



Draft European Roadmap for Research and Innovation on Nature-based Solutions

WP5 Task 5.1

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Executive summary

Section to be developed

About NetworkNature

NetworkNature is a resource for the nature-based solutions community, creating opportunities for local, regional and international cooperation to maximise the impact and spread of nature-based solutions. The project is funded by the European Commission under the Horizon 2020 programme.

NetworkNature's activities:

- Synthesise & strengthen the NBS evidence base by gathering experiences, knowledge, tools and services from over 30 Horizon 2020 projects.
- Engage existing stakeholders & expand the NBS community to new sectors and target audiences, by creating new partnerships and identifying sectoral champions, sharing knowledge in dedicated events, educating young generations and communicating the latest findings in the field.
- Ensure NBS science informs the policy agenda and vice versa. As an interface between NBS innovators and knowledge generators as well as business and policy makers, NetworkNature is a bridge between the European policy landscape and the NBS community.
- Accelerate the uptake of NBS across science, business, policy and practice by providing guidance and capacity building, creating and operating new European NBS regional hubs, coordination of the [EU H2020 Nature-based Solutions Task Forces](#) and networking with practitioners, business, investors and policymakers.

Introduction

What are NBS ?

The term nature-based solutions (NBS) emerged in the late 2000s as a new concept to address and mitigate societal, economic and ecological challenges simultaneously. This conceptualisation was initiated by the World Bank and supported by the International Union for Conservation of Nature (IUCN) and later on by the European Commission (EC) (Davies et al. 2021). Nature-based solutions are defined by the EC as solutions that are *“inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions. Nature-based solutions must therefore benefit biodiversity and support the delivery of a range of ecosystem services.”* Describing NBS similarly, other definitions exist such as the ones developed by IUCN or by the United Nations Environment Assembly (UNEA).

The concept of NBS draws and builds from a variety of previously conceptualised approaches including e.g., Green Infrastructure, Ecosystem-based approaches or ecological engineering^{1,2}.

Wider socio-political context

Since its emergence, the NBS concept, components and aims evolved quickly, as NBS were increasingly explored and implemented for different purposes, such as climate mitigation and adaptation, urban resilience or disaster risk reduction (Cassin & Matthews 2021), and examined as a response to the emergence of new environmental and social challenges such as Covid-19 (Davies et al. 2021). This growth in the use of and research around NBS has occurred in parallel with an increased reference to NBS by political bodies, as well as in policy instruments³. For example, the rate of growth in relevant publications has increased considerably over the last five years⁴.

In Europe, policy-makers have integrated NBS into the new European Green Deal and its associated Biodiversity Strategy to 2030, the proposal for a Nature Restoration Law and the Climate Adaptation strategy as an innovative action to support achievement of multiple goals. NBS are also strongly integrated within the European Commission Framework Programme for Research and Innovation, Horizon 2020 and Horizon Europe.

Nature-based solutions have also gathered interest from international bodies, technical international organisations (e.g. The Organisation for Economic Co-operation and Development (OECD)), United Nations science-policy fora (e.g. the Intergovernmental Panel on Climate Change (IPCC), the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), but also directly from UN institutions and conventions. Nature-based solutions were referenced as possible means to support the delivery of desired climate outcomes by the United Nations Framework Convention on Climate Change (UNFCCC) during COP 26 and at the Convention on Biological Biodiversity (CBD), for the post-2020 Global Biodiversity Framework the use of the term NBS is growing despite on-going debate⁵.

More recently in March 2022, at the Fifth Session of the United Nations Environment Assembly (UNEA-5.2) was adopted a resolution on NBS (UNEA/EA.5/Res.5), which included a multilaterally agreed definition of NBS recognising the important role NBS play in the global response to climate change and its social, economic and environmental effects. Under the resolution, NBS are defined as 'actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems, which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services and resilience and biodiversity benefits'. This resolution and its associated recommendations could help the further use and implementation of NBS in international bodies, as well as in practice. Therewith, for the first time the concept of NBS has been globally agreed by all 193 UN Members states.

Lastly, NBS are being used or referenced more and more by the private sector, by specialised actors such as consulting firms in sustainable development, climate resilience or biodiversity, ecological engineering, and landscape and architecture firms, as well as by larger or multinational companies. Research has identified the importance of 'nature-based enterprises' in responding to increased demand for NBS from the public and private sector⁶.

Supporting R&I on NBS

Nature-based solutions are designed and implemented by a variety of actors and in a range of contexts, and encompass a large variety of approaches. NBS are also strongly linked to other sustainability concepts and goals such as nature-based or nature-positive economy⁷. The main objectives of NBS and its multiple aspects and impacts, call for dialogues and collaborations toward the optimal uptake and implementation of NBS in any given context.

Furthermore, as NBS support major EU policy priorities, such as the EU Green Deal, it is highly relevant for experts across Europe to gather their efforts into developing a common roadmap,

to better coordinate R&I and its supporting role for decision-making (in public and private contexts).

This European Research & Innovation Roadmap to 2030 on Nature-based Solutions aims to bring forward key levers for R&I to help achieve EU goals for NBS development and deployment. It provides an overview of knowledge needs and knowledge implementation gaps, and helps facilitate synergies and complementarities between the past, on-going and forthcoming activities and supports of European R&I on NBS.

This roadmap was co-developed with multiple researchers and stakeholders, contributing to identify and organise the Roadmap contents and structure. It also builds on the first NBS R&I roadmap from 2017⁸ as well as all the R&I work done and achieved in EU-funded NBS projects. This new roadmap is organised around four main pillars for R&I to support the further development and implementation of NBS in Europe.

1. *Advancing NBS knowledge and data on NBS*
2. *Closing the NBS research-implementation gap*
3. *Mainstreaming NBS in policy*
4. *Building awareness, capacities and dialogues on NBS*

[Link to follow up project of NetworkNature \(2023-2027\) under development](#)

Methodological approach

This first draft of the European Roadmap on Research and Innovation on NBS was developed as part of³. This draft draws on the results of several streams of work (**Figure 1**) and each stream's methodologies are described in detail below.

