Learning needs for mainstreaming nature-based solutions in river systems

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ABSTRACT: This paper presents the outcomes of a learning needs assessment for upscaling and mainstreaming nature-based solutions in river systems. This study was undertaken as part of the EU Interreg NWE ResiRiver project (2023-2028) and provided insight in the Technology Readiness Levels and Societal Readiness Levels for nature-based solutions across The Netherlands, Germany, France, Belgium and Ireland. Furthermore, target audiences and learning needs were identified. The outcomes will be used to develop a learning platform and a tailor made training programme for the eleven organizations participating in ResiRiver and their direct partners in the process of implementing nature-based solutions in river systems.

1 INTRODUCTION

Nature-based solutions (NbSs) are increasingly being implemented in river systems to address, for example, flood risk, riverbed erosion, drought effects and water quality. Meanwhile they provide economic, social and/or environmental benefits. But despite the scientific evidence about the effectiveness of NbS in riverine systems management (e.g. Bridges et al. 2021), NbS implementation is hampered by a variety of systematic issues related to decision making, financing, managing, engineering and design, public participation, etcetera. As a result, NbSs have in most organisations not yet become standard practice (Bérczi-Siket et al., 2022).

The EU Interreg NWE project ResiRiver (Creating Resilient River Systems by Mainstreaming and Upscaling Nature-based Solutions, see https://resiriver.nweurope.eu/) therefore aims to accelerate the upscaling and mainstreaming of NbS through bridging the gap between practice, science, society and policy (Schielen et al, 2024). The project consists of a partnership between local, regional and national water management authorities, municipalities, NGO's in stakeholder engagement and universities and has a duration of five years from 2023 onwards. The project is centers around five pilot projects and five strategic studies (WP1) that are supported by a learning environment and tailor made training modules (WP2). Together, these feed into guidelines and policy briefs for upscaling and mainstreaming NbSs in river systems (WP3).

As part of ResiRiver WP2, this paper presents the outcomes of an assessment of the learning needs for mainstreaming NbSs in river systems. The outcomes will be used to develop a learning platform and a tailor made training programme for the eleven project partners across The Netherlands, Germany, France, Belgium and Ireland.

2 METHODOLOGY

Two steps were taken to identify the most important learning needs related to mainstreaming NbSs in river systems. Firstly, broad scoping of learning needs was done through a brief questionnaire that focused on target audience, target audience's learning needs, training materials,

intended use of learning platform and training modules. Responses were received from all project partners: authorities (n=6) and knowledge institutes (n=5). The results were discussed in an online workshop with partner representatives. Subsequently, a workshop with a broader group of professionals working for the project partner organisations and similar organisations was held during the project launch (n=45 participants) to identify the learning needs in more detail and link them to respectively Technology and Societal Readiness Levels (TRLs being a measurement for the maturity level of a particular technology; SRL being a measurement for how ready society at large is to accept a particular innovation). For the distinctive readiness levels, definitions of the EU (2014) and Innovation Fund Denmark (2018) were used (Table 1).

The combined outcomes were subsequently used to identify learning needs to effectively move up the 'stairways to mainstreaming' for NbSs in river systems in the participating countries. These insights will be used in the remainder of the project to develop tailor-made training materials.

Table 1. Definitions of Technology and Societal Readiness Levels

Level	Technology Readiness	Societal Readiness
9	Actual system proven in operational environment	Successful deployment in real stakeholder context
8	System complete and qualified	Final testing in real stakeholder context
7	System prototype demonstration in operational environment	Demonstrated in real stakeholder context
6	Technology demonstrated in relevant environment	Demonstrated in simulated stakeholder context
5	Technology validated in relevant environment	Validated in simulated stakeholder context
4	Technology validated in lab	Stakeholder context validated
3	Experimental proof of concept	Stakeholder context proof of concept
2	Technology concept formulated	Proposed solution in stakeholder context
1	Basic principles observed	Societal problem in stakeholder context

3 RESULTS: READINESS LEVELS FOR NBS

Respondents associated themselves with various pilots, revealing diverse pilot experiences. They provided insightful suggestions for advancing the project, such as the need for financial support, successful stories, public engagement, and effective communication strategies. In addition, they highlighted challenges, including financial constraints and the need for budgetary considerations, time constraints, and political support. Opportunities were identified in showcasing successful projects, providing scientific proof, and enhancing project visibility. Finally, respondents emphasized the importance of examples, proofs, political support, knowledge transfer, collaboration, trust-building, and societal involvement.

