EU Research and Innovation projects on NbS database update

Methodology and results

WP3 Task 3.1.1

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Introduction

Under its Work Package on mobilising evidence and knowledge for supportive policy-making and practice, NetworkNature undertook a comprehensive mapping of research and innovation (R&I) projects, including some implementation projects, related to Nature-based Solutions (NbS) across the European Union (EU). An initial mapping was published in 2021, covering the projects funded by the European programmes BiodivERsA, Horizon 2020, the Seventh Framework Programme (FP7), Interreg, and LIFE (EU's funding instrument for environment and climate action) from 2011 to 2021. In November 2024, NetworkNature released an updated version of this mapping, incorporating the latest projects funded by these programmes and featuring projects funded by additional sources, including Horizon Europe, Driving Urban Transition (DUT), Water4All, EJP Soil, and the Sustainable Blue Economy Partnership (SBEP). These latest data provide essential insights into the distribution and focus of funding allocated to NbS R&I.

Methodology

Data collection and screening process

The methodology of this R&I projects database was first designed for the creation of the mapping published in 2021 and has been refined on the occasion of this first update in 2024 to foster greater robustness. First, all projects funded by the selected programmes were extracted into databases, regardless of their specific relation to NbS. In a second step, the software R Studio was used to screen these large databases using two successive keyword searches on projects' titles and abstracts.

1. In the first round, projects were filtered using a set of "biodiversity" keywords (**Annex 1**), based on Goudeseune et al. (2018) and Biodiversa+ scoping review (Akoumianaki et al., 2021).

2. In the second round, the search was screened using "services and approaches" keywords (**Annex 2**), developed from the NbS keywords list under NetworkNature (Ruiz et al., 2020), along with additional research (Eggermont et al., 2015; European Commission Directorate-General for Research and Innovation et al., 2021; Akoumianaki et al., 2021; Thinknature et al., 2019; European Environment Agency, 2021; Ruiz et al., 2020) and adjustments based on selected sample projects.

All remaining projects were compiled into a single database, which was manually reviewed to remove projects not related to biodiversity or NbS (e.g., medical research).

Projects selection

The final list of relevant projects was further refined by applying NetworkNature's definition of NbS. To do so, each project's title and abstract

were manually reviewed and rated using three key criteria based on the European Commission's definition of NbS and the Milestone paper 3.1 of NetworkNature (Ruiz et al., 2020). The criteria are the following:

- *Biodiversity benefits* Projects designed to maintain (at the minimum) and enhance the functionality and connectivity of ecosystems.
- *Social and economic benefits* and/or *increased resilience* Projects that maintain and/or increase the quality of life and the delivery of ecosystem services and stimulate economic growth and/or projects increase the capacity of a system to recover from stress and disturbance while retaining the essential functions, structures, and identity.
- *Societal Challenge* Projects designed as a response to one or more societal challenge(s)[1].

Each project was rated on a scale from 0 to 3 for each criterion:

- 0 — the criterion is not mentioned
- 1 — the criterion is mentioned only in the description of the project's context
- 2 — the criterion is mentioned in relation to the core objectives of the project but either not detailed and/or studied
- 3 — the criterion is detailed and studied in the project

Projects scoring 2 or higher across all three criteria were selected. From the initial collection of 13,156 projects, 175 projects were added to the database. Below is the distribution of the newly added projects by funding programmes:

[1] Climate Resilience; Water Management; Natural and Climate Hazards; Green Space Management; Biodiversity; Air Quality; Place Regeneration; Knowledge and Social Capacity Building for Sustainable Urban Transformation; Participatory Planning and Governance; Social Justice and Social Cohesion; Health and Well-being; New Economic Opportunities and Green Jobs (EC and Directorate-General for Research and Innovation 2021)

Programme/ initiative	Number of added projects
Horizon 2020 + Horizon Europe	96
Interreg	27
LIFE	25
Biodiversa+	14
Water4All	2
DUT	4
EJP Soil	4

Projects categorisation

To enhance analysis and facilitate database navigation, the selected projects were categorised using several typologies, as outlined below. A thorough review of the projects' abstracts was carried out to assign the NbS types, approaches, environments and societal challenges. For each category, a maximum of two options were assigned per project. If a category was not relevant for describing a project, it was marked as "NA" for that specific category.

- ***Type of NbS**, following the typology developed by Eggermont et al. (2015)*

Type	Definition
Type 1	Solutions that involve making better use of existing natural or protected ecosystems
Type 2	Solutions based on developing sustainable management protocols and procedures for managed or restored ecosystems
Type 3	Solutions that involve creating new ecosystems

- ***Types of approaches studied**, 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

**Elements added or modified from the original typology*

- ***Type of environment**, adapted from the "Mapping and Assessment of Ecosystems and their Services (MAES)" European Commission 2020 report.*
    - Coastal, shelf and open ocean
    - Cropland
    - Forest
    - Grassland
    - Inland wetland
    - Marine inlets and transitional water
    - Mountain
    - Multiple
    - Non specific
    - Rivers, lakes and ponds
    - Sparsely vegetated land
    - Urban ecosystems

- ***Types of Societal Challenge(s) tackled**, following a typology derived from the European Commission (2021) and the IUCN typologies (IUCN, 2020)*

IUCN Societal Challenge Typology	EC Societal Challenge Typology	Typology Derived for NetworkNature mapping
Climate Change	Climate Resilience	**Climate Resilience**
Water security	Water Management	**Water Management**

Food security	-	**Food security**
Economic and Social Development	Social Justice and Social Cohesion	**Social Justice and Social Cohesion**
	New Economic Opportunities and Green Jobs	**New Economic Opportunities and Green Jobs**
	Participatory Planning and Governance	**Participatory Planning and Governance**
Disaster Risk reduction	Natural and Climate Hazards	**Natural and Climate Hazards**
Human Health and well-being	Health and well-being	**Health, Well-being & Air Quality**
	Air Quality	
-	Green Space Management	**Green Space Management**
	Place Regeneration	**Place Regeneration**
	Knowledge, and Social Capacity Building for Sustainable Transformation	**Knowledge, and Social Capacity Building for Sustainable Transformation**
Environment degradation and biodiversity loss	Biodiversity Enhancement	**Biodiversity Enhancement***

