Knowledge gaps database update

Methodology and results

WP3 Task 3.1.1

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Introduction

In 2021, NetworkNature first published a database on knowledge gaps around Nature-based Solutions (NbS), accessible on the NetworkNature online platform. This resource was created to compile knowledge needs on NbS, serving as a valuable tool for the NbS community to identify and address them. It played a key role in supporting the identification of core action areas in the development of the European Research and Innovation Roadmap on NbS to 2030.

In 2024, NetworkNature updated the database, using a more advanced screening methodology to better depict the moving landscape of NbS research needs. This report details the refined methodology employed for updating the database and provides a concise analysis of the key findings from this update.

Methodology

Knowledge gaps are defined by NetworkNature as pieces of knowledge, information or data that are missing or insufficient to allow the development or implementation of NbS at various scales. These gaps can exist in research, data, or the access to and/or implementation of existing knowledge. This work aims to collect and analyse knowledge needs from 2021 to 2024 and update the existing knowledge gaps and needs database.

1. Desk Study

A Desk Study was performed between February and June 2024 to review scientific, grey and institutional publications from January 2021 up to March 2024.

Scientific literature

The Web of Science (WoS) platform was used to identify relevant scientific articles from January 2021 to March 2024. To do so, a tailored query search was developed based on the keywords used in the initial database (see **Table 1**). The NbS-related keywords were specifically searched within titles, while a proximity search was applied to capture knowledge gaps or research needs terminologies within titles, abstracts or keywords. No geographic limitations were imposed on this search. The final query used was as follows:

***Box 1**. Search query*

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(TI=(("agro*ecological") OR ("agro*forestry") OR ("ecological engineering") OR ("ecological restoration") OR ("ecosystem-based adaptation") OR ("ecosystem-based disaster risk reduction") OR ("ecosystem-based management") OR ("ecosystem-based mitigation") OR ("green infrastructure") OR ("blue infrastructure") OR ("nature$based solutions") OR ("nbs") OR ("protected areas"))) AND (TS=((knowledge OR research) NEAR/3 (gap* OR need*)))
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The search yielded 172 scientific articles, from which 243 knowledge gaps were collected. It is important to note that only explicitly stated knowledge gaps were considered.

To enhance the comprehensiveness of the results, additional searches were conducted using Google Scholar and Google. These efforts identified nine additional articles not indexed in WoS, contributing a further 55 knowledge gaps.

Grey and institutional literature

The search engines Google Scholar and Google were used to identify relevant grey and institutional publications. Searches included terms related to "knowledge gaps" or "research needs" (including variations such as "lack of knowledge", "overlooked", and "understudied") and various terminologies associated with NbS (see **Table 1**). A total of 33 publications were selected, identifying 321 gaps in knowledge, data and implementation.

***Table 1**. Non-exhaustive list of NbS-related terms searched*

Agro-ecological approaches
Agroforestry
Ecological engineering
Ecological restoration
Ecosystem-based adaptation
Ecosystem-based disaster risk reduction
Ecosystem-based management
Ecosystem-based mitigation
Green and Blue Infrastructure
Nature-based Solutions
NbS
Protected areas

2. Categorisation

In total, 619 citations from both scientific and grey literature, as well as institutional publications, were categorised into 32 broad topics (see **Table 2**) and 11 types of approach. The approaches are adapted from the IUCN typology in Cohen-Shacham et al. (2016)[1] (see **Table 3**).

[1] Cohen-Shacham, E., Walters, G., Janzen, C. & Maginnis, S. Nature-based solutions to address global societal challenges. (IUCN International Union for Conservation of Nature, 2016).

Table 2: List of broad topics

Broad themes	Broad topics
NbS governance	Approaches and governance systems for implementation
	Planning and policy frameworks
	Protected area management
	Stakeholder engagement
NbS capacity building	Awareness and capacity building
	Communication
	Knowledge base
NbS technical design	Biodiversity benefits
	Business and private sector integration
	Direct and indirect benefits for climate mitigation and adaptation
	Impacts for health and well-being
	Interdisciplinary studies and methodologies
	NbS interaction at the landscape scale
	Negative impacts
	Performance and characteristics of plants
	Relationship between biodiversity, ecosystem functions and ecosystem services
	Risks from slow-onset events
	Social cohesion and environmental justice
	Socio-economic benefits
	Synergies and trade-offs between goals
	Technical references, design standards and guidelines

	Upscaling NbS
NbS evaluation	Cost/benefit evaluations
	Effectiveness across socio-ecological contexts
	Effectiveness compared to conventional approaches
	Effectiveness of hybrid solutions
	Effectiveness at different geographical scales
	Effectiveness at different time scales
	Impact assessment
	Methodologies and tools for systematic evaluation
	Monitoring tools
	Valuation tools
Non specific	Non specific