As shown in Table 2, an average TRL of 4,15 was scored. Most pilots were considered to have a TRL between 2-4. Exceptions were the Rhone and VNF channel restorations (average TRL around 8), which are actually part of the ResiRover project as evaluations to learn from past projects. Furthermore, an average SRL of 3,44 was scored, with most pilots receiving average SRL-scores between 1-3. Exceptions were again the Rhone and VNF channel restorations, as well as the Wantij tidal park. Here, the difference between Rhone and VNF channel restorations stands out, with average SRLs of respectively 9 and 3. For Wantij and Ballybay the average SRLs were larger than their TRLs, probably as a result of public engagement activities.

The results suggest that NbSs in rivers systems have on average slightly higher TRLs than SRLs, suggesting a technology push rather than a societal pull for most NbSs. However, differences between average TRL and SRL were small. Accordingly, respondents stressed the importance of maintaining a balance between TRL and SRL. A readiness level of 4 suggests that there is proof of concept, but that this is not yet validated in a real-life setting. Accordingly, suggestion of key factors to increase TRL/SRL included e.g.: increasing political will, realisation of real-life prototypes, storytelling and technical guidance.

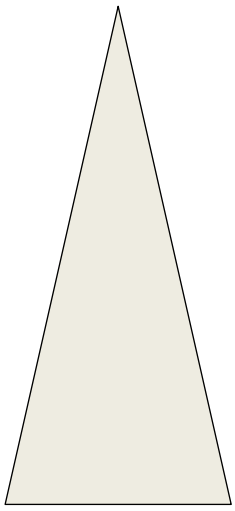
Table 2. Technology (TRL) and Societal Readiness Levels (SRL) for NbSs as indicated by project launch participants

Pilots (P) / Studies (S)	NbS type	Av. TRL	Av. SRL	Δ
Bunker Bay (DEU) - P	Natural riverbank protection	3,00	2,67	0,33
Lys (FRA) - P	Wetlands	2,86	1,33	1,53
Rhone (FRA) - S	Channel restoration	8,00	9,00	-1
Vesdre (FRA) - S	Natural flood management	2,00	N/A	N/A
VNF Channel restoration (FRA) - S	Channel restoration	8,33	3,00	5,33
Ballybay (IRL) - S	Natural flood management	2,50	3,00	-0,5
Rhine Meuse Estuary (NLD) - S	Ecosystem Analysis	2,00	1,00	1
Wantij (NLD) - P	Tidal park	4,00	4,67	-0,67
Gelderse Poort (NLD) – P	Sediment nourishment	3,00	2,00	1
Nourishment Meuse (NLD) - P	Sediment nourishment	2,00	2,00	0
Other	-	4,67	5,00	-0,33
Total average		**4,15**	**3,44**	**0,71**

4 RESULTS: LEARNING NEEDS FOR NBS

A variety of target audiences is identified within respondents' own organisations, organisations they need to collaborate with, educational organisations and the general public (Table 3). Respondents gave estimations of the group size and knowledge level of each target group.

Table 3. Target audiences and perceived knowledge levels

Target audiences	Group size	Perceived knowledge level
<u>Within organization</u> - Upper management - Corporate communication - Project organization - Corporate learning centers		Low – medium or Medium-strong
<u>Project partners organizations</u> - Practitioners, management and politicians in local, regional and national public agencies - Contractors - Consultancies		Low – medium or Medium-strong
<u>Education (engineering, environmental and planning)</u> - Researchers, lecturers - MSc students - BSc Students - Secondary education students		Low - medium
<u>General public</u>		Low

Learning needs within organizations encompass three key levels: technical, organizational, and strategic, each considered crucial for successful implementation and sustainability within NbS initiatives. Recognizing the diverse expertise and experience levels among target audiences, learning needs are segmented into general and advanced categories. General learning addresses foundational knowledge across technical, organizational, and strategic domains, fostering essential understanding for all involved in NbS projects. In contrast, advanced learning delves into specialized topics, offering advanced management and strategic insights tailored for experienced professionals and decision-makers, enhancing their ability to lead and innovate within NbS contexts.

At the technical level, reported general learning needs revolve around understanding the core definition of NbS, supplemented by informative posters and videos showcasing current NbS case

studies and their successes. In the advanced level, there is a deeper focus on the intricacies of design guidelines, materials utilized in NbS, and considerations regarding environmental impacts is called for. Additionally, respondents reported that this level should delve into asset management techniques, particularly emphasizing maintenance and monitoring practices. These advanced learning objectives are tailored for individuals directly engaged in NbS project implementation, necessitating a profound comprehension of technical aspects to ensure operational efficiency and environmental sustainability. Within the technical realm, expertise in design guidelines and recommendations is deemed fundamental for developing NbS solutions that are both effective and environmentally friendly. Leveraging insights from case studies enables practitioners to refine their strategies and mitigate potential challenges. Furthermore, a comprehensive understanding of the materials employed in NbS interventions is considered crucial to ensure longevity and minimize adverse environmental effects. Moreover, technical proficiency in asset management, especially in maintenance and monitoring, was called for by respondents to uphold the long-term efficacy of NbS projects and sustain their positive impact over time.

