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I. SESSION DESCRIPTION

ID: 07

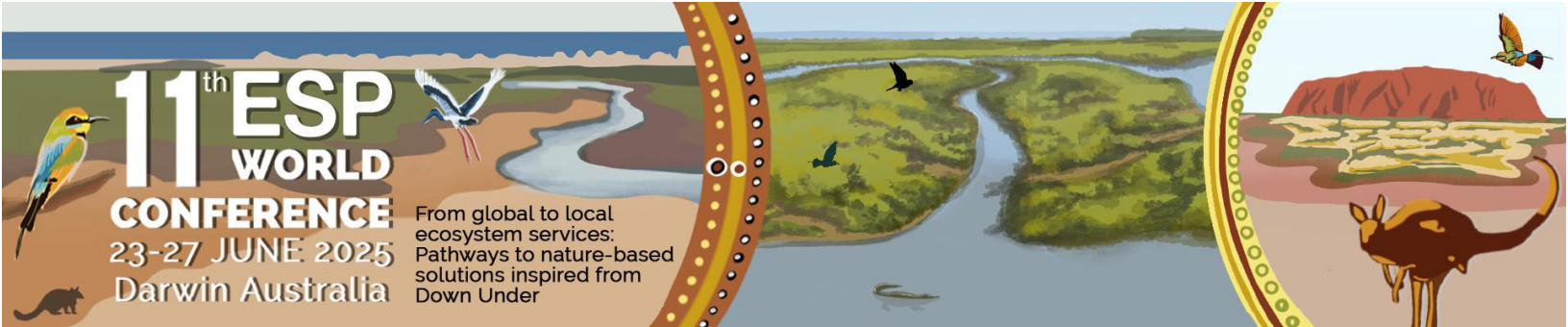
Adaptive solutions to enhance positive synergies between forest and water ecosystems

	Name	Organisation	E-mail
Host:	Zane Lībiete	Latvian State Forest Research Institute 'Silava'	zane.libiete@silava.lv
Co-host(s):	Juris Zariņš	Riga Forests Ltd.	juris.zarins@rigasmezi.lv
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Abstract:

Freshwater is vital for human wellbeing, and important for delivery of a wide range of ecosystem services, including drinking water, livelihoods, habitats, recreation opportunities and cultural significance. In forested catchments, the continuous interplay between aquatic and terrestrial environment is complex and specific. Watercourses have a profound impact on nutrient supply and erosion processes in the riparian zone, moreover, they play an important role in the dispersal of terrestrial and aquatic organisms, including invasive species. Riparian forests protect the watercourses from pollution, decrease erosion risks and support diverse structures important for biodiversity, such as trees with microhabitats, groundwater discharge areas and dead wood for terrestrial and aquatic organisms.

Aspects of the global change, such as climate warming, pollution, and biodiversity decline alter both forest and water ecosystems, as well as the complex relationships between the two. Warmer temperatures and changing precipitation patterns leading to more extreme draughts and flooding affects the dynamics of natural disturbances in the riparian forests. Changes in water level fluctuation and thus soil moisture due to prolonged flooding and flooding-drying conditions can additionally affect the magnitude of greenhouse gas fluxes in riparian zones.



Severe windthrows, insect outbreaks and invasions of alien species substantially affect the natural dynamics of the riparian zones, affecting the capacity of the forests to ensure wide variety of ecosystem services. Also, with the altered disturbances, as well as presence of aggressive invasive species the protective functions of the riparian forest can be weakened, affecting waters. Tailored management solutions are essential to prevent and/or mitigate such negative outcomes.

Adaptive management and nature-based solutions (NbS) are increasingly recognized as effective strategies for addressing environmental challenges while providing multiple co-benefits. Recent research highlights the importance of integrating these approaches in forest and water ecosystem management to enhance resilience, biodiversity, and ecosystem services. For instance, NbS such as ecological forest management and wetland restoration have been shown to improve water quality, sequester carbon, and support biodiversity, thus contributing to achieving sustainable development goals and climate resilience. Case studies from various regions demonstrate the practical benefits and scalability of these solutions.

