



BOOK OF ABSTRACTS

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I. SESSION DESCRIPTION

ID: B2

Planning and implementing Nature-based Solutions for water management at different scale

Hosts:

	Title	Name	Organisation	E-mail
Hosts:	Dr.	Anda Ruskule	Baltic Environmental Forum	anda.ruskule@bef.lv
	Dr.	Blal Adem Esmail	Ruhr-Universität Bochum	blal.ademesmail@rub.de
Co-hosts:	Dr.	Kristina Veidemane	Baltic Environmental Forum	kristina.veidemane@bef.lv
	Dr.	Carla Sofia Ferreira	Research Centre of Natural Resources, Environment and Society (CERNAS), Polytechnic Institute of Coimbra	carla.ssf@gmail.com
		Paulina Guerrero	Ruhr-University Bochum	guerrero@umwelt.uni-hannover.de
	Dr. Ing.	Kremena Burkhard	Leibniz University Hannover	burkhard@umwelt.uni-hannover.de
	Dr.	Zane Lībiete	Latvian State Forest Research Institute "Silava"	zane.libiete@silava.lv
		Ivo Vinogradovs	University of Latvia	ivo.vinogradovs@lu.lv
	Dr.	Derek Vollmer	Conservation International, Arlington	dvollmer@conservation.org
	Dr.	Nidhi Nagabhatla	United Nations University, Institute of for Water Environment & Health	nidhi.nagabhatla@unu.edu
	Dr.	Lina Suleiman	Division of Urban and Regional Studies, Department of Urban Planning & Environment, Royal Institute of Technology	lina.suleiman@abe.kth.se
	Prof. Dr.	Dagmar Haase	Department of Geography, Humboldt University of Berlin	dagmar.haase@geo.hu-berlin.de



Abstract:

Freshwater systems are exposed to multiple socio-environmental and socio-economic pressures, including extreme climate events, rapid urbanization, land-use change, pollution, and aging infrastructures. Necessity to move towards sustainable water management practices is a widely recognized development target.

Nature-based Solutions (NBS) are increasingly being proposed as viable solutions to address water related societal challenges (e.g. improvement of water quality, enhancing water supply and security, reducing flood hazard, etc.) alongside, or instead of, the dominant view of water engineering, by offering a more circular approach that restores natural hydrology to deliver socio-economic and environmental benefits (UN-WWDR 2018). NBS can range from minimum interventions, which improve the delivery of ecosystem services by adjustment of management practices or extensification of land uses, up to intensive ways of transformation or creation of new ecosystems and forming multi-functional landscapes, e.g. meandering of rivers, and reconnection to flood plains, construction of wetlands, etc. In urban contexts, NBS are advocated under different terms, including Green Infrastructures, Low Impact Development, and Sustainable Drainage Systems.

A strategic and integrated planning approach is required for enhancement of green and blue infrastructures and sustainable water resource management, through implementation of NBS at different scales. This can involve existing policy instruments for environmental management and land use governance, such as river basin management plans, protected areas management, agri-environmental schemes, as well as landscape and spatial planning. Furthermore, the ecosystem service framework provides a key assessment tool for evaluating scenarios and trade-offs of NBS, and comparison with conventional practices.

Despite the massive body of research as well as extensive experience in applying different NBS through existing policy instruments, a call for “better evidence-base” on the social, economic and environmental effectiveness of NBS remains actual (EU, 2016). Moreover, a way towards an integrated approach to support sustainable water resource management through deployment of the EU-wide green infrastructure still must be investigated.

The session sets out to collect empirical evidence of case studies, from the watershed to the urban scale, on NBS for water management and enhancement of green and blue infrastructure, as well as highlight the potentials for integration and effective governance of freshwater systems from local to regional, national and EU levels. It aims to explore the key factors deemed significant in facilitating or hindering the uptake of NBS as viable solutions for current water challenges (e.g. context, type of individual and organisational actors, social and technical instruments, and governance processes). It will contribute to a deeper understanding of the challenges and opportunities for mainstreaming NBS to achieve better water management and nature conservation. In order to address scale specific perspectives, the first part of the session will be mostly focusing on NBS at watershed scale, while the second part will be more dedicated to water security and NBS in urban areas.

Goals and objectives of the session:

The session aims to gain an overview from various initiatives across Europe and the World on applying NBS for integrated water management and expansion of green and blue infrastructures, from the watershed to the urban scale. The session welcomes discussions about barriers to implement NBS and appropriate solutions to overcome these problems, such as suitable measures for different planning and governance levels and distinct biophysical settings as well as possibilities for integration.

Some of the questions to be addressed by the session are:

- 1) How to enhance the required evidence base in order to mainstream NBS in water management within watersheds and in urban areas? What is missing and what should be done differently?
- 2) Can ecosystem services concept and approaches/methods serve as a “currency” for NBS evaluation?
- 3) Can co-benefits of NBS (e.g., recreation opportunities, habitat provision) appropriately be considered in water-related decision-making processes? How are they valued and by whom? Would the involvement of communities make a difference?
- 4) How to achieve an integrated approach to watershed management supporting deployment of EU-level green and blue infrastructure?
- 5) What are the main challenges for implementing NBS for water management? What are the scientific and institutional constraints?