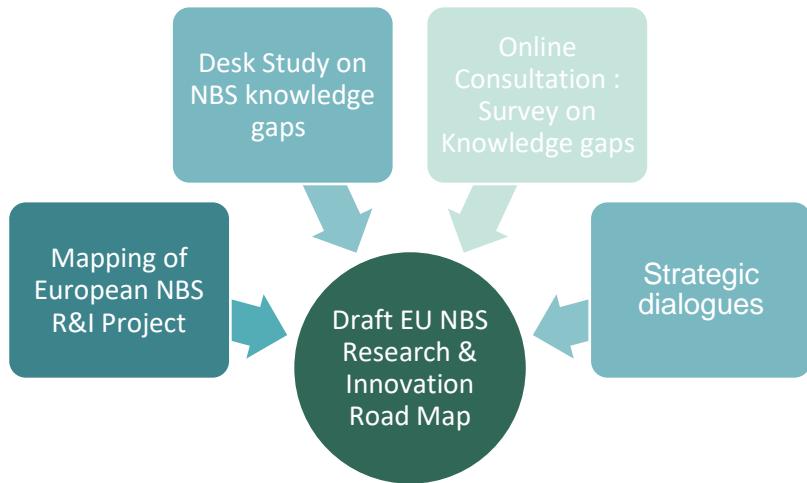


Figure 1 : Process towards the development of a first draft of the European Roadmap for R&I on NBS

1. Mapping the EU Research, Innovation and Implementation landscape on NBS

The mapping of EU projects provides an overview of the Research, Innovation and Implementation supported to date by the European level on NBS. It was conducted using information from databases on existing European programmes: BiodivERsA, Horizon 2020, Seventh framework programme (FP7), Interreg and LIFE (EU's funding instrument for the environment and climate action) over the years 2011–2021¹.

The databases were screened using two successive keyword searches on the title and abstract of each project using the software R Studio.

1. First, sorting with “biodiversity” keywords selected from Goudeseune et al. 2018 (**Annex 1**)

¹This mapping focuses on four major EU research programmes and as such is not exhaustive since analysing all EU programmes was not possible with available resources. Nonetheless, implementing a similar mapping of NBS projects in other EU programmes (e.g. European regional development fund or the European agricultural fund) could certainly help gain clarity on the EU landscape of research, innovation and implementation projects on NBS.

2. Then sorting with “services and approaches” keywords (**Annex 2**), this list was constructed by:

- i) using the NBS keyword lists developed under NetworkNature¹⁰
- ii) further exploratory work on scientific publications and grey literature^{1,3,11,12}
- iii) And testing and adjustment of the draft keyword lists on selected samples of NBS projects.

The projects were compiled within a single database and carefully reviewed to remove projects on topics not related to biodiversity or NBS (e.g. medical research)

The remaining projects’ titles and abstracts were manually checked to retain NBS-relevant projects using criteria derived from the European Commission’s definition, in accordance with the criteria defined in the Milestone paper 3.1 of NetworkNature¹⁰. The list of essential criteria for a project to be considered as R&I on NBS was derived as follows:

- *Biodiversity benefits* i.e. projects are designed to maintain (at the minimum) and enhance the functionality and connectivity of ecosystems.
- *Social and economic benefits* and/or *Increased resilience* i.e. projects 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* i.e. the projects are designed as a response to one or more societal challenge(s)².

All projects were rated for each criterion using the following rating scale, based on information present in their title and abstracts, using the following scale:

- 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

² 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 (European Commission and Directorate-General for Research and Innovation 2021)

Construction of the EU NBS Project Database

The EU NBS Project Database was constructed using identified projects, which used NBS or were included in the H2020 NBS topics, and if each of the three assessed criteria had a score greater than or equal to 2.

From an initial screening of more than 60.000 projects, the EU NBS Project Database is presently comprised of 262 projects, including 101 projects from H2020 and FP7, 35 NBS projects from BiodivERsA, 87 NBS projects from Interreg and 39 NBS projects from LIFE Climate Change Adaptation area (the only LIFE priority area it was possible to analyse at the time of the development of the first roadmap draft – to be completed in 2022). ([Link to the database to be inserted](#))

The projects included within the Database were tagged according to:

- **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 categories	Types of Approaches
Ecosystem restoration approaches	<ul style="list-style-type: none">• Ecological restoration• Ecological engineering
Issue-specific ecosystem-related approaches	<ul style="list-style-type: none">• Ecosystem-based adaptation• Ecosystem-based mitigation• Ecosystem-based disaster risk reduction
Infrastructure-related approaches	<ul style="list-style-type: none">• Green infrastructure
Ecosystem-based management approaches	<ul style="list-style-type: none">• Ecosystem-based water management*• Ecosystem-based Fisheries management*• Ecosystem-based forest management*• Ecosystem-based agricultural management*
Ecosystem protection approaches	<ul style="list-style-type: none">• Area-based conservation approaches

*Elements added or modified from the original typology

- **Types of Societal Challenge(s) tackled**, following a typology derived from the European Commission¹⁴ and the IUCN¹⁵ typologies

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

*Not included in analysis since considered prerequisite for NBS

- **Type of environment:**

- Agricultural land
- Coastal
- Dryland
- Forest
- Freshwater
- Marine
- Mountain
- Urban
- Wetland

2. Collecting and synthesising knowledge gaps on NBS

The examination of knowledge gaps and needs utilised a desktop study of key European publications on NBS in combination with a review of selected literature. An online survey was used to gather insights from the NBS community.

Desk Study:

The desk study started with the analysis of key European publications on NBS. The analysis of those publications allowed us to identify knowledge gaps but also to search for additional bibliography for other relevant publications. To further the study, the search engine of Google Scholar, Science Direct, as well as Google for grey literature was used to research relevant publications, prioritising already comprehensive syntheses of knowledge gaps.

The search was made using the terms “knowledge gaps” and “nature-based solutions” (as well as their variations). Since the term nature-based solution is an umbrella term we also used different terminology of approaches linked to NBS (**Table 1**). The NetworkNature and European Commission Task Forces on NBS were also mobilised to retrieve further relevant publications.

Table 1. *List of terms searched with “Knowledge gaps.”*

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 area

In total 19 publications synthesising (mostly EU) knowledge gaps on NBS were selected as relevant for the desk study (see Annex 3). Knowledge gaps were identified only when clearly stated as such in the publication and citations were gathered into a final database

([NetworkNature Knowledge gaps database](#)), analysed and referred to in this roadmap. 155 unique citations were identified and then regrouped and categorised into 28 broad gaps.

Online Consultation:

An online survey of individuals active within the European NBS R&I sphere was conducted to gather direct feedback from a wider community. The consultation was opened from the 4th of September to the 15th of October on the NetworkNature website and was relayed via the European Commission Task Forces, NetworkNature members, on the NetworkNature and Biodiversa+ social media and sent through different mailing lists. Half of the responses originated from academia/higher education, and half from stakeholder organisations including international organisations (17%), private companies and SMEs (13%) and national and local policy makers or advisors (5%). The responses collected identified 48 knowledge gaps, of which 29 were indeed gaps relevant to NBS. Similarly, to the desktop study, these gaps were also organised within the previously identified 28 broad knowledge gaps.

For more information on the collection and synthesis of knowledge gaps on NBS, find [here](#) the full report on practical, research and innovation needs.

3. Developing strategic objectives for NBS R&I

A strategic workshop was organised in November 2021 to directly mobilise high-level EU experts and global R&I programmes representatives to:

- Present and discuss results of previous work by NetworkNature identifying trends in R&I support for NBS and synthesising key areas where knowledge gaps are prevalent.
- Propose and collectively work on draft topics for the roadmap based on previous work and participants' inputs – either in terms of refining or clustering previously identified topics or proposing new ones, as well as distinguishing potential knowledge gaps between actual research and innovation needs and gaps in knowledge uptake and implementation.

