BOOK OF ABSTRACTS

I. SESSION DESCRIPTION

ID: S5

Beyond water: Understanding the role and co-benefits of NBS used for water management

Hosts:

	Title	Name	Organisation	E-mail
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Abstract:

Nature-Based Solutions (NBS) have gained considerable popularity in the past years, as they are thought to be a reliable tool in the transition towards greener, more resilient and socially inclusive cities, while contributing to overturn the dominance of urban grey infrastructure (Lafortezza et al., 2018 and Castellar et al, 2021). According to Nika et al., (2020), NBS for water management have received a particularly high scholarly attention. NBS devoted to supporting urban water cycle include “units” dedicated to promoting water purification (e.g., constructed wetlands and vertical gardens), sustainable urban drainage (e.g., swale, ponds,

rain gardens) among others. Moreover, NBS constitute a promising approach for onsite water treatment and reuse in cities. Even though NBS for urban water management are considered as multifunctional and capable of providing plenty of "co-benefits"- i.e., benefits adjacent to their main purpose of purification, storage, preventing runoff, etc. (Castellar et al, 2021) - there is still no agreement on how to measure or estimate these co-benefits.
The ecosystem services concept and methods, developed and continuously improved by its active community, might provide useful tools to assess and measure such NBS' benefits and to contribute to a sustainable environmental management. In this regard, the ESP Working Group S5 - ES in Water Management has recently published a special issue on "Incorporating ecosystem services into water resource management" in Environmental Management, Springer. The issue highlights the important role of ecosystem services in integrated water resource management as A) flexible concept and a way to connect with stakeholders, B) useful tool to engage in participatory processes and capacity building, C) assessment method for reflecting the plurality of values of the environment, D) decision-support system for environmental analysis (Vollmer et al. 2022). Still, the uncertainty under which the decision-making process operates makes it challenging to accept and rely on the implementation of innovative concepts and methods, including nature-based solutions, less engineering and less centralised approaches. There is significant uncertainty brought about by assessment tools (incl. ES assessments) and decision-making support models (Hou et al. 2013). Furthermore, externalities such as the uncertainty of the socio-economic (incl. pandemic, war, geopolitical hegemonies, political priorities) and environmental (incl. climate change impacts, biodiversity loss) factors influence the prospects of the future, under which decisions should be taken.

Goals and objectives of the session:

In this session we aim to discuss how the ecosystem services or related concepts and their application can be operationalized to assess and estimate the co-benefits of NBS for water management and address the plurality of uncertainties under which the decision-making process operates. We invite innovative contributions on topics broadly relate to:
Evidence on how NBS for water management provide co-benefits and deliver ecosystem services beyond water management, such as climate mitigation, governance, social justice, air quality, urban regeneration among others.
Innovative methodologies to measure any of above-mentioned NBS' contributions or to address uncertainties in existing methodologies.
Case studies and approaches to address, assess and communicate uncertainties in water resource management through ecosystem services as a system analysis tool.

Planned output / Deliverables:

A draft conceptual framework of uncertainties related to the application of ES methods and NBS in IWRM.
In addition, depending on the session participants' interests and the quality of contributions, we could explore the possibility of a collaborative paper, based on the session conclusions and a metanalysis of evidence gathered therein.

Session format:

Standard session (presentations)

Voluntary contributions accepted:

Yes, I allow any abstract to be submitted to my session for review

Related to ESP Working Group/National Network:
Sectoral Working Groups: SWG 5 – ES in Water management