Planned output / Deliverables:

Recommendations on strategic and integrated approaches for deployment of river-based green infrastructures and NBS for water management.

Possibilities to develop joint publications or a Special issue based on the outcomes of the session will be discussed. This can include the topics of ecosystem services, nature-based solutions, water management and water security, based on the contributions from this and previous sessions of the ESP SWG5 “ES and Water Management”.

The findings of the session will be up taken by the LIFE Integrated Project on “Implementation of River Basin Management Plans of Latvia towards good surface water status” (LIFE GoodWater IP). The session is organised also in co-operation with the COST Action Land4Flood on “Natural Flood Retention on Private Land”. Contributions from experiences all over Europe and beyond are very welcome.

Related to ESP Working Group/National Network:

Biome working group: BWG 2 – Freshwater Systems

II. SESSION PROGRAM

Date of session: Wednesday, 9 June 2021

Time of session: 11:00 – 17:30

Timetable speakers

Time	First name	Surname	Organization	Title of presentation
11:00 11:05	Anda	Ruskule	Baltic Environmental Forum, Latvia	Introduction
11:05 11:18	Jānis	Šīre	Latvian Environment, Geology and Meteorology Centre	Demonstration of nature-based solutions for improvement of the status of water bodies in Latvia
11:18 11:31	Zane	Kalvīte	Latvian State Forest research institute "Silava"	Green infrastructure for water protection in forestland: Solutions, effectiveness and practical application in Latvia

Time	First name	Surname	Organization	Title of presentation
11:31 11:44	Francesco	Di Grazia	University of Siena	Ecosystem services of the Piave River catchment (Italy), examining climate and river restoration scenarios
11:44 11:57	Katrin	Karner	University of Natural Resources and Life Sciences	Optimizing land and water-based ecosystem services under climate change – a regional case study application in Austria
13:30 13:35	Blal	Adem Esmail	Ruhr University Bochum	Introduction
13:35 13:48	Luís	Valença Pinto	Polytechnic Institute of Coimbra & Mykolas Romeris University	An urban nature-based solution for pluvial flood regulation: a case study from Coimbra, Portugal
13:48 14:01	María	Guerrero-Hidalga	CETAQUA	Intangible damages of combined sewer overflows spills in recreational services of coastal urban areas
14:01 14:14	Maria Susana	Orta Ortiz	University of Trento	Upscaling nature-based solutions and assessing cumulative benefits for stormwater management in the city of Las Palmas de Gran Canarias
14:14 14:27	Busani	Masiri	IIE MSA	The role of green infrastructure towards water security - chasing legitimacy in a changing urban environment
14:27 14:40	Nandita	Singh	Södertörn University	Nature-Based Solutions for Sustainable Water management in the Peri-Urban: Towards a better understanding of opportunities and constraints in Stockholm County, Sweden
14:40 14:53	Nicola	Salliou	ETH Zürich, IRL, PLUS	A model-based dialogue between design, science and stakeholders for the design of sustainable and resilient cities
14:53 15:00				Discussion
15:30 15:43	Mario	Balzan	Institute of Applied Sciences	Mapping and assessing ecosystem services to plan and assess water management actions at different scales in Malta
15:43 15:56	Evelyn	Uuemaa	University of Tartu	Dimensioning of riparian buffer zones in agricultural catchments at national level

Time	First name	Surname	Organization	Title of presentation
15:56 16:09	Mark	Turner	Greater Manchester Combined Authority	Evidence led nature-based solutions in the North West River Basin District: the Natural Course approach
16:09 16:22	Annelies	Broeckx	University of Antwerp	The use of a multi-scale Topographic Position Index for the identification of upstream depressional wetlands
16:22 16:35	Muhammad Abdur	Rahaman	Centre for People & Environ	Nature-based solution for water management in salinity affected coastal belt of Bangladesh
16:35 16:48	Jemal Ahmed	Tadesse	Addis Ababa University	Total economic valuation of Ecosystem Services of the Sudd Wetland for green infrastructure planning and development
16:48 17:00	Ivo	Vinogradovs	University of Latvia	Green infrastructure planning as a tool for operationalizing ecological solidarity for rural- urban cohesion
17:00 17:30				Moderated discussion about barriers to implement NBS and suitable measures for different planning and governance levels

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

B. Biome Working Group sessions: B2 – Planning and implementing Nature-based Solutions for water management at different scales

Demonstration of nature-based solutions for improvement of the status of water bodies in Latvia

First author: Jānis Šīre

Other author(s): Linda Fībiga

Affiliation: LIFE GOODWATER IP (LIFE18 IPE/LV/000014), Latvian Environment, Geology and Meteorology Centre, Latvia