**Not included in analysis since considered prerequisite for NBS*

Analysis

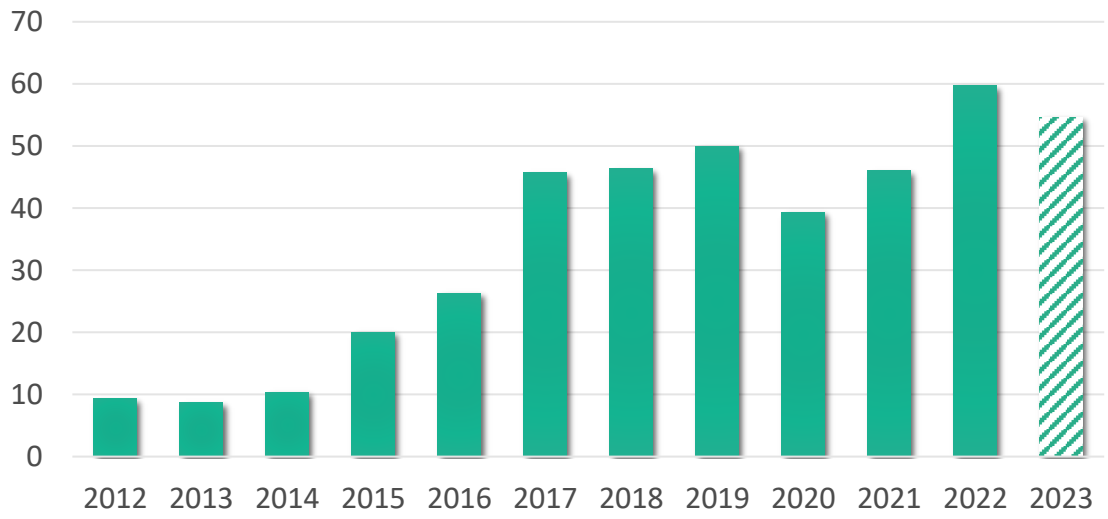
This report presents and discusses the NbS R&I trends based on the collection and categorisation of R&I and implementation research projects across Europe. It explores the evolution of funding patterns as well as the NbS typologies, approaches, and ecosystems targeted by these projects.

Projects count

This updated mapping introduces 172 new projects, bringing the total number of NbS R&I and implementation projects in the database to 471, from 2011 to May 2024. To ensure a comprehensive analysis, this report reflects insights based on all 471 projects – rather than focusing solely on those added in the 2024 update. However, it is important to note the data collection concluded in May 2024, meaning the report does not capture the full scope of projects for the entire year.

To highlight temporal trends in NbS-related R&I projects, an annual moving average of project counts was calculated. This analysis reveals an increase in the number of NbS-related projects over time, with a slight decline noted in 2020 and 2021.

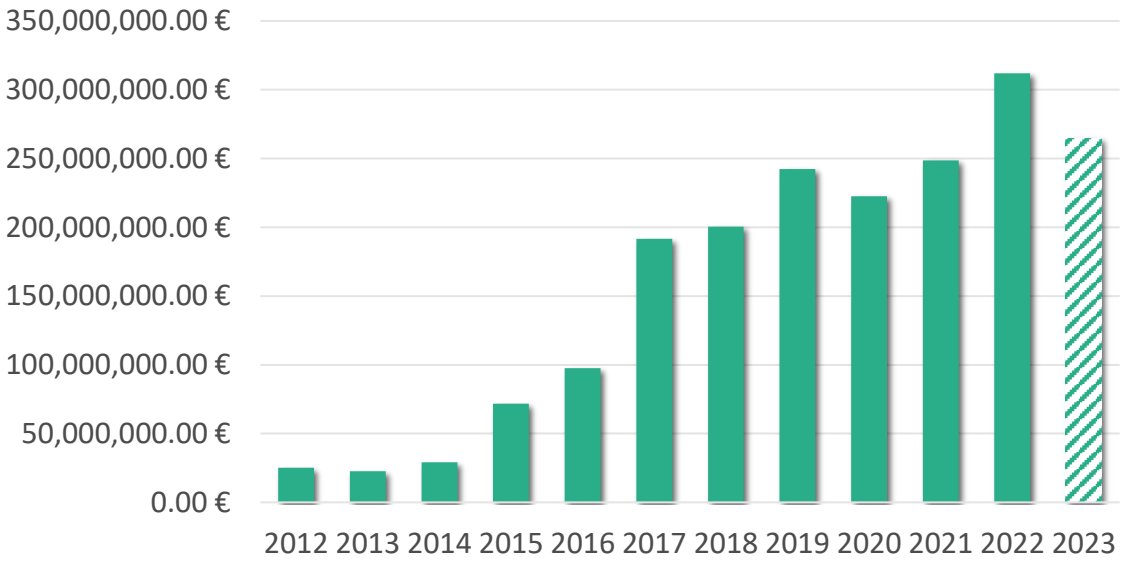
Figure 1. Annual moving average of projects count *(2023 is marked with hatching as it is influenced by the number of projects in 2024, which is not complete for this year)*



Funding

Between 2011 and 2024*, more than 2 billion euros have been allocated to NbS R&I and implementation projects, although funding data is unavailable for 13 projects. These results underscore sustained robust investments in NbS R&I since 2015, with particularly significant growth from 2017 onward. However, a slight decrease in funding was observed in 2020, mirroring a similar decline in the number of projects during that year.

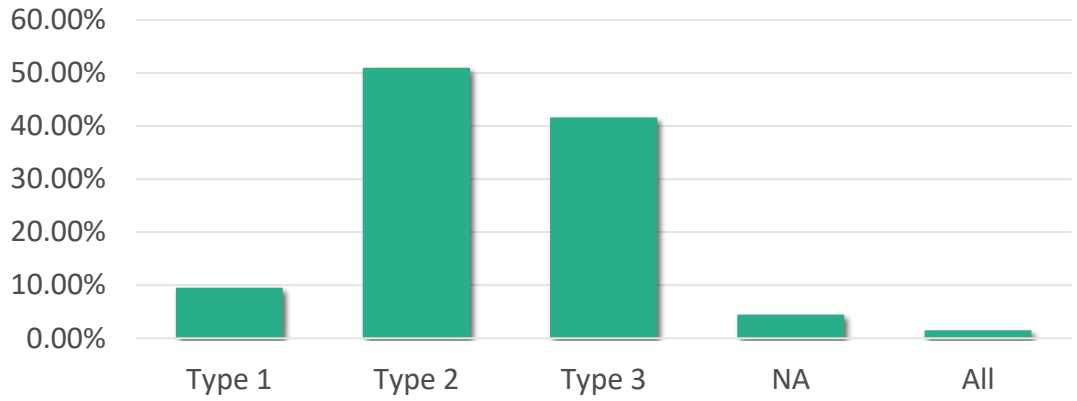
Figure 2. Annual moving average of funding *(2023 is marked with hatching as its figures are influenced by the 2024 budget allocation, which are not complete for this year)*