II. SESSION PROGRAM

Date of session: Tuesday, 1 October 2022
Time of session: 13:30 – 15:30

Timetable speakers

Time	First name	Surname	Organization	Title of presentation
13:30 – 13:40	Welcome and introduction			
		Modelling and quantification		
13:40– 13:50	Kremena	Burkhard	Leibniz Universität Hannover	Modelling of climate change adaptation and ecosystem services and their risks in the Wadden Sea, Germany
13:52 – 14:02	Xavier	Garcia	Catalan Institute for Water Research (ICRA)	Evaluating the socioeconomic impact of basin scale nature-based solutions based on eco-hydrological modelling
14:04 – 14:14	Maija	Fonteina	NGO "Baltic Coasts"	Developing methodology for assessing the impact of the nature-based solution on the aquatic ecosystem
14:16 – 14:26	Arjan	Gosal	University of Leeds	Accuracy of modelled changes in freshwater provision over time
14:28 – 14:35		**Wrap-up of the first block**		
		Social dimensions		
14:35 – 14:45	Annelies	Boerema	IMDC	Mainstreaming coastal nature-based solutions
14:47 – 14:57	Kati	Vierikko	Finnish Environment Institute (SYKE)	Who wants to see water in cities? Public perception and acceptance of different nature-based solutions
14:59 – 15:09	María	Peréz	Leibniz University Hannover	Embracing a combination of bottom-up and top-down participatory approach to map the spatial distribution of potential Nature-Based Solutions in Costa Rica
15:11 – 15:21	Francis	Turkelboom	INBO	Beyond NBS co-benefits: uncertainties and application domain
15:23 – 15:30		**Wrap-up of the second block and session**		

III. ABSTRACTS

Abstracts are ordered based on the session program. The first author is the presenting author unless indicated otherwise.

1. Type of submission: Abstract

S. Sectoral Working Group sessions: S5 - Beyond water: understanding the use and impacts of NBS for water management

Mainstreaming coastal nature-based solutions

Presenting author: Annelies Boerema
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Mainstreaming nature-based solutions into coastal management and policy making requires an in depth understanding of the coastal flood defence contribution of such measures as well as their additional societal benefits. We applied a holistic assessment framework and demonstrated the added value of nature-based measures for coastal cities (Belgium). We investigated six different nature-based coastal solutions in comparison with a hard reference scenario with a grey dike. The study consisted of three parts: (1) pre-design development for each NBS to obtain coastal protection against a sea level rise of +1.5m; (2) develop a holistic assessment framework based on ecosystem services of each NBS; and (3) discussions with local governments to make an inventory of their (practical) considerations or possible resistance for implementing such soft solutions. With the pre-design we could demonstrate that the required dune height can be 1 meter lower than the required dike height in order to protect against the same rise in sea level of +1,5m. The ecosystem services analysis showed the added value of all nature-based measures compared to the hard reference dike, with moderate added benefits for sand measures (nourishments) and the highest gains for measures with plants and animal species (dune vegetation, reef species). From our discussions with local governments, we learned that there is an overall willingness to rethink today's coastline but only if all current user functions are integrated, with many practical considerations (e.g. accessibility, maintenance), and much attention for communication to the local stakeholders.

Keywords: Coastal cities, coastal protection, nature based solutions, holistic assessment, stakeholder input

2. Type of submission: Abstract

S. Sectoral Working Group sessions: S5 - Beyond water: understanding the use and impacts of NBS for water management

Developing methodology for assessing the impact of the nature-based solution on the aquatic ecosystem

Presenting author: Maija Fonteina Kazeka
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that nature-based solutions (NBS) are used as a support tool to improve water condition. Effectiveness of NBS implementation is planned to be evaluated within the project LIFE GOODWATER IP. The envisaged measures include environmentally friendly drainage system elements (meandering, artificial rapids, two-stage ditches, bottom dams, sedimentation ponds), green infrastructure elements in forest and agriculture lands (bufferstrips, constructed wetlands, overland flow areas), and solutions to reduce effects of hydrological and morphological modifications (fish passes, reconstruct culverts, improvement of riverbed). To evaluate the effectiveness of the implemented measures and their impact on ecological quality of water bodies a twofold ecosystem services (ES) assessment approach is applied - before and after the implemented activities- to assess the ecosystem response in the future. Ecological responses to restoration and sustainable management measures are generally slow and difficult to predict, therefore it might be challenging to interpret the results to determine whether the observed changes are due to the measures or influenced by background conditions. One of the challenges in developing ES assessment methodology is the uncertainty in evaluating the effectiveness of the implemented measures. Simultaneously advanced assessment methods are required to identify biological quality elements that are sensitive to hydromorphological and eutrophication pressures, which can be integrated into river basin management plans for comprehensive ecological quality assessment. Methodology foresees the use of 40 indicators, partially related to ES potential and partially - to ES flow. Sensitive biological elements of the aquatic environment, such as macrozoobenthos, zoobenthos, could be affected by the project activities. On the contrary it is difficult to attribute fluctuations in elements dependent on the aquatic systems such as waterbirds, amphibians, shadow zones, to the impacts of the implemented NBS.