In total twenty-six experts participated in this workshop and collaboratively identified the important levers for R&I to support the further development and deployment of NBS. The results from this workshop were used to further inform R&I needs, but most importantly to develop the pillars and levers of the present EU R&I Roadmap on NBS.

Taking stock

1. Mapping of EU R&I and Implementation projects landscape³

Mapping and analysing the current European research, innovation and implementation landscape of projects on NBS is essential to build the evidence base on NBS by taking stock of what, where and when NBS have been studied and implemented in Europe. As such it is an essential tool to profile EU support of R&I and implementation on NBS and help programme future efforts.

The analysis of the data on funding allocation from the EU NBS Project Database (H2020, FP7, BiodivERsA and Interreg) revealed an increase in funding for NBS projects from 2011 to 2017 in European programmes considered, increasing from fewer than 25 to more than 100 million euros per year (Figure 2). From 2017 through 2020, NBS project funding through European programmes plateaued just above 100M euros per year. The same trends can be observed for the number of projects funded per year, with the number of projects tripling in 6 years from 2011 to 2017, then remaining steady at about 30 projects funded per year from 2017 through 2020.

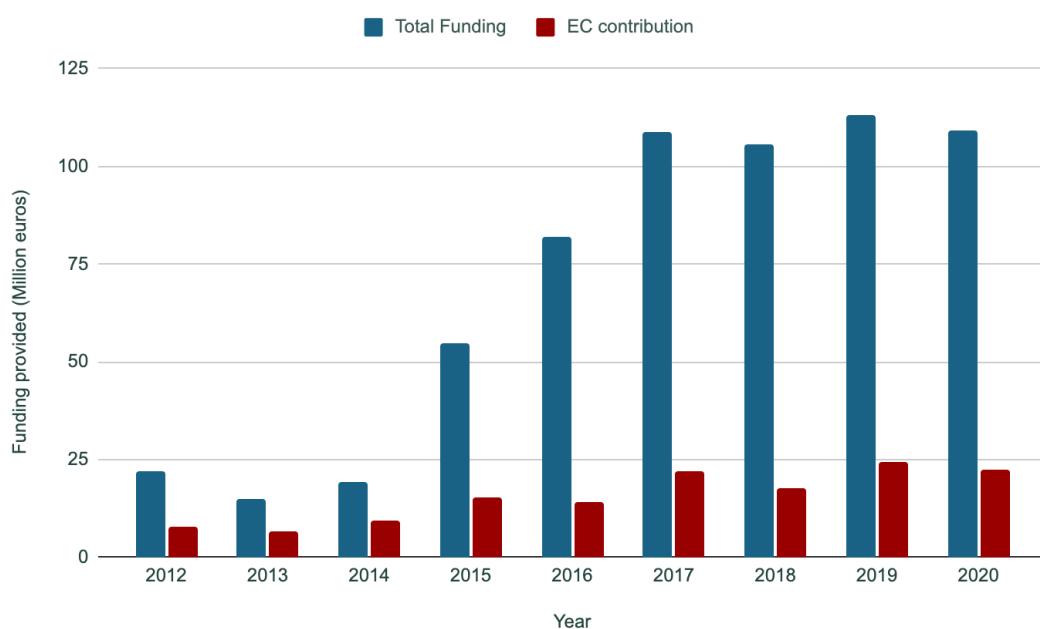


Figure 2 : Funding in million euros of NBS Projects per Year, rolling 3 year average

³ Analyses were done without considering Life CCA projects, to not bias the analysis since this stream of projects is only focusing on Climate change adaptation. Life CCA projects will be included in the analysis when other streams of LIFE (Nature and Biodiversity) are mapped.

The database of projects was categorised using multiple typologies as described in the methodology. The main findings resulting from the analysis of the categorisation are presented in the following (Detailed figures are available in [Annex 4](#)):

- The most studied NBS type in the database of NBS R&I and Implementation projects is Type 2 (Solutions based on developing sustainable management protocols and procedures for managed or restored ecosystems), with nearly 50% of all projects focused on these. Type 3 NBS (Solutions that involve creating new ecosystems) accounted for 39% of those described in the database of NBS R&I projects, followed by Type 1 (Solutions that involve making better use of existing natural or protected ecosystems) NBS, which accounted for 10% of projects.
- The type of Societal Challenge (SC) most studied was Social Justice and Social Cohesion, New Economic Opportunities & Green Jobs and Participatory Planning and Governance with nearly 30% of projects (recognising, however that this is a rather broad category), followed by Climate Resilience (26%), Food Security (16.5%) and Natural and Climate Hazard (16%).
- The approaches most studied in the database were ecosystem-based management approaches, which was studied in 31% of all projects. In these, the most commonly applied physical interventions included Green Infrastructure and Ecological Restoration, representing 20.5% and 18%, respectively, of all projects.
- The most represented ecosystem types in our database were Urban and Agricultural land, which were focus areas for 23% and 20% of all projects, respectively, followed by Coastal and Forest environments, representing 12.5% and 11% of the projects, respectively.