Contact: janis.sire@lvgmc.lv



Nature based solutions can be applied to improve the status of water bodies, thereby supporting achievement of the EU environmental objectives set by the Water Framework Directive (2000/60/EC). Such approaches are tested by a LIFE programme Integrated project “Implementation of River Basin Management Plans of Latvia towards good surface water status” (LIFE GOODWATER IP), implemented by 19 partners in Latvia. The project expects to achieve good status for 9 (5%) out of 164 (89 rivers and 75 lakes) of the surface waterbodies currently at risk in Latvia. As an indirect result of the project, in the long term, up to 50 water bodies (30%) affected by similar pressures are expected to reach good status. Actions in several thematic areas will be implemented – reduction of the point-source pollution caused by urban wastewater; reduction of diffuse pollution from agricultural and forestry lands; reduction of effects of hydrological and morphological alterations; capacity building actions; awareness rising of various stakeholders; support to respective authorities. Trialing of new approaches and methods to demonstrate remediation and improvement of significantly affected water bodies will be used: SWAT water quality modelling system; national sewage sludge strategy elaborated–; methods and approaches demonstrated for reduction of pollution with nutrients from agriculture and forestlands (buffer strips, green infrastructure elements, sustainable and environmentally-friendly drainage system elements); reduced effects of hydrological and morphological modifications (fish pass, reconstruction of culverts, reconstruction of riverbed in streams incorporated in drainage system, mitigation measures in natural riverbeds (addition/removal of stones or gravel, large wood debris, silt, vegetation etc.); use of planning tools: a small-scale grant schemes for supporting local initiatives; recommendations/guidelines for reducing the pollution loads and impacts of alterations; joint cooperation platform involving competent authorities and stakeholders.

Keywords: water management, LIFE programme, GoodWaterIP

2.Type of submission: Abstract

B. Biome Working Group sessions: B2 – Planning and implementing Nature-based Solutions for water management at different scales

Green infrastructure for water protection in forestland: Solutions, effectiveness and practical application in Latvia

First author: Zane Kalvīte

Other author(s): Ivars Kļaviņš, Arta Bārduleleva Rove, Zane Lībiete

Affiliation: Latvian State Forest research institute "Silava", Latvia



Contact: zane.kalvite@silava.lv

With 53% of the land cover, forests in Latvia are the most widespread terrestrial ecosystems that provide a number of highly valued ecosystem services (ES) in all ES categories. Water protection is an important regulating ES, but timber and energy wood have high economic and social importance as well. Forest management intensification due to the growing demand for renewable resources may lead to deterioration of aquatic ecosystems, by increased soil disturbance resulting in increased loads of sediments, nutrients and mercury from forestland, and also by direct effects on the riparian forests with high ecological value. Only 33% of surface waterbodies in Latvia correspond to good ecological status, therefore, land management practices should include environmental considerations. Potentially adverse effects of forestry operations may be mitigated by taking into account water quality issues during the forest operation planning and implementation and by application of green infrastructure solutions, such as functional riparian forest buffers, peak flow control dams, sedimentation ponds and others. This presentation provides an overview of several recent and ongoing studies of forestry–water interactions, implemented in Latvia under various national and international frameworks (e.g., State– and company–funded research, Interreg Baltic Sea Region Programme and LIFE Programme). It discusses several findings: i) the impact of different forest management operations (forest road construction, regeneration felling) on water quality on varying spatial scales; ii) the effectiveness of water protection solutions in forest drainage network maintenance; iii) the impact of beaver activity and beaver dam removal on water quality parameters. It also briefly outlines the most important knowledge gaps and highlights the major topics for future research related to the interactions between land management and water quality.

Keywords: forest management, green infrastructure, water protection

3. Type of submission: Abstract

B. Biome Working Group sessions: B2 – Planning and implementing Nature–based Solutions for water management at different scales

Ecosystem services of the Piave River catchment (Italy), examining climate and river restoration scenarios

First author: Francesco Di Grazia

Other author(s): Steven A. Loiselle, Bruna Gumiero, Luisa Galgani, Elena Troiani



Affiliation: University of Siena, CSGI, Italy

Contact: francesco.digrazia@student.unisi.it

The development of new approaches for the analysis of long-term changes in riverine carbon, hydrological and nutrient cycles is important to identify potential impacts on the ecosystem services provided to the local population. In the present study, we explore a series of scenario of climate and river basin management on the spatial variations of carbon storage and sequestration, nutrients (N & P) and sediment delivery and water yield combining citizen science and modelling (InVEST) to support decision making for one of Italy's most important rivers. Bringing together traditional and novel information sources about land use, nitrogen, phosphorus and carbon contents of the topsoil, vegetation and river, we explore possible impacts on national and European directives related to water quality (Directive 2000/60/EC) and habitat (Directive 92/43/EEC). The Piave River is one of the most artificialized waterways in Europe. Among the scenarios developed (current and future-2050) we explore potential restoration actions to the riverbed to return the functional processes to the river ecosystem. We also explore the potential of long-term trends in agricultural land abandonment and their potential impact on ecosystem services. The participation of the local population as citizen scientists, coordinated by experts and using standardised methods allowed for both increased engagement with the project as well as fundamental data gathering for the ecosystem service models.