Keywords: Water bodies, water quality, nature-based solutions, impacts on the aquatic environment

3. Type of submission: Abstract

S. Sectoral Working Group sessions: S5 - Beyond water: understanding the use and impacts of NBS for water management

Modelling of climate change adaptation and ecosystem services and their risks in the Wadden Sea, Germany

Presenting author: Kremena Burkhard
Other author(s): Jonas Lenz, Conrad Jackisch, Anett Schibalski, Boris Schröder
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The German North Sea coast is characterised by continuous dikes and below sea level elevation of a big share of the terrestrial land. The system is vulnerable to climate change and specifically to predicted increase in sea levels and extreme weather events and changes in seasonal precipitation. Therefore, adaptation measures to the predicted change in pressures in the area is needed.

Within the inter- and transdisciplinary project RUINS (Risk, Uncertainty and Insurance under Climate Change. Coastal Land Management on the German North Sea) the ecosystem services Water flow regulation, Crop production and Wind energy are assessed through a chain of models that integrate climate change impact predictions and eco-hydrological modelling until the end of the 21st century. The supply of all three services depends on their co-production from nature-based and infrastructural solutions that are represented as management scenarios in the models. The insufficient water flow regulation imposes the highest risk in the area due to the low elevation and the complex water management reliant mostly on a system of canals and pumps that require precise operation in order to prevent floods, especially due to extreme events. Therefore, this service and the respective management scenarios are in the core of the study.

In order to represent the complex model results and the related risks and uncertainties of the projected future scenarios, the interaction between the key variables and the involved model uncertainties are represented in a Bayesian Belief Network (BBN). It shows the relations and assesses the conditional probabilities between the different states (scenarios) of the variables and their impact on the final ecosystem service. This provides a key communication paradigm that highlights the uncertainties and risks of the projected future states in relation to their probabilities as key consideration in the decision-making process. Depending on the stakeholders' aversion to risk, the uncertainty information might also impact the decision-making process and the management of the system and is therefore included in the BBN. A web application, which enables policy makers to access the effect of modelling scenarios on ecosystem services and their uncertainties, is in development, based on the results of the study.

Keywords: impact modelling, risk, uncertainty, probability, Bayesian belief network

4. Type of submission: Abstract

S. Sectoral Working Group sessions: S5 - Beyond water: understanding the use and impacts of NBS for water management

Who wants to see water in cities? Public perception and acceptance of different nature-based solutions

Presenting author: Kati Vierikko
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The water cycle is expected to be drastically influenced by climate change across Europe, with critical changes to water quantity, water quality, and seasonal distribution. In urban areas stormwater flood risks aggravated by climate change, increased soil sealing, runoff from traffic areas polluting brooks, modified channels of brooks and rivers decreasing ecological values. Long drought seasons enhances water scarcity and decreases wellbeing of urban citizens and nature. Nature-based solutions (NBS) such as rain gardens, wetlands, stormwater ponds or urban biofilters are expected to improve flood and drought control, quality of water, air, soils and biodiversity, and food / materials production. Technological innovations and implementation of different NBS has gained much attention in green infrastructure planning in European cities. But do urban residents accept and value these solutions? The project 'To Ally Technology, Nature and Society for integrated urban water management (ATENAS)' studied perceptions and acceptance of different NBS in cities, and whether management measures to improve water resilience are valued by residents. We were also interested if residents are satisfied with current climate adaptation policy and tools in three countries: Finland, France and Poland. Based on over 700 respodents we will present main findings of our study and compare similarities and differences in values and perceptions of NBS and water. In general, residents in three countries gave positive values for water in cities and supported measures to improve water resilience. However, their values and acceptance of NBS in general are contradict as residents do not necessarily want to see all types of NBS or forms of water close to their home. We argue that there is a need for collaborative knowledge production and planning of NBS to decrease resistance of local residents towards NBS.