By focusing on the interconnectedness of forest and water environments, the session aims to highlight the multifaceted benefits of sustainable management practices. Key areas of discussion will include:

- Innovative practices in forest management that enhance ecosystem services.
- Nature-based solutions specifically aimed at improving water quality and other ecosystem services in forested catchments.
- Case studies and examples of good practices.
- Policy frameworks and community engagement strategies that support these integrated approaches.

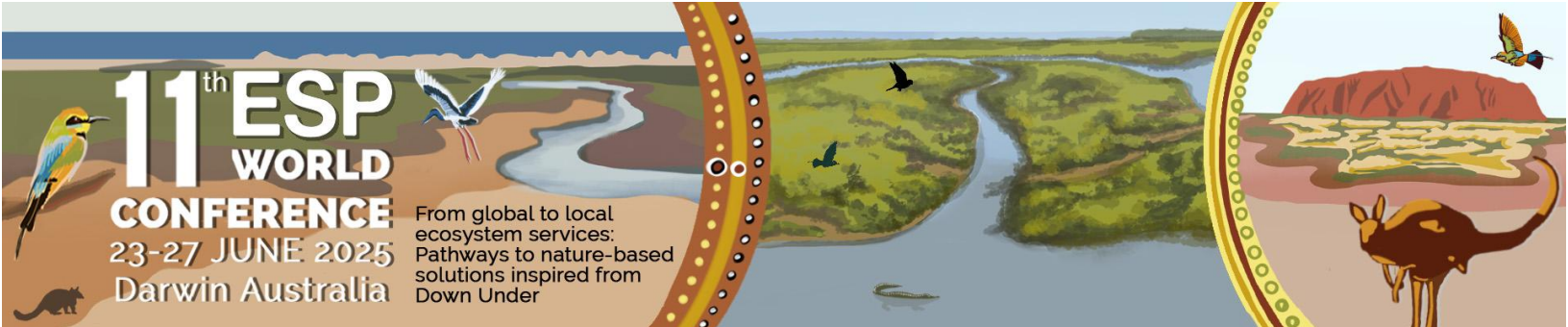
We welcome presentations mainly from temperate and boreal forests of the Northern hemisphere, including boreal and hemi-boreal regions, as well as from temperate forests of the Southern hemisphere showcasing planning approaches and good practice examples of adaptive management solutions in forested river catchments. While our focus is primarily on forest land, topics pertaining to different tree-dominated ecosystems (e.g., tree plantations in riparian zones established or managed to safeguard and increase ecosystem services) will also be considered.

Goals and objectives of the session:

This session will delve into the innovative integration of adaptive management strategies and nature-based solutions to enhance ecosystem services within forest and water ecosystems.

Aims of the session:

- To explore and share innovative forest management practices that contribute to ecosystem services.
- To discuss the implementation and benefits of nature-based solutions for water quality improvement in forested areas.



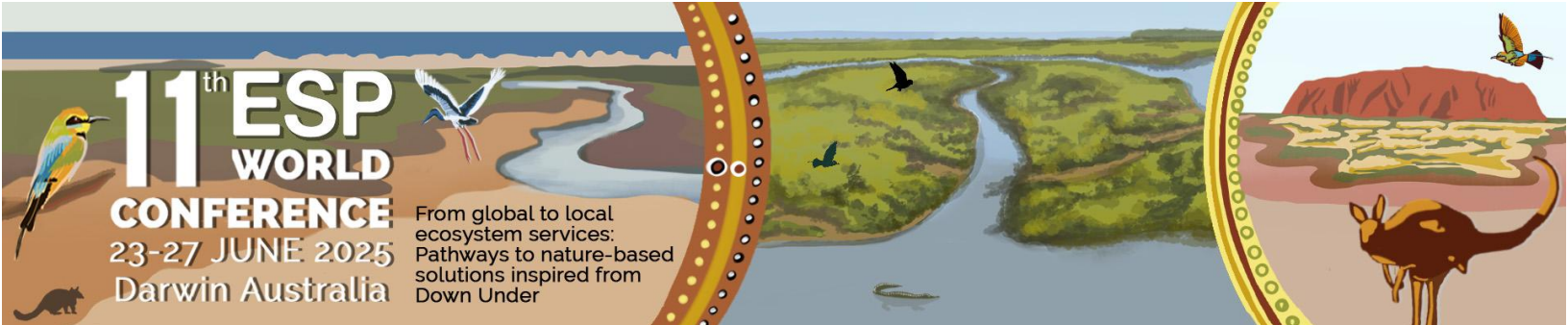
- To present successful case studies, providing practical insights and lessons learned.
- To identify general preconditions for successful NbS implementation in forest–water nexus.
- To identify effective policy frameworks and community engagement strategies that support the adoption of nature–based solutions.