***Table 3**: List of broad approaches and approach types following an adaptation of the IUCN typology in Cohen-Shacham et al. 2016.*

Broad approaches	Types of approaches
Ecosystem restoration approaches	Ecological restoration
	Ecological engineering
Issue-specific ecosystem-related approaches	Ecosystem-based adaptation
	Ecosystem-based mitigation
	Ecosystem-based disaster risk reduction

Infrastructure-related approaches	Blue & Green infrastructure
Ecosystem-based management approaches	Ecosystem-based water management
	Ecosystem-based fisheries management
	Ecosystem-based forest management
	Ecosystem-based agricultural management
Ecosystem protection approaches	Area-based conservation approaches
Non specific	Non specific

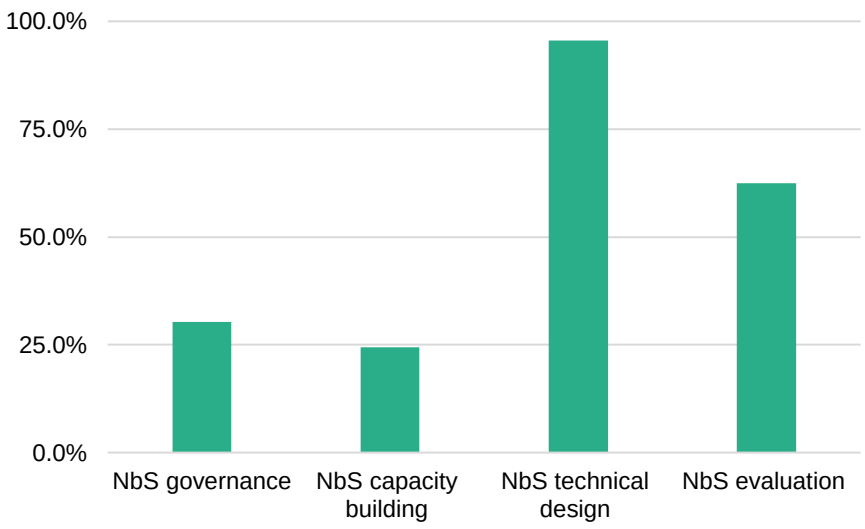
Analysis and results

1. Insights from the broad topic's classification

The analysis and categorisation of the identified gaps provide a more comprehensive overview of the current state of knowledge and areas requiring further data and research attention.

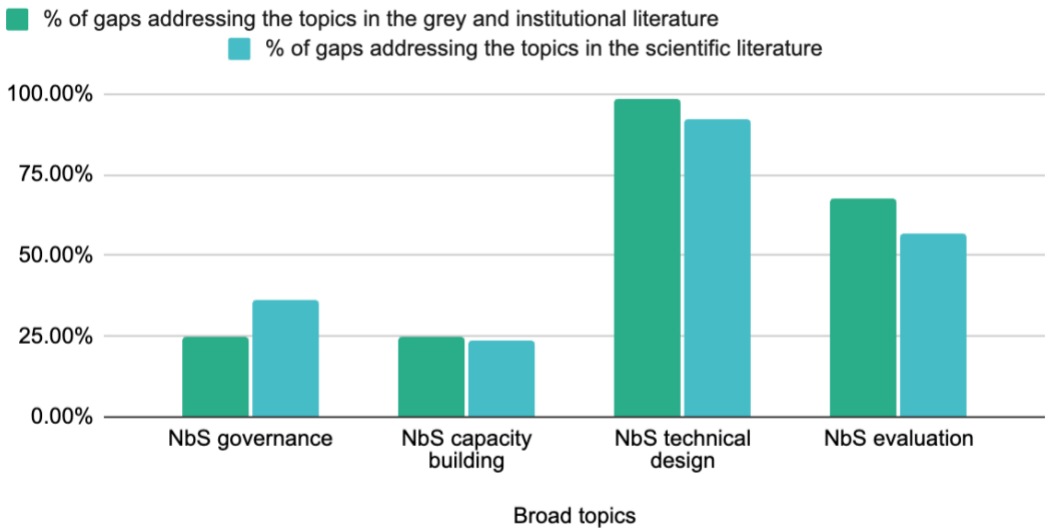
The four broad themes are addressed as follows by the identified knowledge gaps:

***Figure 1**: Percentages of broad topics addressed by the collected gaps (Sum > 100% as one gap could be categorised in multiple categories): NbS governance (30.4%, NbS technical design (95.5%), NbS capacity building (24.4%), Evaluation of NbS impacts (62.5%).*



The desk study identified significant knowledge gaps primarily in NbS technical design, followed by gaps in the evaluation of impacts of NbS, in governance and in capacity-building. This marks a shift from the 2021 analysis, which predominantly highlighted gaps related to NbS evaluation. The current study shows a clear move towards addressing NbS technical design, with 92.3% of gaps in scientific literature and 98.4% in grey literature focusing on this area, compared to 57% and 67.6%, respectively, centered on evaluation (see **Figure 2**).