Keywords: urban water, public values, nature-based solutions

5. Type of submission: Abstract

S. Sectoral Working Group sessions: S5 - Beyond water: understanding the use and impacts of NBS for water management

Evaluating the socioeconomic impact of basin scale nature-based solutions based on eco-hydrological modelling

Presenting author: Xavier Garcia
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Despite their vital role to sustain human well-being, around the world freshwater ecosystems are severely threatened by anthropogenic pressures. To avoid the degradation of these ecosystems, and complementary address other societal challenges, such as water security, more and more researchers and practitioner are advocating for the application of nature-based solutions (NbS), that is, solutions that are supported by natural processes and ecosystems. Despite their potential, there are not yet many options to assess their impact in socioeconomic terms, especially regarding the application of NbS at a river basin scale. This study presents the development of an approach to evaluate the socioeconomic impact of basin scale NbS based on the coupling of an eco-hydrological model and a set of ecosystem services valuation functions. This approach has been developed for the Catalan Internal Basins. Concretely, a comprehensive SWAT+ model has been created to predict the biophysical effects of NbS. Five ecosystem services (ES) valuation functions (drought mitigation, peak storm mitigation, hydropower production, provisioning of timber, and carbon) that use SWAT+ biophysical output variables quantify in economic terms the impact of NbS. To test this approach, we evaluated the socioeconomic impact of the thinning of the forests of Catalan Internal Basins, as a measure to increase the blue/green water ratio, which has been significantly altered in the recent years due to land abandonment and/or re-afforestation. Results demonstrate that this NbS is highly beneficial due to the increase in the provisioning of timber and production of hydropower, as well as the mitigation of droughts. Costs due to the enhancement of flood risk do not exceed these benefits. These results demonstrate that this approach can support the elaboration of river basin management plans (RBMP) by evaluating the impact in socioeconomic terms of a wide variety of NbS, capturing the trade-offs and synergies among ES.

Keywords: ecosystem services modelling, eco-hydrological models, nature-based solutions, forest management, water security

6. Type of submission: Abstract

S. Sectoral Working Group sessions: S5 - Beyond water: understanding the use and impacts of NBS for water management

Embracing a combination of bottom-up and top-down partici-patory approach to map the spatial distribution of potential Nature-Based Solutions in Costa Rica

Presenting author: Veronica Alejandra Neumann
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Communities are essential players in understanding and reflecting on possible potential solutions to mitigate the effects of climate change and rapid urbanization. Especially when it comes about current complex socio environmental and economic challenges, such as wastewater and water quality, habitat loss and fragmentation, and most importantly, community health, safety, and security. In this regard, the European Commission defines Nature-Based Solutions (NBS) as solutions inspired and supported by nature to address societal challenges while delivering a range of ecosystem services. This promising concept of NBS does not only pretend to provide simultaneously economic, social, and environmental benefits, but also to provide potential mitigation and adaptation strategies for urban settlements. Implying with this, the consideration of existing regulatory frameworks and policies that stimulate local participatory processes, and the current non-governmental stakeholder constellations that aim to create collective actions to preserve nature and human health. As a result, this paper aims to embrace a combination of bottom-up and top-down participatory approach to map the spatial distribution of potential NBS in urban areas in costa Rica. That is, to develop a comprehensive assessment tool to visualize the actions and practices employed by community members to mitigate current local socio environmental challenges, and the existence of local regulation and policies that promote the design and implementation of NBS. For this reason, an exhaustive analysis of local regulatory plans and policies, and several interviews and bilateral meetings, in-situ, with members of the communities and municipalities took place. During these visits it was possible to gather relevant datasets, including ecological and socio-economic information, needed to map the potential NBS hubs based on the combination of the bottom-up and top-down participatory approaches. Consequently, this paper does not only aim to enable the foreseen benefits of the different participatory approaches, in urban planning, to be clearly communicated, but also to contribute to a baseline for the upscaling of NBS in urban settlements.