NbS typologies

The projects were categorised based on the NbS typology proposed by Eggermont et al. (2015). More than the majority of the projects (50.96%) falls under type 2 (figure 3), which focuses on solutions based on the sustainable management or restoration of ecosystems. A substantial proportion of the projects (41.61%) aligns with type 3, involving the creation of new ecosystems. In contrast, type 1 projects, aimed at making better use of existing natural or protected ecosystems, are significantly less common. A small fraction of projects (4.46%) remains unclassified, as they do not correspond to any of these typologies.

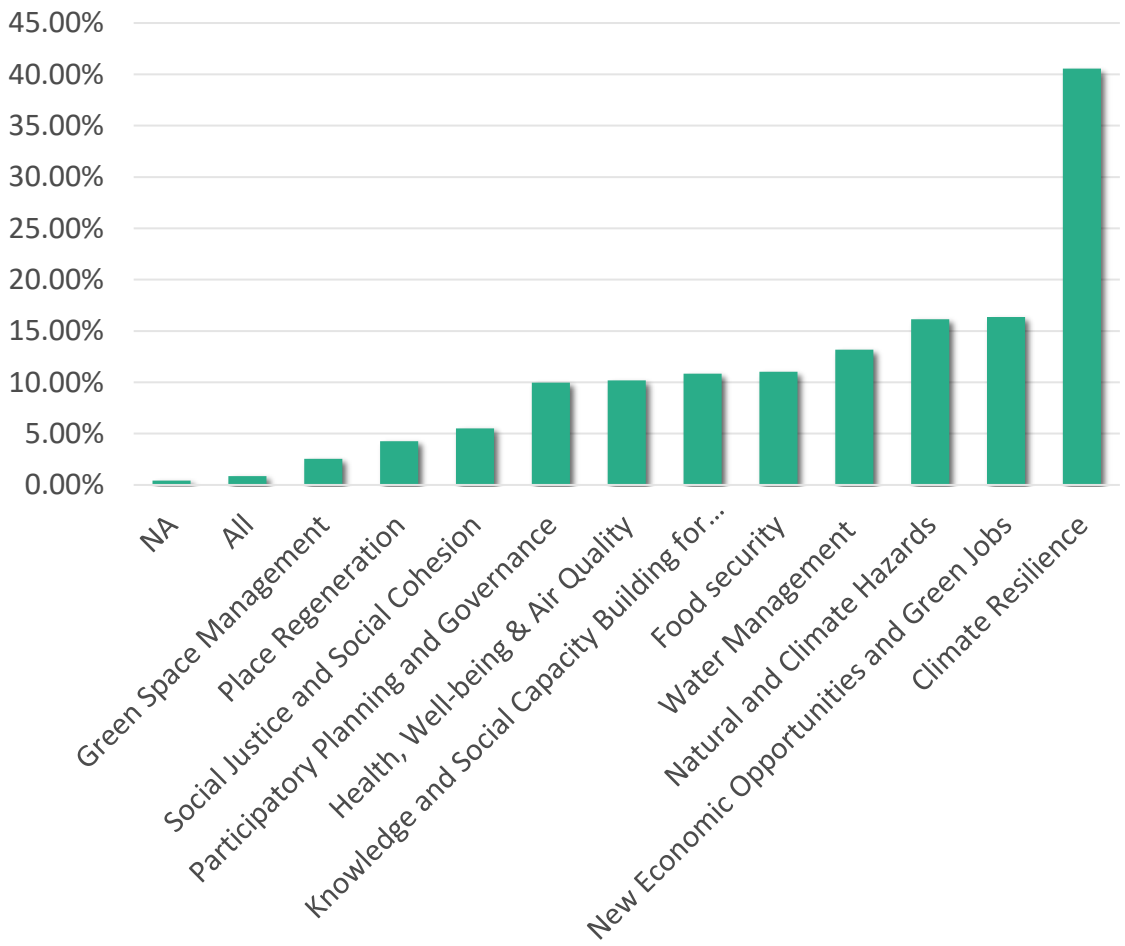
Figure 3. NbS typologies addressed by NbS R&I and implementation projects from 2011 to 2024*



Societal challenges

Overall, a significant proportion (40.55%) of the R&I and implementation projects focus on **climate resilience**, reflecting its prominence among the societal challenges identified by the European Commission and IUCN (figure 4). Other key challenges addressed include fostering **new economic opportunities & green jobs** (16.35%) and addressing **natural and climate hazards** (16.14%). In contrast, challenges such as **place regeneration** and **green space management** have received comparatively less attention. These trends are consistent with the findings observed during the creation of the database in 2021.

Figure 4. Societal challenges addressed by NbS R&I projects from 2011 to 2024*



Over time, there has been some notable evolution in focus (figure 5), with an increasing emphasis on projects addressing **climate resilience**. The proportion of such projects more than doubled from 2011-2017 to 2018-2020 and continues to increase. This shift mirrors Dunlop et al. (2024), which identified that NbS have more recently been regarded for their role in responding to the climate crisis. Similarly, Yang et al. (2024) identified an increasing frequency of climate-related keywords in NbS literature over time. Additionally, **participatory planning and governance** have seen recent growth, with related projects increasing from 5.33% in 2018-2020 to 14.90% in 2021-2024*. This challenge now ranks as the third most addressed, compared to its eighth position in 2011-2017.