Keywords: ecosystem services, river restoration, climate change, citizen science, spatial resolution models

4. Type of submission: Abstract

B. Biome Working Group sessions: B2 – Planning and implementing Nature-based Solutions for water management at different scales

Optimizing land and water-based ecosystem services under climate change – a regional case study application in Austria

First author: Katrin Karner

Other author(s): Erwin Schmid, Hermine Mitter

Affiliation: Institute for Sustainable Economic Development, University of Natural Resources and Life Sciences, Austria

Contact: katrin.karner@boku.ac.at



Conflicts about land and groundwater resources exist in the Austrian Seewinkel region. The groundwater table has been dropped by drainage canals to gain land for agriculture and settlements and by pumping irrigation water for agricultural production. Furthermore, intensive agriculture has led to nitrate leaching and soil organic carbon depletion. Trade-offs between agricultural production and other land and water-based ecosystem services (ESS) might increase under future climate change. Thus, we aim to optimize land and water use practices (i.e. adapting crop rotations, fertilization and irrigation intensities, land conversion) to increase ESS in the Seewinkel region under three climate scenarios for the next two decades. In particular, we applied an integrated modeling framework to assess improvements of regional soil quality and climate regulation (i.e. through maximizing topsoil organic carbon stocks), water quality (i.e. through minimizing nitrate leaching), and quantity (i.e. through minimizing groundwater extraction for agricultural irrigation). Individual ESS are improved by allowing agricultural net benefit reductions between 1 and 50%. Model results show that ESS can be improved significantly through adapting land and water use practices at relatively low reductions of agricultural net benefits. Depending on the climate scenario, topsoil organic carbon stocks can be increased by 1%, nitrate leaching can be reduced by 18–19%, and groundwater extraction can be reduced by 11–83%, when allowing agricultural net benefits to decline by 1%. However, improving ESS beyond a particular level can lead to high costs in terms of foregone agricultural net benefits. This is mainly related to large declines of cropland and increases in grassland or abandoned land. Furthermore, the results indicate that water use practices are less costly than climate regulation practices in the Seewinkel region.

Keywords: land use, integrated modeling, climate change, water management, ecosystem services

5. Type of submission: Abstract

B. Biome Working Group sessions: B2 – Planning and implementing Nature-based Solutions for water management at different scales

An urban nature-based solution for pluvial flood regulation: a case study from Coimbra, Portugal

First author: Luís Valença Pinto

Other author(s): Carla Sofia Ferreira, Paulo Pereira



Affiliation: Research Centre for Natural Resources, Environment and Society (CERNAS), Polytechnic Institute of Coimbra, Coimbra Agrarian Technical School, Coimbra, Portugal; | Environmental Management Laboratory, Mykolas Romeris University, Vilnius, Lithuania
Contact: Impinto@mac.com

The vulnerability of urban areas to pluvial floods has been increasing over the last decades due to urbanization and increasing soil sealing, and climate change, threatening lives and properties. Flood mitigation and regulation strategies have been mainly based on grey infrastructures. However, these structures have a limited lifetime and capacity and cause high environmental degradation. Nature-Based Solutions (NBS), engineered green/ecological systems, can be an environmentally friendly option to reduce flood hazards. Green and Blue infrastructures (GBI), with their natural and semi-natural areas providing a wide range of ecosystem services, are at the very heart of the NBS approach. GBI can enhance water retention, infiltration, and evapotranspiration through greening, reducing runoff and flood hazards. This research investigates the impact of a GBI constructed for local flood regulation in the city of Coimbra, Portugal. The GBI under analysis is an urban park comprising a pond working as part of a retention basin, apart from other green spaces (e.g. grassland and tree cover) and cultural elements. The effectiveness of the implemented solution was assessed through the Curve Number method, used to estimate the runoff within the urban catchment for different return periods, based on the Intensity–Duration–Frequency precipitation curves. The results showed that the implemented NBS can retain runoff driven by a 20-years flood. A decrease is achieved in the peak discharge and flood hazard in downslope urban areas, often affected by floods prior to this urbanization project. Furthermore, the green and blue elements of the NBS provide additional ecosystem services relevant to human wellbeing in urban areas. Findings can support NBS implementation and knowledge on their effectiveness to mitigate flood hazards and adapt to climate change, relevant to enhance urban resilience.

Keywords: nature-based solutions, ecosystem services, urban green and blue nfrastructures, runoff management, pluvial flood

6. Type of submission: Abstract

[B. Biome Working Group sessions: B2 – Planning and implementing Nature-based Solutions for water management at different scales](#)

Intangible damages of combined sewer overflows spills in recreational services of coastal urban areas



First author: María Guerrero–Hidalga

Other author(s): Eduardo Martinez–Gomariz

Affiliation: CETAQUA, Spain

Contact: maria.guerrero@cetaqua.com

Combined sewer systems are drainage structures designed to collect both wastewater and rainfall runoff and take them to the wastewater treatment plants (WWTP). During rainfall events, the increase in the volume flow makes the system exceed its maximum capacity and part of the combined flow is discharged to a water body. These events are known as combined sewer overflow (CSO). Although they avoid flooding in cities and congestion of the WWTP, they cause pollution in rivers and seas, causing damage to the ecosystem and to the services they provide. However, these events are mostly unknown to the general public, which can be directly affected in the case of swimming in polluted bathing waters, and indirectly by harming the ecosystems they live in. In the context of the project RESCCUE (H2020), several damages were assessed and compared under different adaptation scenarios. In Barcelona's case study, intangible damages caused by CSO spills were estimated, in terms of the lost value of the recreational services provided by two coastal urban areas– Barcelona and nearby Badalona. To do so, surveys were carried out about the perception of local beach users and personal interviews to coastal business owners related to the CSO spills and the related health risks. Additional publicly available data was used to elicit the economic value, including the distribution of GDP neighbourhood and economic sector and the hydrological and temporal distribution of the CSO spills in the study areas. The results supported the economic estimation of these intangible damages and exposed different levels of awareness, to be considered by the local authorities.