Keywords: Bottom-up and Top-down participatory approach; Nature-Based Solutions; Spatial distribution

7. Type of submission: Abstract

S. Sectoral Working Group sessions: S5 - Beyond water: understanding the use and impacts of NBS for water management

Accuracy of modelled changes in freshwater provision over time

Presenting author: Arjan Gosal

Other author(s): Paul Evans, James Bullock, John Redhead, Matthew Charlton, Anna Cord, Andrew Johnson, Guy Ziv

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Accurate modelling of changes in freshwater supplies is critical in an era of increasing human demand, and changes in land use, climate, and development or monitoring of Nature-Based Solutions. However, there are concerns that current landscape-scale models do not sufficiently capture catchment-level changes, whilst large-scale comparisons of empirical and simulated water yield changes are lacking.

Here we present the results of modelled annual water yield in two time periods (1985–1994 and 2008–2017) across England, validated against empirical data. Our objectives were to i) investigate whether modelling absolute or relative change in water yield is more accurate and ii) determine which predictors have the greatest impact on model accuracy. We used the Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) Annual Water Yield model. Modelled annual yields showed high accuracy as indicated by low Mean Absolute Deviation (MAD) at the catchment and hectare scales. The accuracy of modelled absolute change in water yield showed a more moderate fit on both the catchment and hectare scales. Relative change had lower accuracy. Anthropogenic modifications to the hydrological system, including water abstraction contributed significantly to the inaccuracy of change values at the catchment and hectare scales.

Quantification of changes in freshwater provision can be more accurately articulated using absolute values rather than using relative values. Absolute values can provide clearer guidance for mitigation measures related to human consumption. Accuracy of modelled change is related to different aspects of human consumption, suggesting anthropogenic impacts are critically important to consider when modelling water yield.

Please note this presentation is based on our recently published study:

Gosal, A.S., Evans, P.M., Bullock, J.M., Redhead, J., Charlton, M.B., Cord, A.F., Johnson, A. and Ziv, G., 2022. Understanding the accuracy of modelled changes in freshwater provision over time. Science of the Total Environment, 833, p.155042.
https://doi.org/10.1016/j.scitotenv.2022.155042

Keywords: Water yield, Human impacts, Model validation, Ecosystem services, Anthropogenic impact

8. Type of submission: Abstract

S. Sectoral Working Group sessions: S5 - Beyond water: understanding the use and impacts of NBS for water management

Beyond NBS co-benefits: uncertainties and application domain

Presenting author: INBO INBO

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The strategy of reconnecting rivers with their floodplains currently gains popularity because it not only harnesses natural capacities of floodplains, but also increases societal co-benefits and biodiversity. Our findings are based on a successfully implemented nature-based solution (NBS) in the Dijle valley in the centre of Belgium (Turkelboom et al., 2021). By using a cause-effect analysis, a comparative social cost-benefit analysis and validation via an expert group, the differences in costs and benefits between a technical solution (storm basins) and an alternative NBS (restoration of the alluvial floodplain) were retrospectively assessed.

The comparison reveals that the NBS option provides similar flood security, lower costs, more ecosystem services benefits and higher biodiversity values in comparison to the technical alternative. However, the assessment had to deal with a number of uncertainties: 1) assessing the impact of a hypothetical technical solution, 2) uncertainties in assessing the differential impact on recreation, denitrification and carbon sequestration, 3) potential benefits of the nature-based solution that could not be assessed (e.g. sedimentation regulation, uniqueness of natural alluvial systems), and 4) the used discount rate.

The Dijle NBS case shows that the business case for working with NBS substantially depends on the spatial and socio-ecological context. Chances for successful NBS implementation increase in conditions of sufficient space to retain flood water, when flood water is of sufficient quality, and when economic activity and housing in the floodplain is limited.

Keywords: Floodplain restoration, system analysis, comparative social cost-benefit analysis, uncertainties, application area