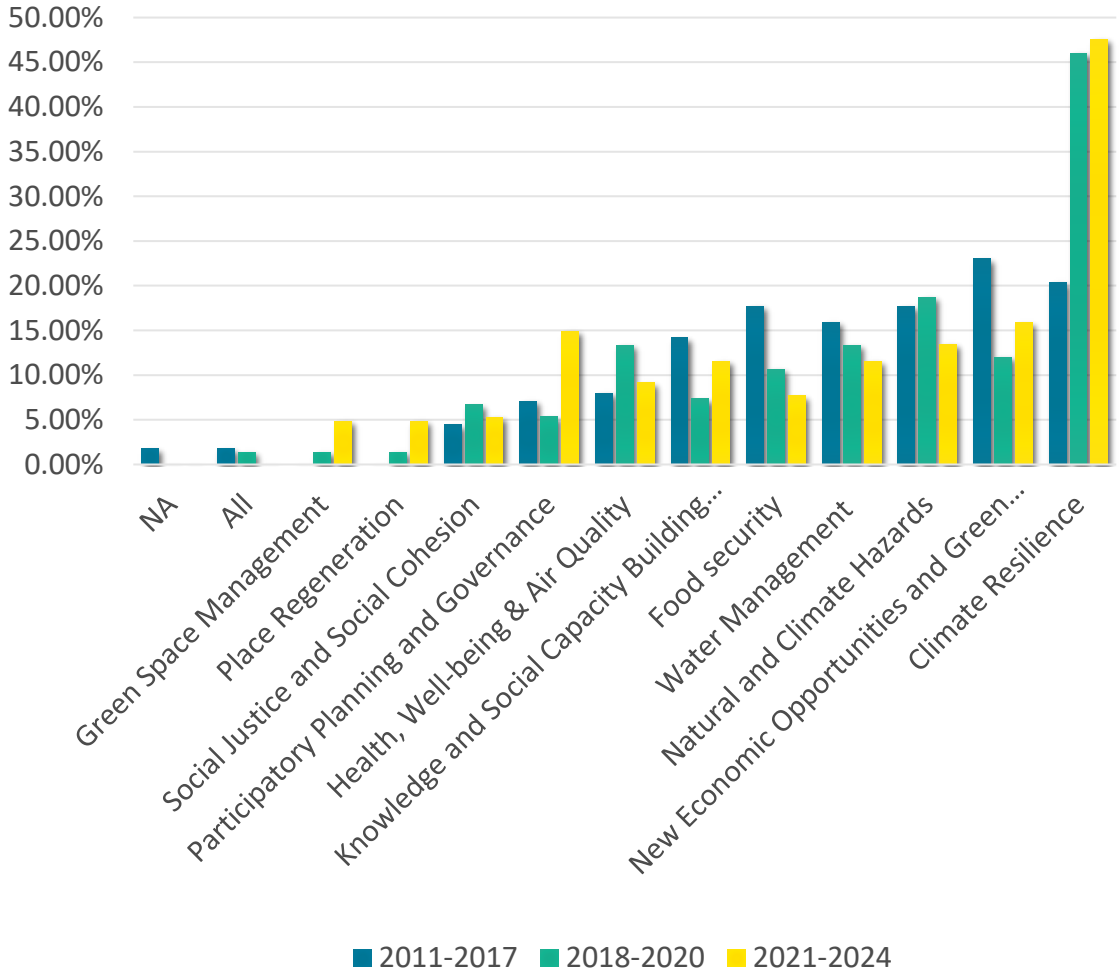
Health, well-being & air quality saw a significant rise in project focus during 2017-2020, notably in 2020 and likely influenced by the COVID-19 pandemic (Davies et al., 2021). However, this proportion has decreased since 2021.

In contrast, projects addressing **water management**, **natural and climate hazards**, and **food security** have experienced a relative decline since 2017. This trend aligns with the findings from Dunlop et al. (2024), which noted that food and water security, as well as economic and social development and human health, remain understudied compared to other societal challenges. Nevertheless, **water management** remained the third most addressed societal challenge during 2018-2020.

Projects targeting **knowledge and capacity building for sustainable transformation** and **new economic opportunities and green jobs challenges** have also declined since 2017 despite a slight recent uptick. This highlights potential gaps in aligning NbS research with economic and social development objectives, as raised by Dunlop et al. (2024).

Green space management and **place regeneration** remain among the most understudied challenges. However, these areas have gained attention since 2018, with notable growth from 2021 onward. They now rank fourth and fifth in projects focused on urban environment, where they are most relevant. Similarly, while **social cohesion and social justice** have seen greater attention in 2018-2020, they remain underrepresented within the broader NbS R&I landscape.

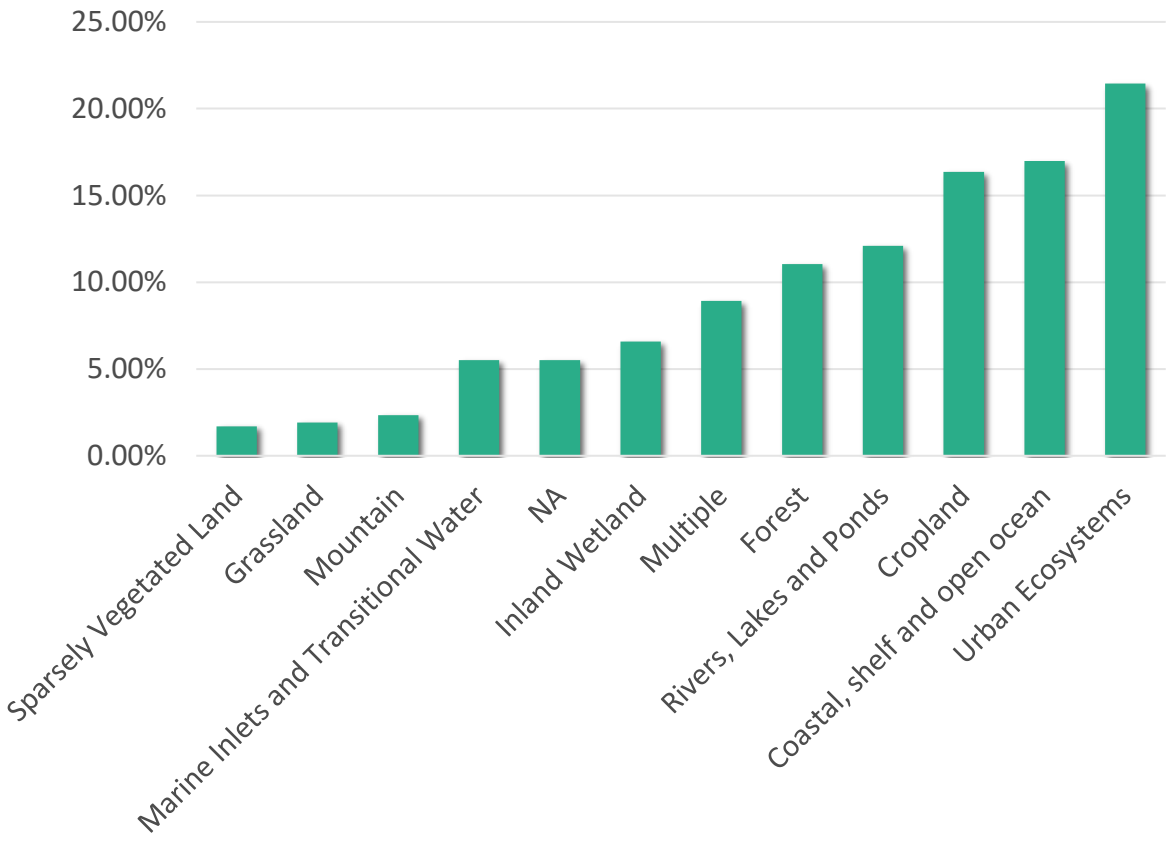
Figure 5. Temporal evolution of societal challenges addressed by NbS R&I projects from 2011 to 2024*