Figure 2: Percentages of gaps addressing the broad topics across the literatures (Sum > 100% as one gap could be categorised in multiple categories)



Key findings on NbS technical design

The most significant knowledge gaps related to NbS technical design refer to technical references, design standards and guidelines, comprising 12.12% of all gaps identified. Other critical areas include the direct and indirect benefits of climate change and adaptation and the synergies and trade-offs between goals, for which gaps are often identified in grey and institutional publications. In contrast, knowledge gaps concerning potential negative impacts and the performance and characteristics of plants are less explored, making up 2.52% and 2.58% of all gaps identified, respectively.

Key findings on the evaluation of NbS impacts

The most recurrent topics of knowledge gaps under this section are linked to the evaluation of NbS impacts, including methodologies and tools for evaluation, covering 15.02% of all identified gaps, and impact assessment, which accounts for 10.99% of all identified gaps. While our findings highlight that knowledge gaps related to the methodologies and tools mainly originate from grey and institutional

publications, knowledge gaps related to impact assessment predominantly come from the scientific literature. In our findings, less attention seems to be given to knowledge gaps related to the effectiveness of NbS compared to conventional approaches (2.26%) and the effectiveness of hybrid solutions (2.42%). Moreover, our analysis shows that the evaluation gaps were more identified in the grey and institutional publications rather than in the scientific literature.

Key findings on NbS governance

The majority of knowledge gaps related to governance pertain to planning and policy frameworks and approaches and governance systems for implementation, respectively, comprised 10.02% and 10.82% of all collected gaps. In contrast, knowledge gaps on the topics of stakeholder engagement and protected area management are less often identified. Furthermore, it should be noted that governance gaps are notably more addressed in the scientific literature than in the grey or institutional publications.

Key findings on NbS capacity building

Finally, the recurrently cited knowledge gaps linked to NbS capacity building relate to the shortcomings in the NbS knowledge base, making up 14.38% of all gaps (e.g., lack of data, reliability, quality, accuracy, methodologies, etc.). Moreover, awareness and capacity-building topics are cited in 7.27% of the collected gaps, mainly coming from grey and institutional publications. Knowledge gaps in communication (e.g., lack of translation of terms across disciplines, need for systematic and integrative compilation of knowledge, etc.) are minimal, only referenced by 2.75% of the gaps.