Reported organizational learning needs encompass various facets such as stakeholder engagements, project alliances, governance structures, and institutional asset management practices. This level of learning underscores the significance of collaboration, tailored project management for NbS, and the integration of diverse objectives into decision-making processes. Professionals at this level were considered to bear the responsibility of harmonizing organizational strategies with project objectives, embedding NbS principles into policy frameworks, and promoting adaptive management methodologies. In particular, effective stakeholder engagements and alliances within NbS projects are deemed crucial components of organizational learning needs. Professionals engaged in NbS-specific project management must navigate a spectrum of stakeholder interests to align project goals with overarching organizational objectives. Governance structures assume a pivotal role in ensuring accountability and transparency, while institutional asset management practices, ingrained within policy frameworks, facilitate adaptive management approaches adept at responding to evolving environmental conditions.

At the strategic level, reported learning needs encompass a range of areas including evaluation methodologies, identification and optimization of multiple benefits, financial considerations, and policy agenda shaping. Here, the emphasis shifts towards synthesizing diverse insights to inform strategic decision-making, with a focus on highlighting the broader societal impact and long-term sustainability of NbS initiatives. Individuals at this level are entrusted with evaluating the effectiveness of NbS interventions, exploring innovative financing mechanisms, and advocating for policy reforms that prioritize NbS within broader environmental agendas. This level of learning demands a nuanced understanding of financial management principles to effectively allocate resources and maximize impact. Additionally, shaping policy agendas to elevate the importance of NbS within wider environmental frameworks is considered crucial for fostering long-term sustainability and societal resilience.

5 RESULTS: TRAINING MATERIALS

Depending on the target audience, a range of learnings needs was identified corresponding to technical, organisational and strategic aspects of NbS implementation. In addition a wide range of training materials was called for, including technical and organisational training manuals (and synthesis thereof), modular lecture/training materials, field masterclasses, peer learning, videos, posters, brochures and many more. After discussing the findings that are presented in Sections 3 and 4 in two workshops, it is identified that the ResiRiver project partners and other target audiences would benefit from a range of training materials (Table 4).

In addition, a need for structuring available information regarding NbS was articulated to effectively navigate through the multitude of NbS guidelines, reports, media platforms and networks that are presently available. Specifically, involved project partners (practitioners) called for bringing together scientific evidence about the multiple benefits of NbS in order to enhance their case to the management of their respective organizations in favor of the implementation of NbSs instead of and/or in addition to traditional ‘grey’ engineering interventions.

Table 4. Recommended training materials and their audiences

Training materials	Target audience
1. Technical manuals including development, implementation and monitoring of NbS, including case studies of experiences, success and failure evaluation as well as environmental impact	Practitioners, students
2. Organizational manuals including decision making tools, multiple benefits and stakeholder involvement	Practitioners, students
3. Masterclasses and/or lectures including presentations on technical and organizational aspects, a good range of webinar series and interactive sessions with "easy to understand" documents	Practitioners, students
4. Hands-on excursions and onsite demonstrations which could include models, games, or complete training sessions	Practitioners, management, decision makers, students
5. Evaluation form or surveys which are interactive would help to define the level of knowledge of the participants and assess future training sessions	Practitioners, management, decision makers
6. Short informative videos relating to content of the technical manuals, a general international definition of NbS and awareness of environment and reason for NbS projects relating to case studies and success	Management, decision makers, students, general public
7. Other training materials which would be beneficial are physical posters to display within organization and to the general public and social media posts	General public

6 CONCLUDING DISCUSSION

The findings of this study seem to suggest that NbS adoption across North West Europe is predominantly the result of a technology push. Societal readiness, both from the general public as well as from involved institutions, mostly follows as NbS are implemented at a small scale. This notion also resonates in the body of literature about effective governance models for the adoption of NbS in general (e.g. Martin et al, 2021; Van der Jagt et al, 2023; Zingraff-Hamed et al, 2021) and for rivers specifically (Rijke et al, 2012; Van Herk et al, 2014).

Through systematic alignment of learning activities and learning materials with the learning needs of various target audiences across technological, organizational and strategic levels, it becomes probable that organizations can effectively build capacity, empowering individuals at all stages of their professional development to contribute meaningfully to NbS mainstreaming efforts. Within the scope of the ResiRiver project, we therefore aim to develop further insight into the alignment of learning activities and training materials for different TRLs and SRLs. This insight can then be used to develop effective learning programmes for mainstreaming NbSs in river systems.

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