Environments

Overall, **urban ecosystems** are the most commonly studied areas, accounting for 21.44% of projects from 2011 to 2024* (figure 6). Other commonly studied environments include **coastal, shelf, and open ocean** areas and **croplands**, aligning with the literature on NbS R&I trends (Yang et al, 2024). Conversely, **grasslands, sparsely vegetated lands**, and **mountainous** areas are the least studied.

Figure 6. Environments studied by NbS R&I and implementation projects from 2011 to 2024*



From 2018 to 2020, **urban ecosystems** were a dominant focus in NbS R&I projects. However, since 2021, there has been a decline in urban-centric projects, accompanied by a growing focus on projects addressing **multiple environments** (figure 7) and a reduced focus on blue-green infrastructure approaches (figure 10). A keyword analysis of NbS literature by Yang et al. (2024) supports this shift: while “urban” has been the most frequent keyword, there is a rise in the frequency of other keywords such as “climate” and “carbon” over time, alongside emerging topics like carbon sequestration and sustainable agriculture.

A similar trend applies to **rivers, lakes and ponds**, which saw a significant rise in project focus during 2018 but have since declined in proportion. Furthermore, projects targeting **croplands** and **coastal, shelf and open ocean environments** have decreased since 2018, though the absolute number of cropland-related projects has remained steady.

In contrast, **forests** and **marine inlets** have gained increased attention, likely reflecting the growing interest in ecosystem-based forest management (figure 10) and restoration-focused marine initiatives (figure 8).

Underrepresented ecosystems continue to include **mountains**, **grasslands** and **sparsely vegetated lands**.

Figure 7. Temporal evolution of environments addressed by NbS R&I and implementation projects from 2011 to 2024*