Planned output / Deliverables:

Outcomes of the session:

- Enhanced understanding of the interconnectedness between forest and water ecosystems.
- Shared knowledge on implementing nature–based solutions to improve ecosystem services in these environments.
- Increased awareness of successful case studies and best practices from around the world.
- Networking opportunities for researchers, practitioners, and policymakers to collaborate on future projects.
- A session report summarizing the main presented findings and examples and including a set of defined preconditions for successful implementation of NbS.
- Depending on the topics of the submitted abstracts – a review paper on exploring and exploiting the forest–water synergies when planning and implementing NbS.

II. SESSION PROGRAM



Room: Bundirrik 4

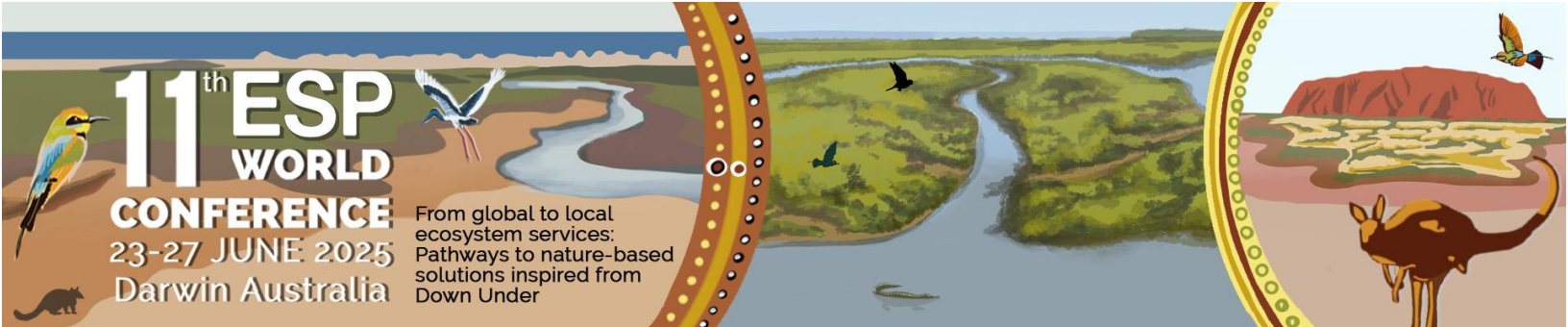
Date of session: 26.06.2025

Time of session: 10:30–12:30

Timetable speakers:

Time	First name	Surname	Organization	Title of presentation
10:30–10:40	Zane	Lībiete	Latvian State Forest Research Institute “Silava”	Introduction
10:40–10:50	Arta	Bārdule	Latvian State Forest Research Institute “Silava”	Management of riparian hemiboreal forests towards good water quality status: the case of Latvia
10:50–11:00	Rafael	Bohn Reckziegel	RIEL Charles Darwin University	Tree structure and water use as a joint pathway towards refined water budgets
11:00–11:10	Zane	Lībiete	Latvian State Forest Research Institute “Silava”	Short-term effects on water quality of green and blue infrastructure establishment in riparian forest in Latvia
11:10–11:20	Malgorzata	Blicharska	Uppsala University	Enhancing the Role of Wetlands and Ponds in Regional Ecological Restoration: Overcoming Barriers to Implementation
11:20–11:30	Valters	Samariks	Latvian State Forest Research Institute “Silava”	Carbon-related ecosystem service evaluation of riparian forests using forest inventory data
11:30–11:40	Māra	Kitenberga	Latvian State Forest Research Institute “Silava”	The willingness of the local community to support the management for the improvement of the quality of the riparian zone in the North-East of Latvia
11:40–12:30	Arta	Bārdule	Latvian State Forest Research Institute “Silava”	Discussion

III. LIST OF ABSTRACTS



The first author is the presenting author unless indicated otherwise.

