plantation 11
MRV 206
Multi-contamination 152
Multidimensional Drivers 7
multifunctionality 73
multifunctional landscapes 69
Multi-Hazard Risk 9
Multi-level governance 216

# N

nano-modified shading 42
natural building materials 85
Natural processes 197
Natural water retention 104
natural water retention 106
nature based carbon storage 85
Nature-based Solution 21
Nature-based solution 45
nature based solutions 184
Nature Based Solutions 223
nature-based solutions 38, 47, 119, 235,

PENDING

237
Nature-Based Solutions 58, 109, 138, 141, 153, 172, 180, 200, 219
Nature-based Solutions 69, 83, 120, 123, 137, 181
Nature-based solutions 75, 77, 108, 112, 125, 170, 197
Nature-Based-Solutions 176
nature inclusive agriculture 85
nbs 192
NBS 221
NDVI 27
Nematodes 200
Nitrogen 35
nitrogen management 13
Nitrogen removal 45
Novel ecosystems 152
nutrient cycling 25
nutrient flow modelling 57
nutrient recycling 143

# O

object-based image analysis 90

# P

Participatory Approaches 176, 178
particle size distributions 194
particulate matter 194
partitioning 194
Phytoavailability 153
Phytomanagement 148
phytomanagement 153, 158
Phytoremediation 152, 156
Planet 88
Planetary Boundaries 137
Planetary boundaries 200
Plant 21
plant functional traits 123
plants 61, 148
P nutrition 44
Policy Coherence 214
Policy instrument 105
pollution 14
Pollution 156
Populus spp. 158
Preventive management 216
PRISMA 2020 48
private landowners 235
production 159
Project governance 208
property-based resilience 226
property rights 96
public engagement 134
public policy 225

# R

Rapid Assessment 83
recovery 94
Regenerative agroforestry 73
Regenerative Hydrology 219
Regional Needs 214
regional studies 33
remain major research challenges and have become indispensable tasks. This scientific session aims to foster a constructive 60
Remote Sensing 7
Remote sensing 27, 206
remote sensing 211
Research 18, 173
residence time 165
Resource recovery 108
resource recovery 194
resource use efficiency 38
Restoration 5
Retrofit urban infrastructure 190
reusing woodchips 47
RGB vegetation indices 90
rhizosphere 42
RTK 62
runoff 23
Runoff. 21
rural livelyhood 229

# S

Salinization 18
Satellite Earth Observation 99
science-policy 233
science-society interface 235
sediments. 16
Sediments. 64
Self-Supervised Learning 180
serious game 235
Shared Socioeconomic Pathways (SSPs) 117
siltation 8

PENDING

site-specific effectiveness 48
social acceptance 206
social innovations 243
societal transformation 243
Society 173
socio-cultural 221
Socio-ecological 176
socio-ecological systems 58
Socio-economic aspects 104
Socio-economic benefits 210
socio-political aspects 221
Soil 5, 21, 64, 67
soil 16
Soil advisors 237
Soil aggregate stability 13
soil amendment 25
Soil and Water Conservation 40
Soil and water conservation. 23
soil and water contamination/pollution 60
Soil biodiversity 200
soil carbon 25
soil ecosystem services 136
Soil ecosystem services 138
Soil erosion 23
soil erosion 48, 51
Soil Erosion 219
soil health 35, 57, 199, 237
Soil health 156, 200
Soil Health 214
Soil heath 49
soil imaging 44
soil literacy 145
Soil loss 23
soil management 69
soil organic carbon 13
Soil organic carbon 55
soil–plant–atmosphere continuum 123
soil resilience 199
soil restoration 25
Soils 18, 88
soil-water-sediment system 98
Spatial decision-support 210
spatial design 145
spatial modelling 114, 196
spatial planning 181
spatial-planning decision making 136
spatial scale selection 136
SpongeBoost 106
Sponge City Roof 127
Sponge measures 99
SpongeScapes 99
SpongeWorks 100
Stakeholder perspectives 105
Strategic alignment 208
student research 237
sub-Saharan Africa 29, 31
Success factors 104
Suitability mapping 210
surface runoff 48
sustainability 35, 148
Sustainability metrics. 208
sustainability trade-offs 57
sustainability transitions 58
sustainable 16
Sustainable Agriculture 40
sustainable agriculture 72
Sustainable cities 170
Sustainable Land Management 9
Sustainable Management 214
Sustainable project management 208
Sustainable Tourism 117
sustainable urban planning 96
sustainable viticulture 69
systematic review 48
system dynamics 158

# T

Technical design 104
terraces 48
Territorial planning 216
territorial planning 225
Terroir 64, 67
thermo-hydric behaviour 123
tolerance to abiotic stress 38
Tourism Climate Index (TCI) 117
Tourism Planning 117
Tracking 204
transdisciplinary approach 243
Transdisciplinary research 55
transformation journeys 206
Transhumance and Quarry-Wetland. 83
transition 233
Transition 240
tree detection 129
tribal livelihoods 73
Trier-Saarburg 119

PENDING

# U

UAV 33, 62, 211
UAV high-resolution landcover classification 90
UAV remote sensing 90
unit operations 165
urban 148
Urban 152
urban agriculture 143, 162
urban community gardens 114
urban digital twins 129
Urban drainage 164, 190
urban drainage 165, 194
Urban Green Infrastructure 112
Urban green infrastructure 125
urban heat island 164
urban hydrology 123
Urban hydrology 190
urbanisation 168
urban maintenance 194
Urban microclimate 190
Urban Nature-Based Solutions Urban resilience Multi-stakeholder governance Urban regeneration Policy–science interface Scaling NbS 142
urban planning 225
urban resilience 77, 162
Urban resilience 112
urban retrofit 226
Urban soil and water systems 141
Urban soils 138, 156
Urban spatial planning 170
Urban system optimisation 108
Urban Water Balance 127
Urban Water Circularity 109
urban water cycle 164
Urban Water System 137
Useful plant 11

# V

vegetation indexes 62
vineyards 62, 90
Vineyards 67

# W

Water 5, 64, 88
water 61
water-balance 192
water quality 8
water quantity 8
water retention 25, 53, 101
Water Reuse 109
water reuse 165
water security 8
water-sensitive urban planning 192
Watershed restoration 27
water supply 8
Wetland restoration 104, 105
wetland restoration 106
wetlands 217
wet weather flow 164
wildfire recovery 90
with the goal of improving their sustainability through both scientific knowledge and traditional farmers' management practices. Hydrologists 60
Woodchip bioreactor 45

# X

x-ray tomography 164