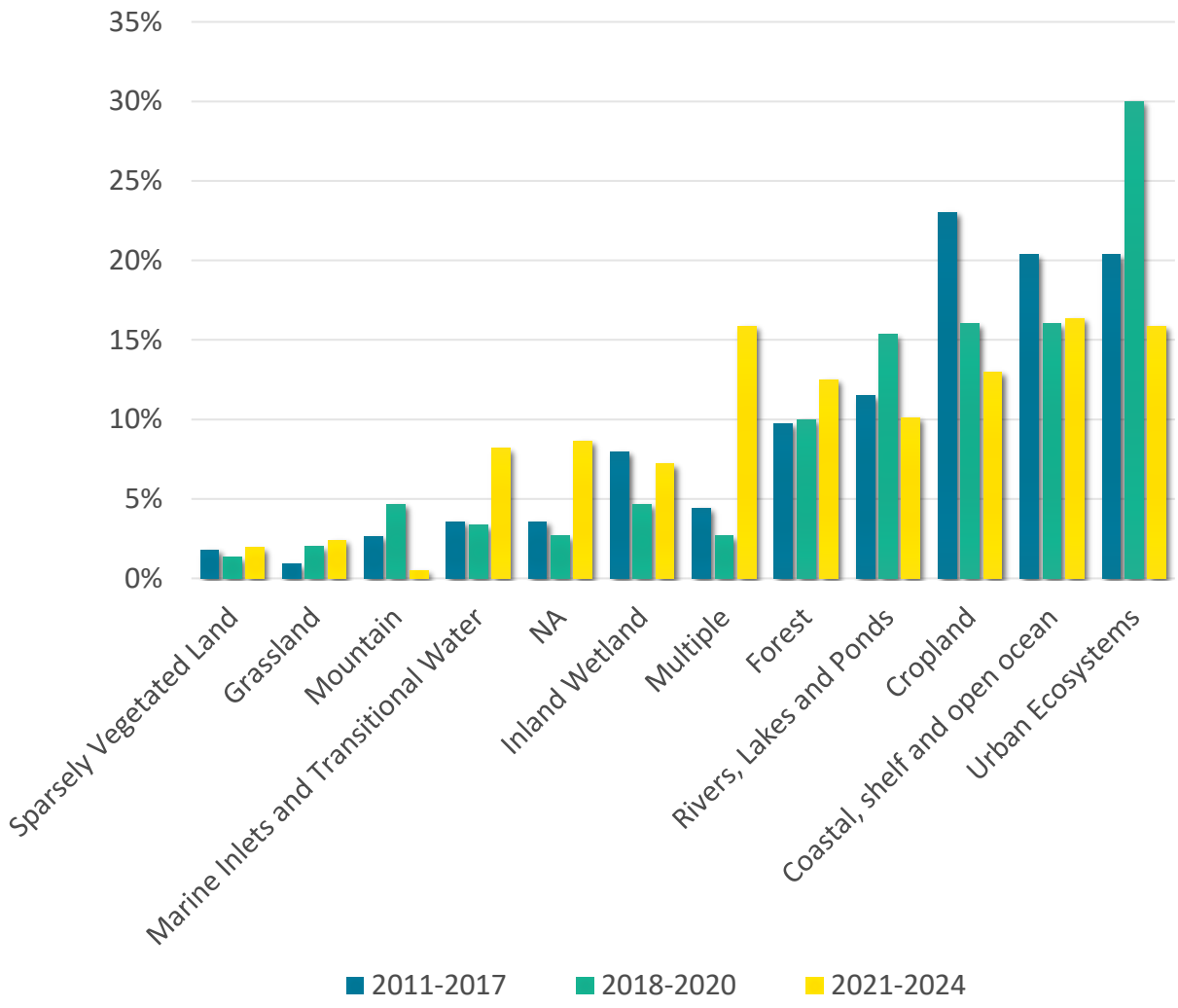


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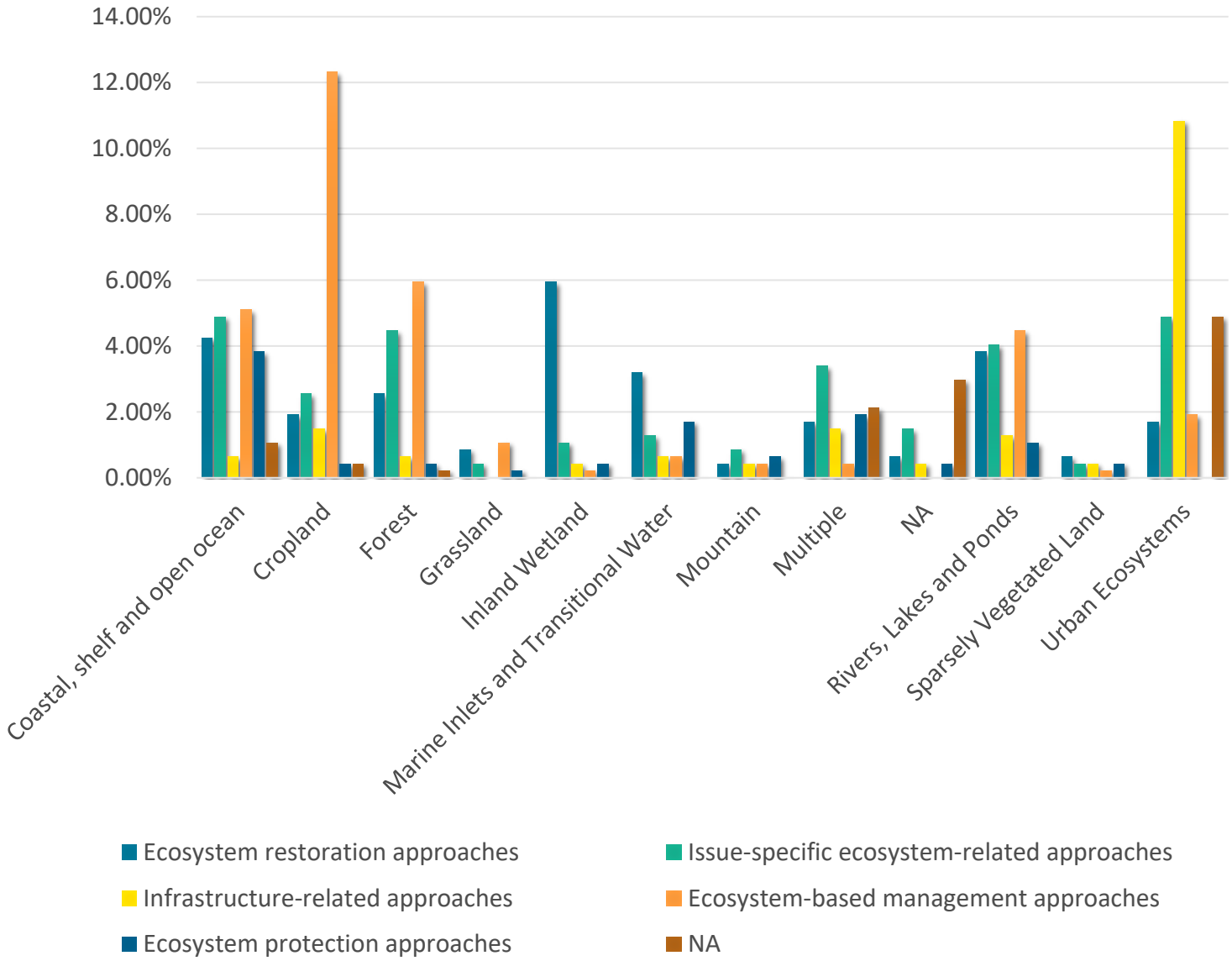
Figure 8. Relationship between environments and approaches in the NbS R&I and implementation projects from 2011 to 2024*



Approaches

Between 2011 and 2024*, a substantial proportion (28.24%) of NbS R&I and implementation projects has adopted **ecosystem-based approaches**. Among these, **ecosystem-based agricultural approaches** dominate (figure 9), largely driven by funding from European Commission programmes (FP7, H2020 and HEU). While these agricultural projects have slightly declined in recent years, there has been a notable rise in **ecosystem-based forest**

management projects since 2018. In contrast, **ecosystem-based fisheries management** remains the least explored ecosystem-based approach.

The second most prevalent approach involves **issue-specific ecosystem-related** projects (27.6%). They have experienced a sharp increase in **ecosystem-based adaptation** projects since 2018 and a peak in **ecosystem-based mitigation** projects in 2021 (figure 10). Adaptation projects predominantly target coastal, shelf and open ocean ecosystems, while mitigation efforts are primarily applied to forests and croplands. Projects focusing on **disaster risk reduction approaches** have remained steady, with a modest increase since 2018.

Ecosystem restoration represents the third major approach, accounting for 24.63% of the projects. This approach encompasses both ecological engineering and restoration projects. Although ecological engineering projects have remained relatively rare, restoration efforts have surged since 2021, likely driven by the EU's Nature Restoration Law process. These efforts primarily target **inland wetlands**, **coastal, shelf and open ocean** areas, and **rivers, lakes, and ponds** (figure 8).

Infrastructure-related approaches, represented exclusively by **blue-green infrastructure** (BGI), comprise 17.20% of projects during the studied period. The prominence of BGI aligns with findings from Davies et al. (2021), which underscore how EU policy connects green infrastructure to NbS as a means of addressing both social and environmental challenges linked to urbanisation. While BGI approaches were dominant between 2011 and 2018 (accounting for 24.78% of projects), their share has declined to 13.94% in 2021-2024. This shift reflects a reduced focus on urban environments and a broadening of scopes to address more systemic challenges.

Finally, **ecosystem protection approaches** have only recently gained traction in the NbS projects we collected. These projects predominantly target **coastal, shelf and open ocean ecosystems** (figure 8). This aligns with broader NbS research trends identified by Yang et al. (2024), albeit a temporal lag, which highlighted a significant rise in coastal protection topics since 2016.