1. Management of riparian hemiboreal forests towards good water quality status: the case of Latvia

First author(s): Arta Bārdule

Other author(s): Toms Artūrs Štāls, Linda Fībiga, Zane Lībiere

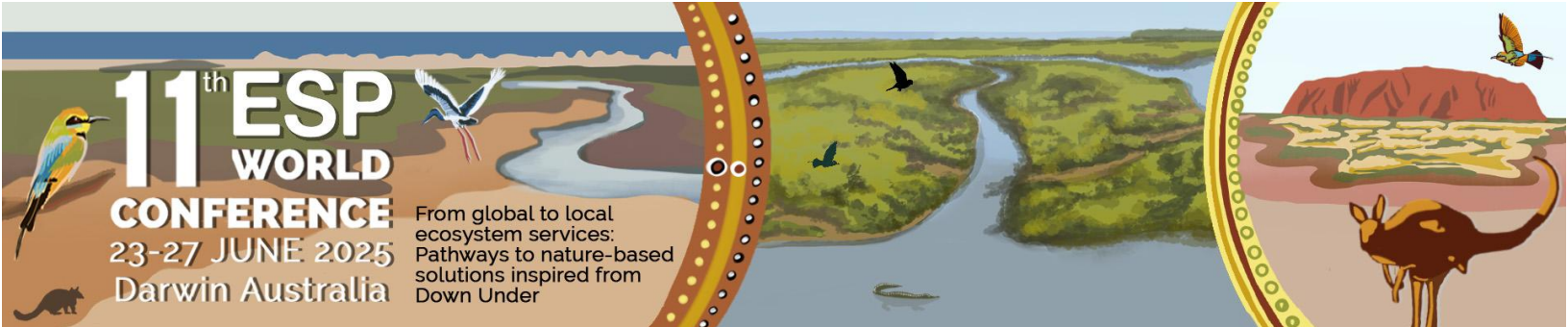
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Keywords: forest ecosystems, riparian forest, hemiboreal region, watercourses, water quality

In hemiboreal region of Europe including Latvia, total country area is fragmented into relatively small units of different land use (forest land, cropland, grassland, wetlands, settlements). In Latvia, forests cover slightly more than half (~53%) of the country's total area. There are ~12500 rivers, streams and large ditches. The total length of rivers is ~ 37500 km, while including ditches, the total length of the hydrographic network exceeds 100000 km. Consequently, a significant share of watercourses flow through forest ecosystems and, thus, forest management practices can alter surface water quality. So far, a number of studies have been conducted with the aim of finding the most efficient solutions for improving water quality in both artificial watercourses (drainage ditches) and natural rivers and streams. Total suspended solids and nutrients (especially nitrates and phosphates) are the most emphasized water quality variables, due to eutrophication being a major water quality issue in the region. In addition, dissolved organic carbon is receiving relatively larger focus, as forests with drained and naturally wet organic soils are widespread in the region (forest with organic soils present ~23% from total forest area in Latvia). The main studied water quality protection and improvement measures so far in forest ecosystems in Latvia are sedimentation ponds, peak flow control structures and overland flow areas.

To improve the state of risk water objects in Latvia, a collaborative project "Implementation of River Basin Management Plans of Latvia towards good surface water status" (LIFE18 IPE/LV/000014, LIFE GOODWATER IP) was initiated in 2020. The project involves testing and



demonstrating the efficiency of targeted water protection in riparian forests in 186 km² ha river catchment. Targeted management of riparian forests includes structural improvement (tree species composition) of riparian forest and construction of sedimentation ponds and peak flow control structure, with continuous water quality monitoring.