2. Overview of progress on the EU's 2017 research policy goals on NBS

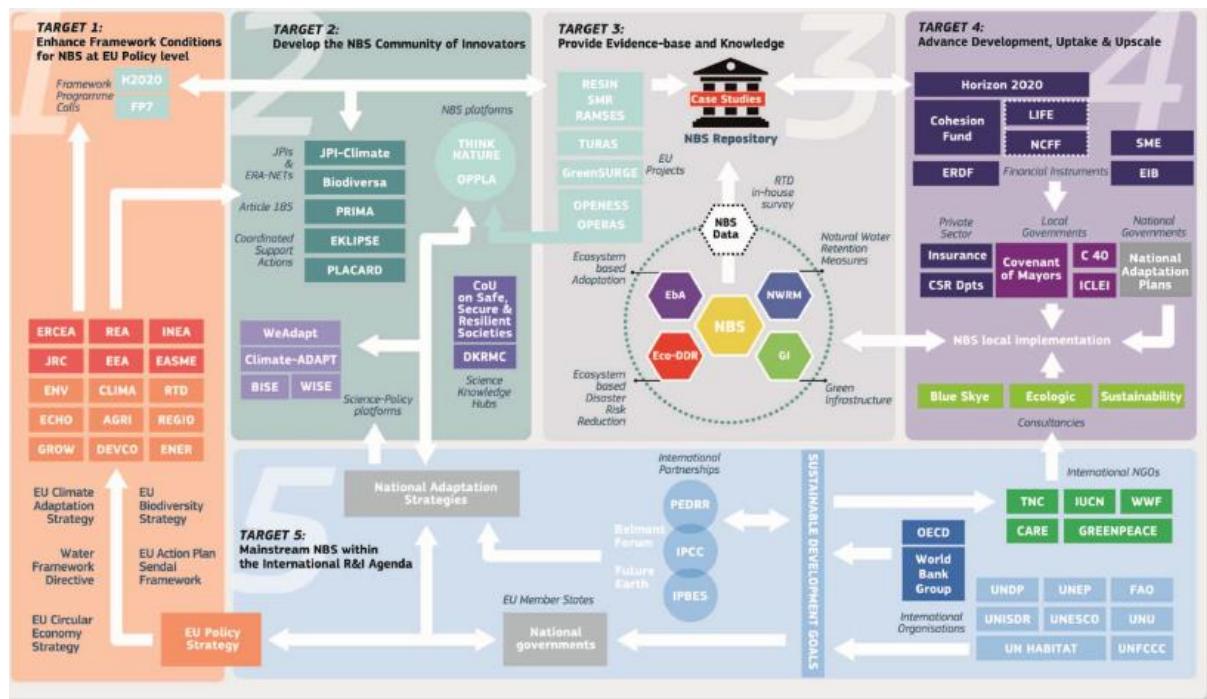


Figure 3 : Mapping of the targets of the Research & Innovation agenda for Nature-Based Solutions
from (Faivre et al. (2017) - Read the full article [HERE](#))

In 2016, the European Commission developed a policy roadmap for R&I on NBS around five policy goals, intending to further develop knowledge and uptake of NBS by pursuing dialogues and initiatives. This section provides an overview of several major advancements that took place since the launch of these five objectives in 2017.

1. Enhancing framework conditions – EU policies

Since 2016, the framework conditions for NBS at the EU policy level have been enhanced in different areas, the main one being:

- *The European Green Deal:*

The European Biodiversity Strategy to 2030, the EU Forest Strategy, the EU Soil Strategy, the EU's Strategy on Heating and Cooling, the Climate Pact and the revised EU Sustainable Blue Economy Strategy, all have specific work streams and policy goals related to NBS, or have identified their potential. In particular the EU Nature Restoration Law (proposal presented in June 2022) and its binding targets per ecosystem type, including urban ecosystems, emphasise the role of NBS in restoring degraded ecosystems. Moreover, the upcoming Urban Greening Plans and corresponding EU

Urban Greening Platform and Green City Accord will foster the implementation of NBS in cities. The EU strategy on adaptation to climate change (2021), clearly identifies NBS for adaptation as one of the main cross-cutting priorities towards the further development and implementation of adaptation strategies and plans at all levels of governance and toward more systemic adaptation.

- *The EU Missions*

The EU Missions will, via specific targets, also push R&I on NBS towards better implementation and uptake of NBS. Three Missions are of particular interest with respect to NBS:

- Adaptation to Climate Change: support at least 150 European regions and communities to become climate resilient by 2030,
- Restore our Ocean and Waters by 2030,
- 100 Climate-Neutral and Smart Cities by 2030.

- *The Zero Pollution Action Plan for Air, Water, Soil*

In the EU Action Plan “Towards Zero pollution for Air, Water and Soil”, NBS are mentioned as one of the solutions to help us ensure sustainable design, collective resilience and more.

- *The Water Framework Directive Floods Directive and Marine Strategy Framework Directive*

The Fitness Check of the Water Framework Directive and the Floods Directive put forward the need for better implementation of the objectives of these Directives (towards full compliance by 2027) that could be based on “best practices on green infrastructure and cost reduction of pollutants at sources”. This implies that NBS could play a significant role in improving the implementation of the Water Framework Directive and the Floods Directive.

2. Develop a community of innovators

The EC supported the development, diversification and expansion of a Community on NBS through specific calls in Horizon 2020 and Horizon Europe, which resulted in funding 32 Horizon 2020 and 4 Horizon Europe projects (*number from July 2022*). This specific portfolio of projects was also joined by four projects on NBS funded under the Green Deal Call. This Community on NBS, established via European projects, built upon the heritage of the FP7 Programme that, while not explicitly addressed NBS, generated knowledge and expertise in green infrastructure (GI), ecosystem services, and the multiple benefits of ecosystem-based approaches used to address societal challenges (EC DG R&I. 2020a).

Within this cohort of NBS projects funded under Horizon 2020, Horizon Europe and the European Green Deal call topics, the NBS Cluster Task Forces were created to gather and synthesise the broad range of approaches and outputs of all these NBS projects within specific (common) topic areas. The objective of the Task Force initiative is to maximise the ecological, social and innovation impacts of these EU-funded projects whilst creating added value and ensuring the policy relevance of project outcomes. Five Task Forces⁴ (TFs) are currently in place to tackle a large variety of subjects with each of them having dedicated topical work streams (**Figure 4**).

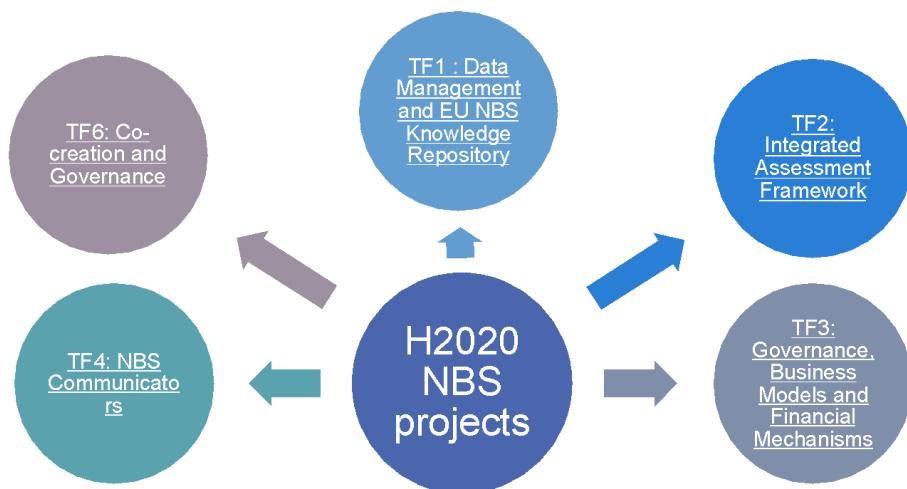


Figure 4 : Diagram of the EU NBS Cluster Task Forces

3. Create and consolidate evidence base

Through Horizon 2020, Horizon Europe and the EU Mission, the EC addressed specific topics within its Work Programmes, which cover a wide range of NBS themes, in particular in several calls in Cluster 6 and EU Mission Ocean, Seas and Water and Mission Climate neutral and smart Cities under the 2021-2022 Work programme.

The EC also supported the development of platforms, databases and networks (e.g. ThinkNature, NetworkNature and NetworkNature+) and an EU knowledge repository on NBS (Oppla) for understanding NBS benefits and promoting knowledge exchange.