Keywords: CSO, urban areas, damage assessment, recreational services

7. Type of submission: Abstract

B. Biome Working Group sessions: B2 – Planning and implementing Nature–based Solutions for water management at different scales

Upscaling nature–based solutions and assessing cumulative benefits for stormwater management in the city of Las Palmas de Gran Canarias

First author: Maria Susana Orta–Ortiz

Other author(s): Davide Geneletti



Affiliation: University of Trento, Italy

Contact: maria.ortaortiz@unitn.it

Stormwater management in cities aims to reduce the flood risk that derives from increasing urbanization and climate change. Such risk can be managed for individual parts of the urban drainage network and for the whole urban watershed. Upscaling nature-based solutions (NbS) can be a strategy to address this challenge at the needed scale. This requires, among other things, the replicability and gradual spread of solutions from local (e.g., several urban blocks) to broader planning scales (e.g., neighborhood and city), as well as the identification of the best options for their siting. This research aims to assess the effects of scales and location on the runoff mitigation potential. To this purpose, we designed several upscaling scenarios for the case study of Las Palmas de Gran Canarias, that differ in terms of NbS type, scales and approaches to determine their location (e.g., by considering existing demand for ecosystem services). For each scenario, we simulated peak flow and runoff volume reduction rates, and the impact on the urban drainage system through GIS-based models. The outcomes reveal which NbS have the greater improvement in terms of runoff mitigation against the demand, and how much locating approaches contribute to it. By using our results, we suggest suitable levels of upscaling for the different NbS and discuss the key elements that should be considered to design effective upscaling strategies.

Keywords: stormwater management, runoff mitigation, nature-based solutions, upscaling

8. Type of submission: Abstract

B. Biome Working Group sessions: B2 – Planning and implementing Nature-based Solutions for water management at different scales

The role of green infrastructure towards water security – chasing legitimacy in a changing urban environment

First author: Busani Masiri

Affiliation: IIE MSA, South Africa

Contact: busani.masiri@gmail.com

Green infrastructure contributes to human well-being through the provision of ecosystem services with utility value such as stormwater management, and water filtration. It has emerged as a way of responding to emerging issues of climate change and deteriorating water quality



in river basins. Green infrastructure is an interconnected network of green space that conserves natural ecosystem values and functions and provides associated benefits to human populations. Thus green infrastructure has been framed from an anthropocentrism point of view that emphasises the dependence of humans on ecological resources. As such the relative advantage that the intended beneficiaries perceive green infrastructure to have matters. This paper analysed the current water- and environment-related legislation in South Africa. In addition policy and strategy documents such as the National Water Resources Strategy, the National Water and Sanitation Master Plan were analysed to ascertain the strategies to be adopted towards water quality management. A deductive qualitative content analysis was used to analyse these documents. The aim of the analysis was to examine if there are any ecosystem services that are prioritised by current policies and if this has any bearing on green infrastructure-related strategies. The analysis showed that current policies, whilst there's an appreciation of the role of the 'best available science' in responding to water quality challenges, there's no specific mention of green infrastructure. This is despite the availability of scientific data and the need to improve service delivery in certain communities. As such there's a need to understand why certain infrastructure is favoured. The reason why people express a preference for specific infrastructure and wish to protect the benefits they draw from it varies. As such this preference (or lack thereof) can lead to the success or failure of a policy or at least a part of it.

Keywords: green infrastructure, water security

9. Type of submission: Abstract

B. Biome Working Group sessions: B2 – Planning and implementing Nature-based Solutions for water management at different scales

Nature-Based Solutions for Sustainable Water management in the Peri-Urban: Towards a better understanding of opportunities and constraints in Stockholm County, Sweden

First author: Nandita Singh

Other author(s): Lina Suleiman

Affiliation: School of Natural Sciences, Technology and Environmental Studies, Södertörn University, Stockholm, Sweden

Contact: nandita.singh@sh.se



Nature-based solutions (NBS) are increasingly reckoned as viable solutions to address water related societal challenges and as a sustainable strategic approach to manage water in terms of quality, quantity and flow. NATWIP, an EU-Cooperation Water-JPI Project, within which this abstract is produced, aims to contribute to closing the water cycle gap by exploring these questions in the peri-urban context, being transitional zones in the process of increasing urbanization. An assessment framework has been developed in NATWIP as a tool to analyze the contextual factors and driving forces, governance processes and the sustainability criteria of NBS projects in the peri-urban context of 6 countries in Europe and outside. This presentation will focus on the findings from two case studies conducted in Stockholm County, Sweden that apply varied types of NBS interventions at different scales and to deal with different water challenges. The first case explores NBS application at decentralized scale as a means for improving wastewater treatment and management in Stockholm Archipelago and its environmental impact on the Baltic Sea, where many of the summerhouses lie outside the municipal network. The second case addresses various water pressures including climate change impacts and flooding at the sub-urban scale with the aim of planning an urban district that integrate spatially ambitious NBS in the form of blue-green structures for multifunctional urban spaces and improving ecosystem services. The findings of the case studies will be presented to draw parallels and contrasts regarding their contexts, and the processes and socioeconomic and environmental benefits concerning NBS and to conclude on general lessons regarding opportunities and constraints for sustainable up-taking of NBS measures.