2. Tree structure and water use as a joint pathway towards refined water budgets

First author(s): Rafael Bohn Reckziegel

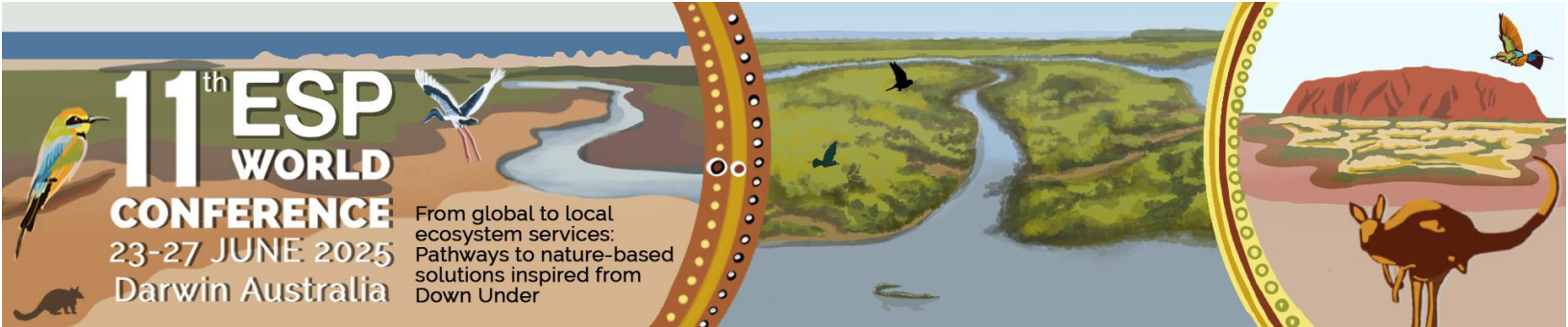
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Keywords: black box, transpiration, sap flow, LiDAR, QSMs

Trees are ecosystem engineers altering water resources availability through evapotranspiration, ground water recharge and microclimate regulation. These processes come along with the provisioning of a range of ecosystem services: flood control, water purification, biodiversity maintenance and habitat provision, carbon sequestration via tree growth and soil health improvement. In addition, the continuous interplay between the Earth's spheres is now challenged by climate change. Therefore, a better understanding of tree (as a functioning structure) and water interactions (availability and demand) can deliver insights that can be linked to the impacts of natural hazard events, a changing climate, plant form and density variations, and forest management. We present research efforts to quantify detailed tree structure using fine-scale remote sensing to assess the high-structural variability of semi-arid riverine woody vegetation as an outcome of their water use, measured through sap flow instruments. Research plots have been monitoring the system's water budget and transpiration of riverine *Eucalyptus largiflorens* (Black Box) woodlands at tree and stand scales for over half a decade, along the River Murray in the southern Murray-Darling Basin (Australia). Half hourly measurements of water loss are coupled with tree point clouds produced with terrestrial laser scanning (TLS; LiDAR) in a



sampling campaign in October 2024, capturing static measurements of the tree woody surface and enabling the retrieval of three-dimensional tree attributes (i.e. branch volumes) via geometrical modelling. Black box trees regenerate through epicormic growth after natural disturbances, thus presenting varied tree morphology and habit, with single stems to multi-stems trees. In opposition to foliage observations and resulting evapotranspiration, revealing the fine structural drivers of tree water use at individual level is a central initiative towards completing a more precise water budget for the whole tree population.

3. Short-term effects on water quality of green and blue infrastructure establishment in riparian forest in Latvia

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First author affiliation: Latvian State Forest Research Institute "Silava"