Lastly, an analysis of the outputs of EU R&I projects was made to develop a State of the Art in EU-funded NBS projects by scanning for results pertaining to key areas³. The resulting evidence base was used to show the relative cost-effectiveness of NBS, explore how they support policy implementation and highlight policy recommendations and knowledge gaps.

⁴ A TFs 5 used to exist on NBS for Hydro- meteorological Risk Reduction but was later on integrated to the other TFs

4. Advancing the development, uptake and upscaling of innovative NBS

Uptake and upscaling of NBS was driven by the EC through the NBS project portfolio by analysing case studies and by implementing best practices in diverse contexts. The emphasis of the current phase of the EU R&I policy agenda is to provide evidence on the cost-effectiveness of NBS and to facilitate progress on NBS evaluation. This work stream is especially supported by the NBS Cluster Task Forces. Lastly, a study led by the European Investment Bank that analyses access-to-finance conditions for innovative NBS, is identifying market failures, barriers and bottlenecks, as well as seeking to derive financial investment profiles for different types of NBS (In progress).

The EU NBS Task Forces (TF) works on building the evidence base and addressing knowledge gaps and needs

One of the objectives of the Task Forces is to increase the projects' policy and practice impact in response to remaining NBS knowledge and implementation gaps

In TF1 an NBS knowledge repository is being created to allow users and third-party applications to search and retrieve NBS case studies. This work aims to address knowledge and data gaps by defining and implementing an effective approach to share, search and reuse data and knowledge related to NBS.

TF2 produced a holistic framework and associated indicators to establish NBS monitoring and assessment schemes, and evaluate both the multiple benefits as well as the trade-offs of NBS actions. This work resulted in the publication of a handbook for practitioners¹⁴, a collaborative effort among 17 EU funded projects and associated European programmes. This handbook details more than 400 key indicators of NBS performance and impact across 12 challenge areas. An associated Appendix of methods¹⁶ provides a detailed description of each method of NBS impact evaluation as well as guidance about their appropriateness, advantages and drawbacks in different contexts.

TF3 aims to support and accelerate the private sector uptake and investment of NBS, notably with the development of a NBS public procurement guide¹⁷ and a report on the vital role of nature-based solutions in a nature-based economy⁷

Addressing knowledge needs and gaps is also tackled in TF4 and TF6 by increasing the visibility of NBS as well as strengthening co-creation for NBS to better involve citizens and stakeholders in assessing problems and issues, in designing NBS and in their implementation and monitoring.

5. Mainstreaming NBS internationally

The European Commission has taken several actions designed to mainstream NBS internationally¹⁸, such as:

- A specific call in H2020 was focused on “Strengthening international cooperation on sustainable urbanisation: nature-based solutions for restoration and rehabilitation of urban ecosystems” in which a subtopic specifically targeted collaboration with China and the Community of Latin American and Caribbean States (CELAC). Through this call, 4 projects were funded: CONEXUS and INTERLACE (EU-CELAC), CLEARING HOUSE and REGREEN (EU-China).
- Sector Dialogues on NBS were organised between Europe and Brazil where all major Brazilian stakeholders involved in NBS met with European experts and EU funded R&I projects¹⁸. A catalogue of NBS within the Brazilian context is forthcoming with contributions by EU-funded NBS Projects (e.g. CONEXUS, Connecting Nature) and the EU-CELAC strategic roadmap made explicit reference to ways in which NBS focus areas are being addressed.
- European projects also contributed to mainstreaming NBS internationally. For example, UrbanByNature, a joint collaboration between EU-funded projects, Connecting Nature and CLEVER Cities, promotes exchange among cities, researchers, SMEs and NGOs to build bridges with the Nature-Based Solutions communities across Europe, Asia, Latin America, and other interested regions.

All those initiatives and more are integrated into a growing recognition of NBS on the international stage with NBS being increasingly highlighted by the UNFCCC and the CBD, but also by the IPCC and IPBES, although the concept of NBS still meets resistance among some countries' governments.

Roadmap to 2030

Overview of the roadmap strategic pillars and levers

The vision of this roadmap is for EU research and innovation to empower policy, practice, businesses and citizens, building on robust knowledge and data on NBS, in mobilizing the full potential of NBS in achieving a sustainable and just transformation of society.

As such, the foundation of this research and innovation roadmap is grounded in the co-development, implementation and dissemination of knowledge and its timeframe is aligned with key EU and global policy processes related NBS and R&I, e.g. the EU biodiversity strategy to 2030 or the EU Missions on adaptation to climate, restoration of oceans and waters or climate-neutral and smart cities. The roadmap highlights four strategic pillars and related levers, including current knowledge needs, for transdisciplinary R&I to support the deployment of evidence-based NBS in Europe and globally. As presented in section 3, these pillars and related levers are the result of a collaborative development process, involving hindsight on past support of some EU programmes working on NBS, a desk study of knowledge needs in EU publications on NBS and multi-stakeholder consultations. The results of these different activities were presented publicly, and to a group of experts from EU projects (Horizon 2020 and HorizonEurope, BiodivERsA, LIFE) working on NBS, alongside representatives of these programmes and NetworkNature partners, to collaboratively synthesize key areas of development and needs under the four strategic pillars presented.

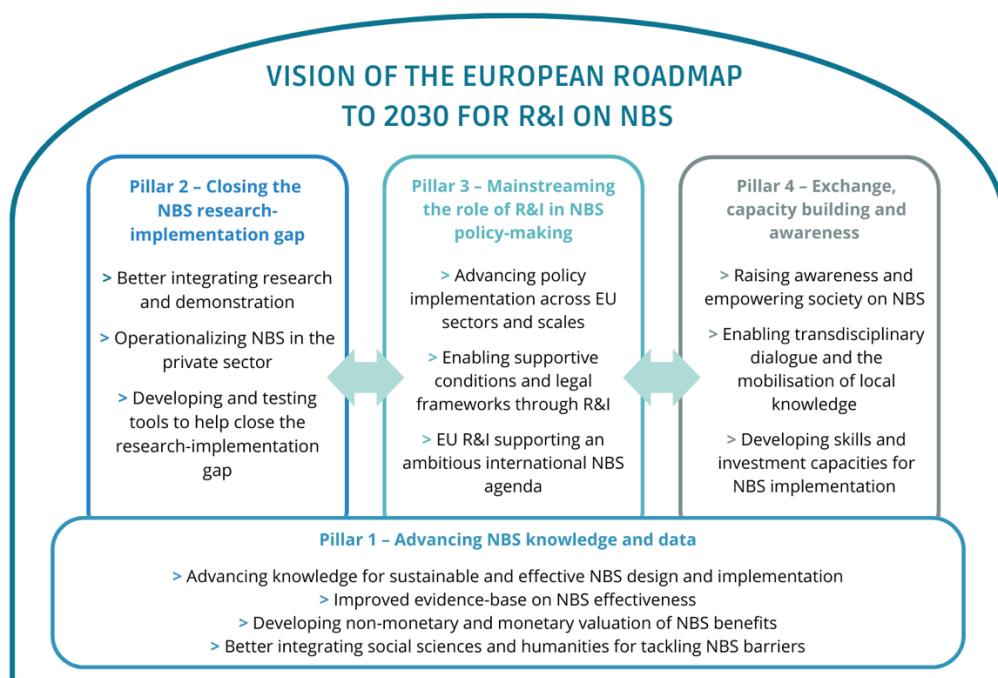


Figure 5 : Vision of the EU Roadmap to 2030 For R&I on NBS

Figure 5 presents an overview of the four strategic pillars of the roadmap and related levers for EU R&I.. It shows the interdependence between the different pillars and highlights the co-development of robust transdisciplinary knowledge as a foundation for the successful and inclusive development and implementation of NBS.