Figure 9. Distribution of approaches targeted by the projects from 2011 to 2024*

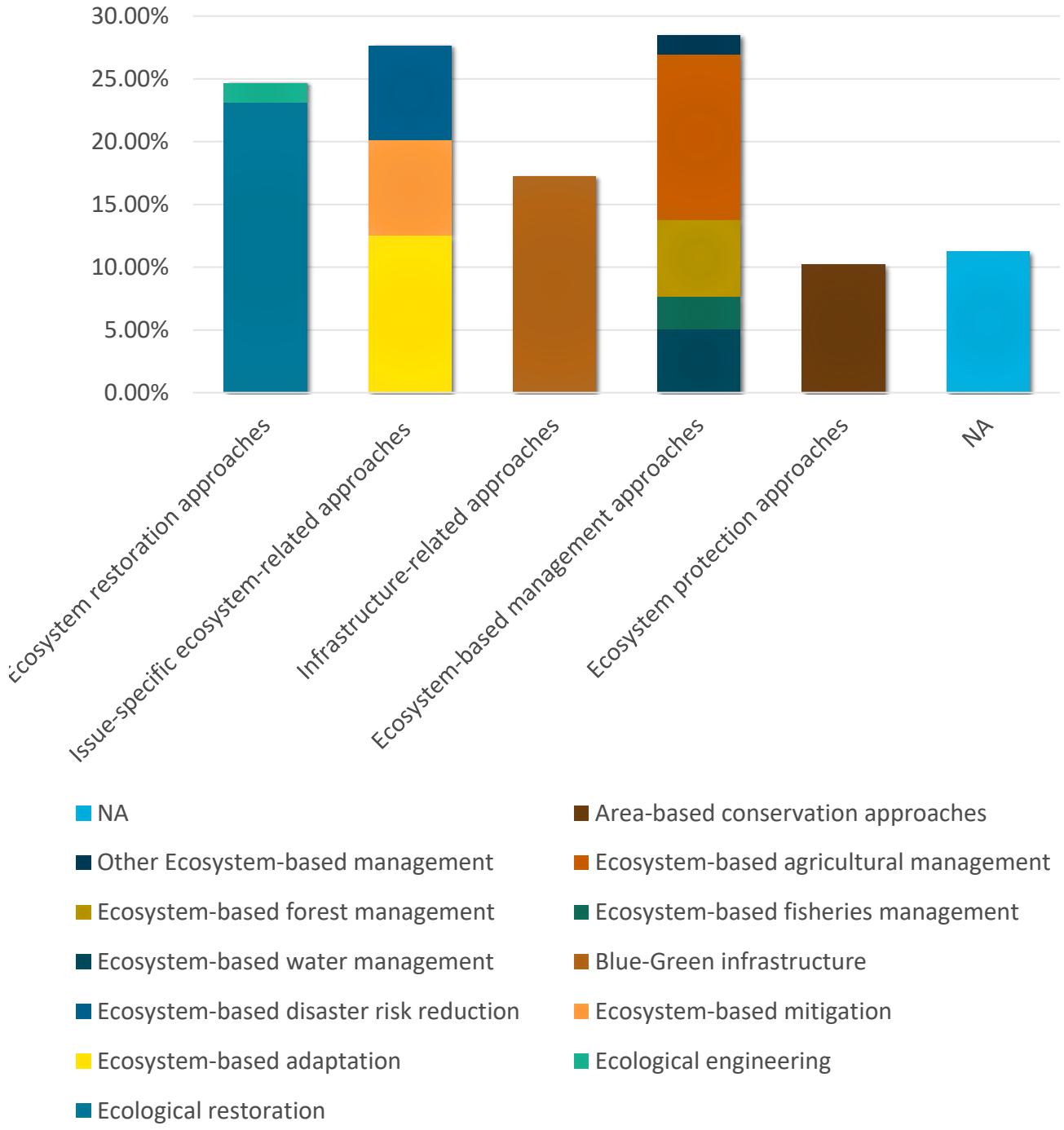
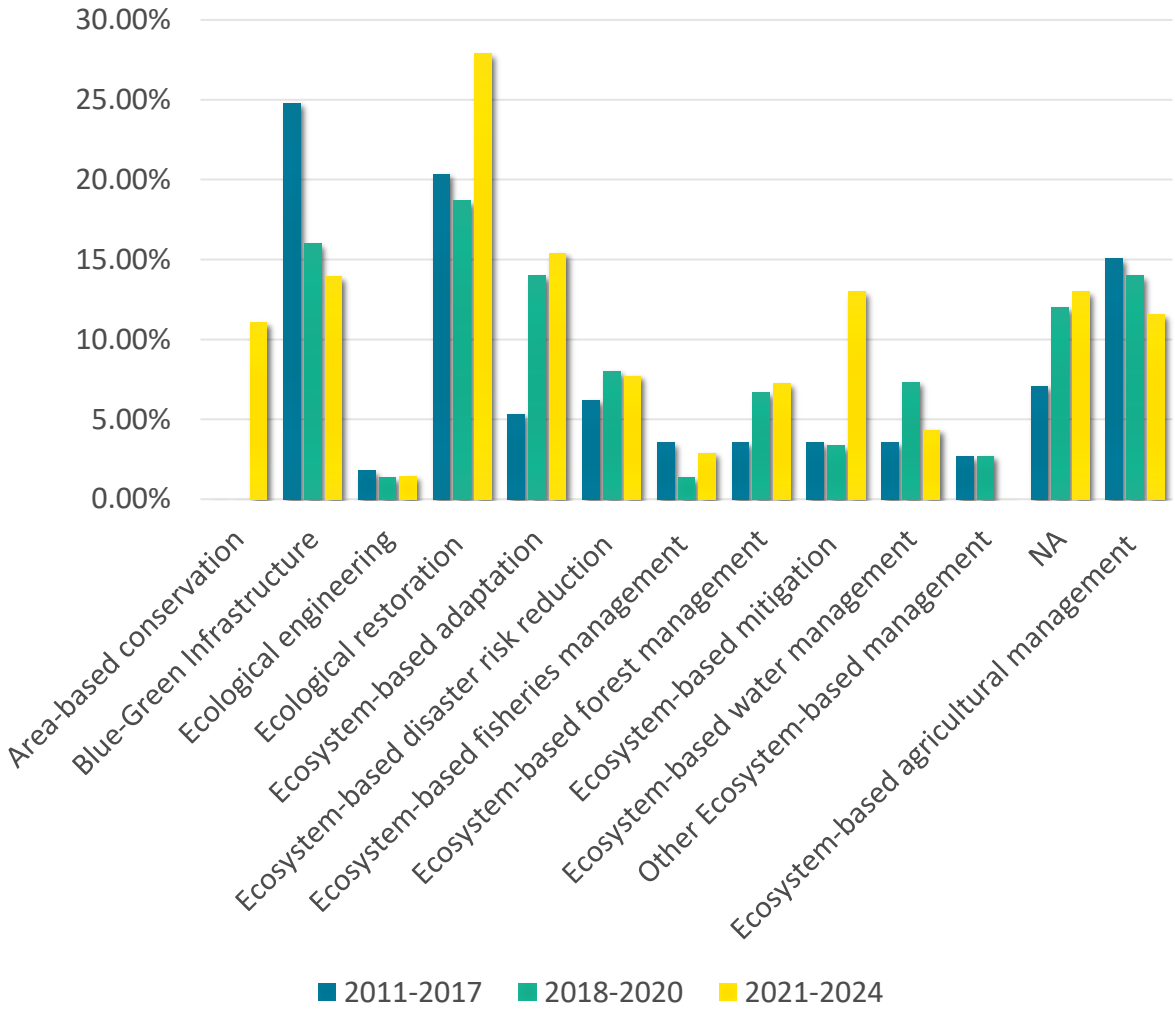