Other author(s): Arta Bārdule, Linda Fībiga, Linda Gerra-Inohosa

Presenting Author: Zane Lībiete

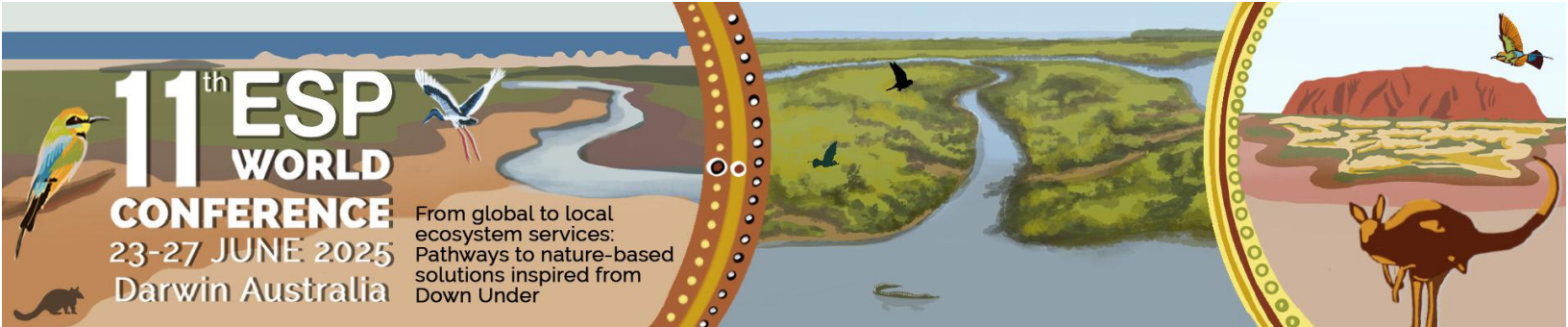
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Keywords: Water chemistry, nutrient retention, nature-based solutions, regulating ecosystem services, hemiboreal forests

In northern Europe, the 20th century forestry was oriented towards the provision of wood and timber resources. Site condition improvement included large-scale drainage and choice of relatively fast-growing tree species suitable for quality timber. Often pure conifer stands were established along waterbodies, resulting in reduced regulating, supporting and aesthetic functions of the riparian area.

Our study site comprises a 1.4 km long stretch of a previously straightened river with planted Norway spruce (*Picea abies* (L.) Karst.) and drainage ditches in the riparian zone. Green and blue



infrastructure measures were implemented in 2023/2024, including tree species' composition change along the river and construction of a peak flow control structure on a drainage ditch entering the stream. Physico-chemical water quality parameters were monitored before, during and after the implementation.

Tree felling was not reflected in all studied general water quality parameters. Stream water nitrate levels were slightly elevated, compared to the same period in the previous year, but the values were generally low. The concentrations of total suspended solids in the stream during the felling remained well below the quality threshold and lower than during the same period of the previous year.

The establishment works of the PFC structure may have temporarily raised the phosphate levels in the stream, but no impact on nitrates or TSS was observed. Shortly after the establishment, some positive impacts on water quality were detected. More explicit water quality improvement is expected due to the targeted riparian zone management aimed to facilitate the development of vegetation characteristic to broadleaved forest and the establishment of a water quality protection structure. These efforts will improve the ecological functions of the riparian buffer.

The study was supported by the project "Implementation of River Basin Management Plans of Latvia towards good surface water status" (LIFE GOODWATER IP, LIFE 18 IPE/LV/000014).

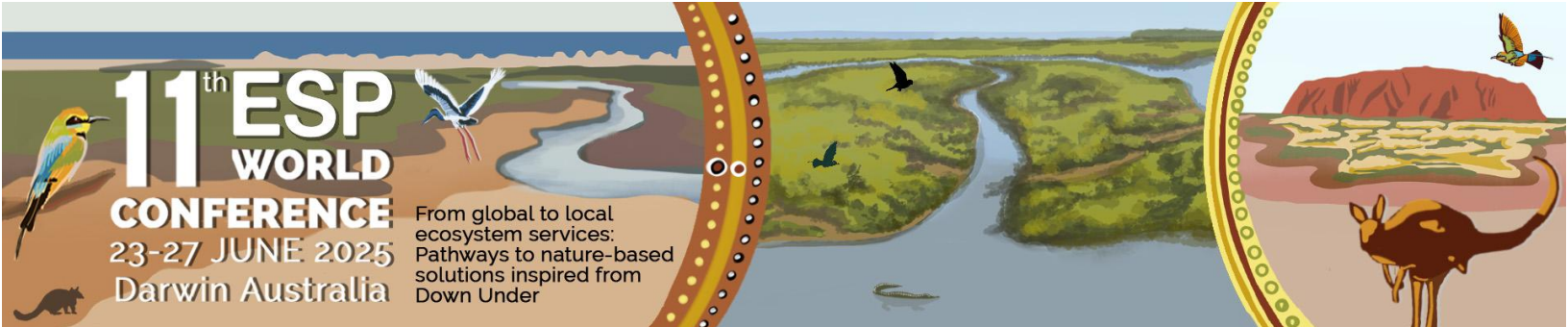
4. Enhancing the Role of Wetlands and Ponds in Regional Ecological Restoration: Overcoming Barriers to Implementation