The four strategic pillars of this roadmap are briefly introduced here and presented in further detail below, through the description of levers presented in the figure and corresponding knowledge needs.

Overview of the four strategic pillars

The four strategic pillars are interdependent and feed one another. In particular

- **Pillar 1 on advancing NBS knowledge and data** highlights key levers for NBS knowledge development to promote the sustainable design of NBS, including links between biodiversity, ecosystem functioning and NBS performance, but also links between multiple goals of NBS, considerations for planning NBS across scales and over time, and considering multiple values of nature, and the need for systemic understanding and approaches to NBS. It further presents related data and evidence needs, as well as the need for transdisciplinary approaches to NBS knowledge development, including the mobilization of social sciences and humanities in addressing NBS barriers and in the area of monetary and non-monetary valuation of NBS. This pillar is particularly linked to others, for instance in the development of evidence of NBS to support NBS policy-making (pillar 3), valuation and operationalizing NBS knowledge in business contexts (pillar 2) and developing the investment case of NBS (pillar 4), or in needing space and methods for the development of transdisciplinary dialogues (pillar 4).
- **Pillar 2 on closing the NBS research-implementation gap** acknowledges levers for the further operationalization of knowledge on NBS, through enabling frameworks and environments for stakeholder empowerment on NBS and innovative approaches to research and implementation, as well as working on the development and uptake of standards for NBS in business and better connecting research and implementation to business needs and skills to deliver NBS. This pillar further elaborates on levers for developing and testing tools for closing the research implementation gap, to facilitate the inclusion of NBS in planning and policy, promoting standards, technical reference and designs, and further promoting resource and knowledge sharing platforms on NBS. Some of the levers under this pillar are especially intertwined with those of other pillars, for instance in relation to valuation (pillar 1) and developing the investment case of NBS (pillar 4), or the development of systematic approaches (pillar 1) and standards and tools described here.

- **Pillar 3 on mainstreaming the role of R&I in NBS policy-making** presents key levers for research and implementation on NBS to support NBS policy making across scales in Europe and globally. It deals with the potential for knowledge and evidence on NBS to support and help integrate NBS policy across scales in the EU, but also across sectors, including bioeconomy and circular economy policies but also, e.g., forestry, climate, health or agricultural policies. This pillar also highlights the role of research in identifying and developing supportive legal frameworks and collaborative governance systems for innovation and deployment of NBS, as well as the potential role for knowledge and evidence in supporting the concept and implementation of NBS in international policy and actions. As such, this pillar is particularly tied to the development and advancement of knowledge and evidence on NBS (pillar 1), with consideration to valuation of NBS benefits and diverse values and knowledge systems, and also links to the development of standards for NBS (pillar 2).
- **Pillar 4 on exchange, capacity building and awareness** highlights levers for research, innovation and implementation work on NBS to contribute to raising awareness among citizens and other societal actors on the topic, through knowledge co-creation, but also for the co-development and implementation of NBS. It further calls for space and methods for transdisciplinary dialogue on NBS and integrating diverse values and knowledge systems, as well as calls on the role of research and implementation in supporting the development of skills for NBS implementation and assessment as well as the development of an investment case for NBS. As such this pillar and described levers are tightly weaved into other parts of the roadmap, and intrinsic to e.g. enabling transdisciplinary knowledge co-creation (pillar 1, pillar 2) or stakeholder empowerment and leadership for the implementation of sustainable and evidence-based NBS (pillar 2).

Together these strategic pillars and levers seek to organize and acknowledge key elements of development of knowledge on NBS and of the role of research, innovation and implementation work in promoting the wider uptake and sustainable deployment of NBS. The section below details more precisely each lever presented in the respective pillars above, and highlights key knowledge gaps referenced in the literature directly relating to these levers for European R&I on NBS.

Pillar 1 – Advancing NBS Knowledge and Data

1a. Advancing knowledge for sustainable and effective NBS design and implementation

Identifying and understanding the factors underlying NBS performance and sustainability is key to their successful design and implementation. Thematic areas requiring the development of further research and innovation are numerous and questions can be overarching, sometimes environment or context-specific. Yet key structural aspects seem to be the object of a broad consensus, including:

- **Links between biodiversity, ecosystem functioning and ecosystem services underpinning NBS** are generally recognised as a key area for strategic development¹⁹, especially between/ feedbacks among ecological integrity (« ecosystem condition »), biodiversity and ecosystem services delivery at multiple scales and in different biogeographic regions. The lack of understanding of the implications of ecosystem functioning and diversity for NBS is also tied in with a lack of mechanistic and long-term information and understanding of biodiversity feedback loops between ecosystem functions and societal processes^{20–23}.
- **Identifying and understanding trade-offs between the desired economic, social and environmental objectives of NBS**^{3,19,24,25} as well as between benefits for different stakeholder groups²⁶ would enable a more strategic approach to NBS design and implementation and an improved understanding, management and evaluation of the multiple benefits of NBS^{11,12}.
- **Recognising the diverse values and understandings of nature in NBS assessment and implementation** is crucial for more inclusive, equitable and just biodiversity conservation and decision-making^{22,27}. There are significant knowledge gaps as to how different worldviews and knowledge systems, and broad and specific values, shape NBS planning and implementation in different decision-making contexts. This includes taking account of many different ways that values can be compared, combined or used in parallel. Comparative research on the contribution of different method families (e.g., ‘nature-based’, ‘behaviour-based’, ‘statement-based’ and ‘integrated’ methods) to NBS assessment could significantly guide NBS policy and decision-making²⁸.
- **The effective design, performance and sustainability of NBS over different scales of space and time** is an area with significant margins for improvement:
 - o Planning NBS across geographical scales, from local/small-scale NBS to thinking NBS at the landscape, regional or national scales, or as networks, as well as understanding NBS interdependence and performance at these different scales, remain pressing questions underpinning challenges for replication and upscaling of NBS^{3,4,29}.