Keywords: nature-based solutions, sustainable water management, peri-Urban, institutional opportunities and constraints, Stockholm

10. Type of submission: Abstract

B. Biome Working Group sessions: B2 – Planning and implementing Nature-based Solutions for water management at different scales

A model-based dialogue between design, science and stakeholders for the design of sustainable and resilient cities

First author: Nicolas Salliou

Other author(s): Adrienne Grêt-Regamey

Affiliation: ETH Zürich, IRL, PLUS (Planning of Landscape and Urban Systems), Switzerland

Contact: nsalliou@ethz.ch



Cities around the world face significant challenges as they must transform towards sustainability while remaining resilient. Cities are being continuously shaped by dynamic and complex interactions between natural and socio-cultural factors. Landscape planning and design, as both collective and creative processes and products of shaping the landscape, need thus to tackle this dynamic to provide societally valued and needed qualities within the environmental and the social constraints of the complex systems. Technological achievements in data acquisition and processing, as well as simulating and visualizing landscapes have invited new ways to plan and design landscapes. They foster iterative feedback loops between data obtained from the environment and the process of designing and planning. While linking outputs from scientists or engineers with designers is not new, this approach entered the urban ecological community, showing effective transformative model that iteratively links urban design and ecology and fostering an inclusive, creative, knowledge-to-action process; especially when embedded in a civic discourse. However, workflows are usually conducted independently, only exchanging their products in the implementation phase. Coping with uncertainties to ensure the delivery of essential services demanded by the next generations requires however a continuous, inter- and transdisciplinary dialogue along the workflow. In this contribution, we present a roadmap for such a dialogue highlighting important interactions in the main steps of the planning and design process. We harness social-ecological modelling approaches as well as datasets, such as LiDar data, to support such dialogue. Finally, we build on real case studies of cities coping with flood risks while producing essential ecosystem thanks to blue-green infrastructures. The case studies cover science only, design only, discontinued and partial science-design dialogue cases. We close with suggesting some guiding principles for researchers and practice to design sustainable and resilient landscapes.

Keywords: dialogue, science-design loop, transformation

11. Type of submission: Abstract

B. Biome Working Group sessions: B2 – Planning and implementing Nature-based Solutions for water management at different scales

Mapping and assessing ecosystem services to plan and assess water management actions at different scales in Malta

First author: Mario Balzan

Affiliation: Institute of Applied Sciences, MCAST, Malta



Contact: mario.balzan@mcast.edu.mt

Recent research has called for a need to better demonstrate the benefits of the Water Framework Directive (WFD) implementation, e.g. through the ability to provide freshwater for irrigation, drinking, the avoidance of flooding or in the case of coastal waterbodies improved gene pool protection, provisioning ecosystem services (e.g. fisheries) and cultural ecosystem services. Whilst, it is generally agreed that the ecosystem services concepts provide a comprehensive framework for assessing the multifunctionality of aquatic ecosystems, and may also be used to evaluate impact of water management and restoration initiatives, the uptake of ES approaches in water management remains relatively low. This presentation provides an overview of recent and ongoing work mapping and assessing ecosystem services in the water bodies of the Maltese Islands, covering (a) specific water bodies and (b) at national scale for major water catchments within the study area. Through collaboration with national stakeholders, relevant ecosystem service indicators have been identified to assess the impacts of water management actions cover coastal, transitional and freshwater bodies. This suite of indicators was used to carry out a first ecosystem service assessment for these water bodies in Malta and may be used to assess the impact of water management actions on ecosystem service capacities and flows. At a national scale, ecosystem service assessments that combine the use of indicators and expert scoring approaches have been carried out to categorise water catchments based on their ecosystem condition and ecosystem service capacities and flows. The operationalisation of ecosystem service concepts for the management of water bodies in Malta is discussed, whilst key spatial patterns relating to the distribution of ecosystem services are presented.