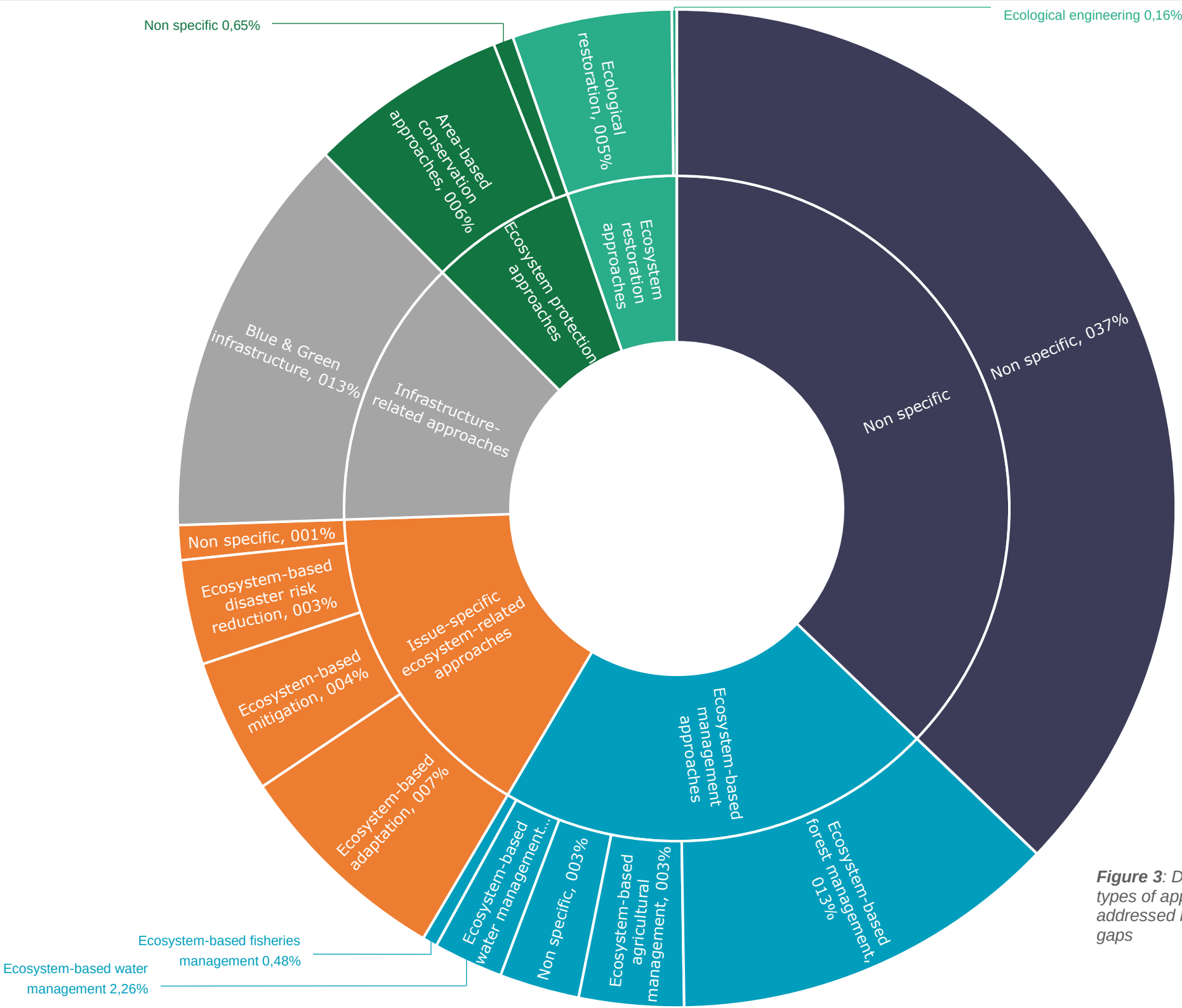


***Figure 3**: Diagram of the types of approaches addressed by the collected gaps*

2. Insights from the approach classification

In a further step, the gaps were also categorised according to broad categories and approaches. This analysis reveals that a significant number of the gaps collected (41.52%) are not specific enough to allocate these to a given category (see **Figure 3**). However, a considerable share of all collected knowledge gaps relates to **ecosystem-based management approaches** (22.32%). More specifically, the sub-category with the largest proportion of total gaps (12.6%) concerns ecosystem-based forest management. Knowledge gaps related to ecosystem-based agricultural management are frequently mentioned in scientific sources and less often in grey and institutional literature, where knowledge gaps on ecosystem-based water management are more prominently cited. Notably, ecosystem-based fisheries management is weakly cited in collected knowledge gaps, accounting for just 0.48% of all the gaps.

The study also highlights knowledge gaps related to **issue-specific ecosystem-related approaches** (16.16%), with ecosystem-based adaptation being the most prominent, cited by 7.11% of all knowledge gaps. Themes of ecosystem-based mitigation and ecosystem-based disaster risk reduction follow, cited in 4.36% and 3.39% of the collected gaps, respectively. It is important to note that many gaps span two or three of these approaches simultaneously.

Infrastructure-related approaches comprise gaps only focused on blue & green infrastructure, which are one of the most addressed approaches, making up 13.09% of all identified knowledge gaps.

Additionally, knowledge gaps associated with **ecosystem protection approaches** account for 7.11%, with area-based conservation approaches addressed by 6.46% of the total gaps. The difference between the two is explained by the gaps addressing protection issues other than the area-based approaches.

Finally, knowledge gaps related to **ecosystem restoration approaches** represent the smallest category, as they can be linked

to 5.33% of all gaps collected. Ecological restoration is more frequently cited within this category than ecological engineering, and these gaps are primarily derived from the scientific literature.

Conclusion

This first update of the knowledge gaps database marks a crucial milestone in tracking the implementation of the NbS R&I Roadmap to 2030. The emerging trends offer valuable insights to inform strategic discussions with programmers and funders, supporting the development of collaborative and thematic pathways for NbS initiatives across the EU. These insights are also valuable to the research community, providing an overarching view of advances in NbS knowledge.

Though it is essential to acknowledge certain limits, while extensive efforts were made to ensure comprehensiveness, the use of precise search terms restricted the scope, balancing comprehensiveness with data manageability. Additionally, some knowledge gaps address multiple approaches and topics, necessitating categorisation choices. As a result, the proportions in each category may not precisely reflect the full scope of each knowledge gap.

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