First author(s): Malgorzata Blicharska

Other author(s): Nairomi Eriksson, Martyn Futter, Pia Geranmayeh

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Keywords: Nature-based Solutions, policy, ponds, wetlands

Urbanization and land-use changes increasingly threaten ecosystem services, exacerbating biodiversity loss and environmental degradation. Nature-based Solutions (NbS), such as wetlands and ponds, offer significant potential for ecological restoration, mitigating urban and regional environmental challenges by enhancing biodiversity, regulating water flows, and improving water quality. Despite their recognized benefits, the integration of these solutions into municipal and regional planning remains limited.

This study investigates institutional and practical challenges hindering the widespread implementation of wetlands and ponds in Sweden, focusing on their role in catchment-oriented landscape planning. Through interviews, stakeholder workshops, and a survey of catchment officers, we identify key barriers—including fragmented governance, regulatory inconsistencies, and capacity constraints—that limit their uptake. A document analysis further reveals gaps between policy objectives and on-the-ground implementation.

Our findings emphasize the need for improved policy coherence, multi-level governance, and institutional collaboration to enhance the effectiveness of wetlands and ponds in supporting biodiversity and ecosystem service delivery. We provide actionable recommendations to strengthen the role of NbS in regional ecological restoration and contribute to global sustainability efforts, aligning with the goals of the UN Decade on Ecosystem Restoration.

5. Carbon-related ecosystem service evaluation of riparian forests using forest inventory data

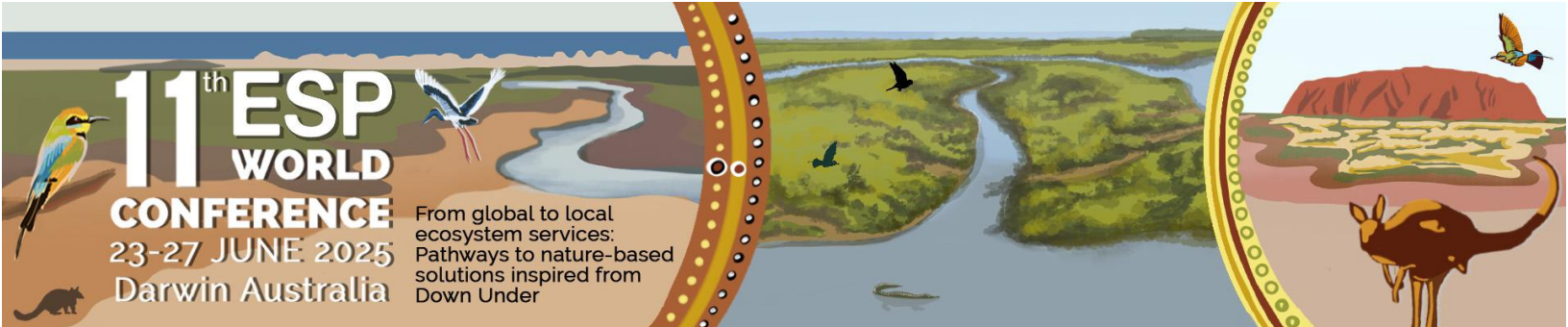
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Keywords: buffer zones, ecosystem quality, provisioning services, recreation, society needs