Keywords: ecosystem condition, ecosystem capacity, ecosystem flow, nature-based solutions, Water Framework Directive

12. Type of submission: Abstract

B. Biome Working Group sessions: B2 – Planning and implementing Nature-based Solutions for water management at different scales

Dimensioning of riparian buffer zones in agricultural catchments at national level

First author: Evelyn Uemaa

Other author(s): Ain Kull, Kiira Mõisja, Hanna-Ingrid Nurm, Alexander Knoch



Affiliation: University of Tartu, Estonia

Contact: evelyn.uuemaa@ut.ee

Intensive agricultural production interferes with natural cycles of nutrients (mostly nitrogen and phosphorus) and may lead to water quality degradation due to excessive nutrient loadings. To mitigate this effect at landscape level establishment of buffering vegetated strips is an efficient measure. Recommending optimal widths for riparian buffer zones to reduce the agricultural runoff is still a challenging task, in particular when considering the spatial variability of the landscape. Empirical-based approaches include assessment of terrain, soil types, land use and vegetation, and are often realised in computationally expensive hydrological simulation. However, trade-offs have to be made between spatial resolution and areal extent. Another elegant empirical-based approach are nomographs, where via triangulation of a specific slope length, terrain slope and soil type recommended buffer width can be easily calculated. Mander and Kuusemets (1998) already developed such a nomograph for Estonian catchments in 1998, yet, a computational use case has not been explored. We implemented the nomograph as a GIS algorithm in Python/QGIS to retrieve the recommended buffer width at national level. We synthesized a specific slope length via a weighted average of flow length, local flow accumulation, and LS factor, and then use the specific slope length, slope derived from 5 m spatial resolution DEM and soil texture classes as inputs for the algorithm. We applied this algorithm and calculated recommendable buffer strip widths for the whole of country of Estonia, over an area of approx. 43,000 km². We evaluated the uncertainty of the results as well the algorithm's sensitivity to input weights. The developed algorithm is applicable in any region with relevant adjustments to local soil types. The result directly informs policy making by being able to more specifically decide and explain variations of buffer zone widths along water bodies.

Keywords: nature based solutions, geospatial analysis, planning

13. Type of submission: Abstract

B. Biome Working Group sessions: B2 – Planning and implementing Nature-based Solutions for water management at different scales

Evidence led nature-based solutions in the North West River Basin District: the Natural Course approach

First author: Mark Turner



Affiliation: Greater Manchester Combined Authority, United Kingdom

Contact: mark.turner@greatermanchester-ca.gov.uk

Natural Course is an EU LIFE Integrated Project aimed at accelerating progress towards the objectives of the EU Water Framework Directive and developing an integrated and sustainable approach to water management. The project covers the North West England River Basin District which includes rural catchments and urban areas. During the early phases of the project the beneficiaries developed an evidence base to understand how nature-based solutions can be used to deliver WFD objectives and wider ecosystem service benefits such as natural flood management and biodiversity uplift. Within the urban environment Natural Course has supported the delivery of sustainable drainage solutions at the individual property scale and planted SuDs-enabled street trees to provide a range of benefits. The project has enhanced small areas of urban green space to provide local flood risk mitigation along with other benefits such as public amenity and enhanced biodiversity. Natural Course has also been active in peri-urban areas through creating and monitoring a number of nature-based solutions that slow the flow of surface water in headwater catchments. These measures provide water quantity and quality benefits alongside enhanced biodiversity and reduced risk of upland fire. Meanwhile, at a catchment scale Natural Course is pioneering an approach to financing nature-based solutions to flood risk in the catchment of the River Wyre that will enable the full range of ecosystem services to be understood and promoted to various purchasers. A catchment plan has also been developed for the Northern Meres of Cheshire to understand how water quality can be improved alongside other benefits. In the final phase of the project, Natural Course will continue to understand and explore the barriers to the wider implementation of nature-based solutions such as governance and the difficulties in changing and modifying land use and management approaches.

Keywords: integration, multi-benefits, biodiversity, evidence, barriers

14. Type of submission: Abstract

B. Biome Working Group sessions: B2 – Planning and implementing Nature-based Solutions for water management at different scales

The use of a multi-scale Topographic Position Index for the identification of upstream depressional wetlands

First author: Annelies Broeckx



Other author(s): Jan Staes, Patrick Meire

Affiliation: Ecosystem Management Research Group, Department of Biology, University of Antwerp (Belgium), Belgium

Contact: annelies.broeckx@uantwerpen.be

There is growing evidence that upstream depressional wetlands (UDWs) may play a disproportionately important role in regulating hydrology. The UDWs themselves are characterised by strong fluctuations in water levels as they are dependent on local water flows. However, most of these UDWs have disappeared by infilling and/or drainage. Yet their restoration may be an adequate response to more extreme weather patterns, leading to floods and droughts. Restoring many of these small-scale UDWs enhances the infiltration and retention capacity. Such storage allows to make better use of precipitation excess to bridge future drought periods. Nevertheless, these UDWs are not included in many wetland inventories due to their small size and because most of them were reclaimed many centuries ago. This study investigates the Topographic Position Index (TPI), a relative topographic index based on a high resolution Digital Elevation Model (DEM), to identify UDWs. When applied at multiple spatial scales on a pre-processed DEM, the TPI is a performant method to identify former UDWs. In order to evaluate its effectiveness, we compare this DEM-based method to a soil-based wetland map for the Nete catchment in Belgium using Partial Least Squares Discriminant Analysis (PLS-DA). A misclassification rate of 35% was found which corresponds with our hypothesis, as we expect that small UDWs are represented to a lesser extent on the wetland map. The results showed that the TPI on a meso scale (up to 1 km) – revealing small UDWs – contributed less in the comparison with the soil-based map due to higher resolution of the TPI maps. This study demonstrates the relevance of TPI which is able to identify certain types of wetlands (strictly groundwater dependent, but mostly temporary wetlands). This highly transferable approach can be applied to other areas with mild topographical variation and presence of sandy (sub)soils.