- Furthermore, the sustainability of NBS and their performance over time and in the face of global change is also an area of significant unknowns, both in terms of long-term NBS benefits delivery^{3,25,30} as well as the costs of NBS over time^{7,31,32}. Finally, the resilience of biodiversity, ecosystems and NBS themselves under slow on-set events or pressures such as climate change, land-use change or invasions by non-native species is also an area where important progress could be achieved^{3,7,12,22,26,30,33}.
 - Understanding and planning NBS across different socio-ecological contexts, including traditional rural systems, is also an area for improvement of knowledge, whether it be analysing more systematically varying contexts when looking at NBS performance²², or exploring different solutions for different contexts, including what NBS are suited for, e.g., dense urban environments, or rural environments used for pastoralism and agriculture^{3,32}.
- Advancing systemic understanding of and approaches to NBS development and implementation is also largely referred to in identified gaps and entails:
 - Developing easy-to-apply methods and tools for systematic evaluation of NBS such as frameworks for identifying, selecting and designing NBS and conducting cost-benefits analyses^{11,22}, systematic comparisons of different processes of design and implementation²⁵ as well as the adoption of standardised indicators for crosscutting measurement of NBS socio-ecological performance^{7,12,22,26,32,34}.
 - Developing systematic processes of engaging and empowering diverse stakeholders and institutions to be involved in NBS implementation in order to address issues of environmental justice³⁵. Such processes need to pay attention to the tensions associated with more inclusive and just biodiversity conservation through NBS³⁶.
 - Identifying and synthesising knowledge on the approaches and governance systems that can reinforce innovation with and the deployment of NBS, enable institutional cooperation and allow to include NBS in planning and policy frameworks^{19,37}. Expert feedback suggests in particular a need for synthesis and systematisation of existing knowledge to generate adaptive governance and financing strategies, alongside a recognised need for business models and financial mechanisms to support NBS implementation without generating negative socio-economic impacts³. This aspect is further highlighted by stakeholders consulted, who experience deep institutional, legal, and governance barriers to implementing NBS at scale and see a strong avenue for science on how to overcome these barriers.

1b. Improved evidence-base on NBS effectiveness

The need for data and evidence on NBS is clearly identified as hampering their wider-scale implementation and goes hand in hand with many aspects of advancing knowledge on NBS. The main gaps for better documentation of NBS relate to:

- **Gathering data**, such as long-term data on biodiversity feedbacks and trade-offs between ecosystem services^{20,21,23}, data on ecosystem services at different scales³⁷ and data on the effectiveness and multiple benefits of NBS, especially in the context of climate change adaptation and disaster risk reduction¹².
- **Addressing the needs for systemic and comparable analyses and evaluations of NBS**, and underlying monitoring needs, which are often linked to assessing NBS design and performance. This entails an improved documentation of ecosystem functions and services, such as carbon sequestration and storage³ or services provided by woodlands³⁸ and also comparing NBS to hybrid and conventional “grey” solutions^{3,12,13,30,32}. This lever also relates to monitoring needs, such as enabling long-term monitoring and evaluation of ecosystem performance and functioning^{4,37}, as well as monitoring synergies and trade-offs between NBS impacts, different policy objectives and different stakeholder groups^{11,25,26}. Stakeholder feedback also highlighted the impression that multiple NBS studies gathering data at the same locations / sites are today very rare.
- **Implementing more relational approaches to NBS assessment and integration** in order to address critiques that NBS are underpinned solely by neo-liberal logics grounded in performance, cost-effectiveness and efficiency. Economic growth and market-based logic are strongly associated with the destruction of biodiversity globally³⁹. Similar, previous studies indicate that urban NBS are often embedded in environments of social exclusion, neoliberal governance and growth ideology^{35,40}. To move beyond these logics and foster biodiversity conservation, R&I can document new relational approaches to NBS assessment that take account of different ways that people live from, with, in and as nature^{28,41}, and allow to identify how NBS can be designed and implemented in ways that align with and promote these diverse human-nature relationships. This includes improved consideration of relational values and worldviews, and indigenous and local knowledge perspectives on human-nature relationships which often assume no separation between humans and the benefits one receives from nature.

1c. Developing non-monetary and monetary valuation of NBS benefits

Non-monetary and monetary valuations of NBS benefits are largely recognised as a key lever where R&I can support NBS deployment. This relates in particular to:

- **Developing research on economic and non-economic benefits of NBS performance**, including social, economic and environmental costs and benefits, and also considering their valuation across time and space^{12,19,22,30,42}. The need for better inclusion of multiple benefits, but also trade-offs and disservices in these analyses, is largely highlighted^{4,11,43}. These are related, for example, to the creation of jobs or growth^{7,44} or to health and human well-being^{25,32,45}, and tied with the need for more comprehensive and large-scale evaluation of the cost-effectiveness of NBS³. As such this lever closely relates to the operational implementation and evaluation of NBS for practice and policy, described in subsequent pillars.
- **Developing methods, tools and skills for a clear appraisal of economic benefits of NBS**, e.g., related to natural capital accounting and financing of NBS, is key for the development of attractive business models and cases^{7,26}, and advancing the methodologies and tools for systematic evaluation of benefits and co-benefits³; Closely linked to the implementation and capacity building, stakeholder feedback shows that while numerous valuation methods per se exist, a significant challenge remains in capacities and skills required for, e.g., regions or municipalities to consistently evaluate the impacts and benefits of NBS, alongside with their communication to the public. This aspect of knowledge and data development is especially relevant to other objectives of NBS operationalisation in business and developing investment capacities for NBS, and is recognised as a priority question by economic actors. As the World Economic Forum states, “*significant barriers are inhibiting their deployment at scale, in particular how investment is linked with inclusive economic benefit, project prioritisation for sustainable financing*”⁵.
- **Non-monetary and monetary valuation methods within the method families of ‘nature-based’, ‘behaviour-based’, ‘statement-based’ and ‘integrated’ methods** can help consider, beyond natural capital or inclusive wealth approaches, the potential for different types of values of nature and NBS in supporting transformative changes towards just and sustainable futures²⁸. R&I can help identify the ways in which NBS and the multiple values of nature can act as both leverage points and levers for transformative change⁴⁶ and

⁵ https://www.weforum.org/communities/gfc-on-nature-based-solutions?DAG=c1&qclid=CjwKCAjwv-GUBhAzEiwASUMm4vsGHHeL5yXosKi3V_kILBJJSKdFXP1gYJGACXUw5ceOJteLf_k_jMRoCEngQAvD_BwE consulted on 02/06/22

opportunities for decision-makers to draw upon NBS and the multiple values of nature to enact change, including motivational, analytical, bridging, negotiation, social and governance²⁸. This highlights a role for R&I in uncovering how different methods and institutional structures promote, impede or exclude different value expressions in NBS design and implementation through norms, conventions, rules and other systems of power.