Figure 10. Temporal evolution of approaches studied by NbS R&I and implementation projects from 2011 to 2024*



Conclusion

The first update of the NbS R&I and implementation projects database marks a significant step in tracking the evolving European landscape. Together with the 2024 revision of the knowledge gaps database, it provides critical advancements for understanding and addressing the dynamics of NbS R&I. These updates offer valuable insights for monitoring the implementation of the

NbS R&I Roadmap and will serve as a foundation for its forthcoming revision. For R&I programmers and funders, the findings shed light on shifting funding patterns and emerging priorities, supporting better-informed decision-making and collaborative strategic planning.

However, it is crucial to acknowledge the inherent limitations of this R&I projects mapping endeavour. While the methodology, in particular the screening process, was designed to be as exhaustive as possible, the broad nature of NbS as an umbrella term means new keywords and approaches may still emerge. Similarly, despite extensive efforts, the selection of programmes cannot fully capture the entire NbS R&I landscape. Moreover, many projects address multiple approaches, environments and societal challenges, requiring categorisation decisions that may not fully reflect their full complexity and scope. Consequently, the proportions attributed to each category should be interpreted as indicative.

Despite these limitations, the update represents a robust effort to synthesise and analyse the diverse and growing field of NbS R&I and implementation, providing a valuable resource, especially for programmers and funders and the research community.

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Annexes

Annex 1. List of biodiversity keywords

Table 1. “Biodiversity” keywords list

*The keywords in green were added for the 2024 update of the mapping

agroecolog	canopy	green space	nature improvement
agrosystem	coast	habitat adaptation	nature reserve
aquatic environment	cultivar	habitat conservation	ocean biology
aquatic diversity	diversity	habitat connectivity habitat diversity	pasture
arable plant	ecological	habitat fragmentation	peatland
biocenosis	ecological gen	habitat heterogeneity	permanent plots
biocultural	ecological community	habitat variability	pollinator
biodiversity	ecological invader	habitat degradation	population dynamics
biodiversity hotspot	ecological network	husbandry	protected area
biodiversity offset	ecological speciation	interspecific	reef
bioecological	ecology	intraspecific	river
biogeograph	ecosystem	invasive plant	seed
biological adaptation	fauna	invasive species	seascape
biological conservation	flora	invertebrate	speciation
biological diversity	food web	ipbes	specie
biological indicator	forest	mangrove	taxa
biological invasion	fragmented habitat	marine	taxon
biological monitoring	functional diversity	meadow	terrestrial environment
biological productivity	functional ecology	mother Earth	tree
biological corridor	functional group	native species	tropical system
biological communit	functional redundancy		urban environment

biome	functional trait	natura 2000	vegetation
biosphere	functional type	natural capital	weed
biota	genetic diversity	natural environment	wetland
biotope	grassland	natural habitat	wildlife
blue infrastructure	grazing	natural heritage	woodland
breed	green infrastructure	nature-based	
bycatch	green roof	nbs	

Annex 2. List of services and approaches keywords

Table 2. "Services and approaches" keywords list

*The keywords in green were added for the 2024 update of the mapping

adaptation to climate change	environment management	nature's contribution to people
adaptation service	environmental management	nature forestry
adaptive management	ecosystem services	natural resource management
afforest	erosion risk management	nbs
agri-environmental measures / agri-environment	erosion risk reduction	protected area
agroecolog	indigenous and local knowledge systems	protected landscape
agroforestry	integrated management	protected seascape
agropastoral	flood risk management	re-naturing
area-based conservation	flood risk reduction	reforest
assisted natural regeneration	flood management	regenerative agriculture
biocontrol	forest based	regenerative farming
biodiversity resilience	forest management	resilience management
bioremediation	green infrastructure	resilience to climate change
blue infrastructure	green space management	resilience to disaster
building with nature	high-nature value	resilient to climate change
climate adaptation service	land restoration	resilient to disaster

climate adaptation strategy	landscape management	restoration
climate change adaptation	management of ecosystem	revegetat
climate change mitigation	management of erosion risk	rewilding
climate resilient	management of flood risk	river basin plans
climate-resilient	management of green space	river management
coast management	management of landscape	silvopastoral
coastal management	management of natural resource	soil fertility
disaster resilient	management of urban biodiversity	soil rehabilitation
disaster risk management	management of water resources	soil remediation
disaster risk reduction	mitigation of climate change	sustainable risk reduction
disaster resilience	natural areas	sustainable use
ecological engineering	natural engineered	urban biodiversity management
ecological restoration	natural infrastructure	urban greening
ecosystem management	natural resource management	urban heat island
ecological infrastructure	natural treatment processes	water resource management
ecosystem-based	natural water retention	watershed management
ecosystem approach	natural-engineered	wetland management
ecosystem management	nature based	woodland management

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UK Research
and Innovation

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