Keywords: topographic position index, digital elevation model depressional wetlands, ecosystem-based adaptation

15. Type of submission: Abstract

B. Biome Working Group sessions: B2 – Planning and implementing Nature-based Solutions for water management at different scales



Nature based solution for water management in salinity affected coastal belt of Bangladesh

First author: Muhammad Abdur Rahaman

Affiliation: Center for People; Environ (CPE)

Contact: rana.bries@gmail.com

Nature-based solutions (NBS) can be promoted as alternative responses to solve complex challenges of watershed management delivering a systemic approach of multiple benefits for well-being, human health, and sustainable use of water in salinity affected areas. To study was conducted in salinity affected south-west coastal districts of Bangladesh in where drinking, domestic and irrigation water scarcity is alarming. To conduct the study, multidisciplinary approach was deployed through household investigation, data validation using focus group discussion, key informants interview and case story collection and also analyzing scientific articles and reports produced by government and non-government organizations. From the insights of the analysis, this paper explored a list of nature based solutions which are effective for water management in the salinity affected coastal areas of Bangladesh. This study presents a detailed analysis of each aspect.

Keywords: nature based solution, salinity, coastal belt, water scarcity, Bangladesh

16. Type of submission: Abstract

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Total economic valuation of Ecosystem Services of the Sudd Wetland for green infrastructure planning and development

First author: Jemal Ahmed Tadesse

Other author(s): Mulatu Dawit Wubshet

Affiliation: Addis Ababa University, Ethiopia

Contact: jemu122@gmail.com

The Sudd Wetland, one of the world's largest wetlands, is one of the Nile wetlands ecosystems located in South Sudan and recognized under the Ramsar Convention as a Wetland of



International Importance. Numerous economic valuation studies of wetlands around the world have been carried out; however, most of these studies have focused on wetlands in developed countries and wetlands in Africa in general and that of South Sudan are underrepresented. This study is hence motivated by lack of such studies in South Sudan in particular. Conducting economic valuation ecosystem services of the Sudd wetland to inform green infrastructure planning and development in the face of in-situ and ex-situ development interventions is vital for better understanding of sustainable wetlands management in Nile Basin. To this end, market price approach and adjusted unit value transfer approaches were applied. The Land Use Land Cover (LULC) map of the wetland shows that the wetland covers about 32 thousand square km. Different stakeholders have been identified at different scales. The global (external) stakeholders play vital role in providing funding for the protection and conservation of different natural and environmental resources, capacity building initiatives, and conducting different studies. The national level stakeholders focus on broader contexts such as formulating policies, regulations, project design and budget approval while the state and local level stakeholders mobilize and organize local communities for conservation of the wetland. The total economic value (TEV) of the wetland amounted at about USD 3.3 billion annually. Regulating services account for 55%, biodiversity services for 37%, and provisioning services for 8% of the TEV while the cultural services account for less than 1 percent. The wise utilization and management of the wetland and the green development path are proposed instead of the status quo situation for the wetland.

Keywords: total economic value, value transfer, biodiversity services, wise use, green development

17. Type of submission: Abstract

B. Biome Working Group sessions: B2 – Planning and implementing Nature-based Solutions for water management at different scales

Green infrastructure planning as a tool for operationalizing ecological solidarity for rural–urban cohesion

First author: Ivo Vinogradovs

Other author(s): Anita Zariņa, Kristina Veidemane, Anda Ruskule

Affiliation: University of Latvia, Latvia

Contact: ivo.vinogradovs@lu.lv



Spatiality specific to ecosystem services could be expressed as providing, benefitting and connecting areas. Such spatiality plays a particular importance in operationalizing ecosystem services assessment for planning and management issues considering rural–urban interactions at regional (river basin) scale. The study focuses upon the rural–urban green infrastructure network and socio–ecological relations between lowland urban centre and its surrounding agro–industrial areas. The questions regarding these interactions are: how can semi–natural ecosystems and services they provide contribute to the well–being of urban dwellers; how different stakeholders perceive and respond to the identified trade–offs in urban development; how stakeholders assess the role of green infrastructure in solving urban challenges in lowland river landscapes? The theoretical framework to address these issues evolves around the concept of ecological solidarity, which can be used as a conceptual tool to link rural–urban divide and to combine sustainable development goals and adaptive land–use management. First, we highlight the interdependencies of flows of ecosystem services between service providing and benefitting areas in rural and urban environment. Through the concept of ecological solidarity we embed rural–urban cohesion in the perspective of green infrastructure as connecting area. Such concept forwards the notion of responsibility of governmental institutions, companies and individuals in sustainable environmental stewardship. Further, we discuss trade–offs and synergies between socio–ecological benefits and planning actions in the context of results of the project ‘Enhancement of Green Infrastructure in the Landscape of Lowland Rivers’. We argue that human–environmental sustainability in the ‘Anthropocene’ of 21st century can be achieved solely through the recognition of interdependence of socio–ecological dynamic and spatiality at state’s, municipal and individual level.

Keywords: green infrastructure, flood control, ecological solidarity, lowland river landscape