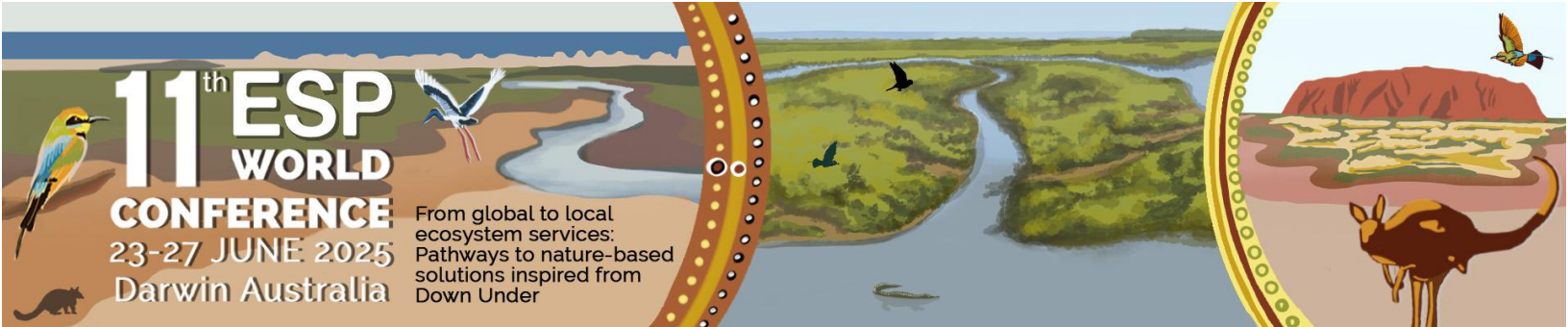
Riparian forests are protected unique ecosystems and society-favored nature areas for recreation. Provisioning ESs are diverse, however, this study focuses on timber and carbon storage-related services of riparian forests, to fill the knowledge gap of such areas. Increasing societal demands and nature conservation policies are pushing forest management towards a more inclusive approach. In Latvia, all rivers have a fixed-width buffer based on the length of river, small rivers have 0–10m, but larger 0–50 m, where forest management activities are prohibited. Quantitative assessment of the provisioning ecosystem services in protected riparian forest buffer zones could provide insight into the impact of protection regulations. In this study, we aim to compare the provision of different ES in the riparian forest protected buffer strips located adjacent to the stream (0–10; 0–50 m) with an ES distance of 51–200 m from the stream bank without protection.

The results indicate that most assessed ecosystem services (above- and below-ground C stock; C stock of timber assortments, and total growing stock) are higher in riparian forest adjacent zones compared to distant zones. Comparison between different adjacent zone distances from waterbodies indicates that evaluated provisioning ES values are increasing from 10 to 50m zone, but firewood amount is larger closer to waterbody (first 10 meters). The obtained results suggested that the current protection status of riparian forest buffer zones has facilitated the provision of several timber and carbon storage-related ecosystem services, however first 10m from waterbodies are more susceptible to disturbances.

Recognizing diverse ecosystem services helps forest managers adapt new methods, integrate ES into forest planning, enhance profitability and biodiversity, sustain the forest sector, and fulfill society's needs.

6. The willingness of the local community to support the management for the improvement of the quality of the riparian zone in the North-East of Latvia.

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Keywords: Riparian Zones, property rights, ecosystem services, willingness to pay

The conservation and management of riparian zones in protected areas is challenging due to the simultaneous demands of conservation regulations, the demands of active nature tourism and the needs of local communities. The willingness of the local community to contribute in the management of riparian zones is an essential contribution to the establishment of effective long-term riparian zone management. The aim of study was to gain an insight into the perceptions of the local community, particularly local landowners, on the management views of riparian zones in nature protection areas. We used a semi-structured questionnaire survey to gather data from four distinct localities (Vilkene, Liepupe, Limbazi, Salacgriva) within the North Vidzeme Biosphere Reserve (NVBR) in Latvia. In total, 734 respondents were interviewed, of which 40% were landowners who owned land in riparian zones. Landowners attitude did not differ significantly from those without property rights in their willingness to undertake voluntary work to improve the quality of riparian zones. Respondents with and without property rights were not in favour of private financial resources being used to improve riparian areas, but both groups were positive about volunteering. The provision of information to the local community on the benefits to the riparian areas of the volunteer work could have a positive impact on their future commitment and willingness to participate.