1d. Better integrating social sciences and humanities for tackling NBS barriers

The mobilisation of social sciences and humanities to better understand the relationship between NBS and society is largely recognised as a strong avenue for R&I in tackling barriers to their deployment, with calls for further investment. As such this lever is closely linked to the one on promoting transdisciplinary dialogues and approaches to R&I on NBS. Elements under this lever relate in particular to:

- **Understanding the influence of the diverse values of nature on NBS performance.** This includes a more detailed consideration of how diverse worldviews and knowledge systems, broad and specific values influence the design, evaluation and successful implementation of NBS across contexts and cultures, related to inclusiveness, acceptability, performance, aesthetics and sustainability^{14,32,47}.
- **Further developing approaches to the co-creation and co-implementation of NBS**, e.g. in urban contexts to involve stakeholders beyond acceptability questions but also addressing NBS (long-term) planning, maintenance and monitoring^{3,32}. Expert consultations also raised further examples such as the co-development of pathways for NBS across scales with the modelling community, or developing specific governance approaches to, e.g., protected and productive areas, or supporting the identification of investment needs and pathways⁴⁸ and better characterisation of NBS markets⁷.
- **Studying the role of NBS in change and transition processes**, including social and environmental justice dimensions of NBS design and implementation. The potential of NBS in contributing to transformative change⁶ appears promising, contributing elements related to human values about nature and knowledge types, community engagement processes, and environmental management practices, which need to be explored further³⁸. The deployment of NBS at local and regional scales also raises questions in terms of assessing who can access NBS benefits and how to avoid reinforcing existing or creating new inequalities and social injustice, e.g., through gentrification^{3,24,32}.

⁶ As understood in IPBES, 2019 and Diaz et al 2020

Pillar 2 – Closing the NBS research-implementation gap

2a. Better integrating research and demonstration

The further integration of excellent research with demonstration is identified as a general strategic lever for bridging the research-implementation gap, closely linked to the co-development and operationalisation of knowledge and the development of transdisciplinary dialogues. While research and demonstration projects yield significant impacts by testing concepts and building pathways to effectively reach out to end-users, some areas call for further attention, such as:

- Identifying and supporting the enabling framework conditions or environments for stakeholder leadership and empowerment on NBS, linked to supportive policies, adequate financing mechanisms and building user ownership^{3,7,22,29,37}, and as such closely linked to promoting transdisciplinary dialogues and awareness raising highlighted in subsequent pillars.
- Developing innovative approaches to integrate research and demonstration is also called for in expert feedback. This can entail more coordinated/systematic approaches to demonstration activities, e.g., what would an ideal sampling pattern look like for demonstration projects, building towards a more strategic approach to the location and involvement of non-academic partners involved, or addressing issues in persistence of project outcomes over time, and exploring complementary approaches to the support and implementation of demonstration projects.

2b. Operationalising NBS in the private sector

As key actors of potential NBS design and implementation, the active and ongoing engagement of businesses across multiple sectors applicable to the topic of NBS is essential, and opportunities for R&I include:

- Significantly improve the connection of the development of NBS evidence with business concerns, applications and also skills and expertise, e.g., by understanding the value of nature as an input and output in economic processes⁷, articulating business questions and actors early on in R&I, as well as ensuring business feedback of needs towards R&I and mobilising private sector knowledge and expertise to help operationalise NBS in these contexts.

- Drive the development of standard methods and indicators on NBS for their **operationalisation in business**, which is widely recognised as an important lever for R&I to promote the uptake of NBS. This relates generally to developing the practical design and implementation of NBS at an operation level, e.g., on the need for adaptive management and governance, to refer more clearly to ecosystem complexity, temporal scales, effectiveness, and uncertainty^{44,48}. This also includes developing further research on NBS business cases, including economic viability and long-term costs as well as value chains in different sectors, and is tied to the development of elements around the valuation of NBS³ and of standard and practical methods for NBS integration in business models, such as natural capital accounting methods to enable NBS financing^{3,7,32}.
- **Build the capacity of the private sector to deliver NBS.** As demand increases for NBS, publications have identified potential bottlenecks in supply exacerbated by shortages of skilled and experienced suppliers of NBS in the private sector³. Research has identified the potential of nature-based enterprises in the private sector to support the delivery of NBS, simultaneously delivering multiple economic benefits in terms of new innovations, skills, jobs and enterprises^{6,7}. However, nature-based enterprises in the private sector faces many challenges which need to be addressed through further research and policy interventions³¹.

2c. Developing and testing tools to help close the research-implementation gap

Various sources identify knowledge-intensive tools needed to help bridge the gap between NBS research and implementation. These relate to:

- **Developing guidance for NBS design and implementation, and tools to facilitate the inclusion of NBS in planning and policy frameworks**, for example using web-based decision support approaches⁴, combining real-time monitoring and control systems³, scenarios with NBS and grey infrastructure or different levels of implementation to help understand investment needs⁴⁸, or at the metropolitan level with, e.g., user-friendly valuation tools for the evaluation of risk reduction^{3,37} and guidance on measures to spur demand for NBS⁷. Such tools should reflect on the working realities of planners and decision-makers. Another focus should also be on expanding existing planning and design tools, which are already accepted and applied by, e.g., adding a component or module of NBS.
- **Identifying and promoting standards, including technical references, design standards and guidelines**, is called for in various contexts beyond business operationalisation highlighted previously, including for flood risk reduction and climate change adaptation^{3,12}. References to standards not only relate to technical aspects, but also in terms of

developing indicators for cross-site comparisons¹², but also participatory approaches to translating and sharing lessons learned in principles and standards specifically¹⁹.

- **Promotion and further development dynamic resource platforms and knowledge sharing opportunities** on best practices, with a clear need for better accessibility of NBS resources and outcomes over time, but also better communication of existing evidence into policy and practice³⁰ and help to assess knowledge and better share information on NBS and related initiatives³⁷.

While these appear to be important avenues to help closing the research-implementation gap, it should be noted that stakeholder consultations also highlighted the difficulty in handling the multiple standards and best practices already available, suggesting there is a challenge in tying these efforts with the need for systemic analyses mentioned previously. In addition, this aspect is also directly related to subsequent levers of the roadmap on developing capacities, so that guidance and best practices should capture the inherent variability in which NBS works best in a given context in a way that is accessible and manageable for end-users.

Pillar 3 – Mainstreaming the role of R&I in NBS policy-making

3a. Advancing policy implementation across EU sectors and scales

Advancing the policy implementation of NBS across scales and sectors is an area where R&I can provide significant support, in particular to

- **Support better policy implementation of NBS from EU to local scales and integration in the EU regional policy.** Stakeholder inputs highlighted the impression that there is extensive knowledge of NBS applications at the EU level, particularly through EU demonstration projects and access to a significant number of experts. However, this knowledge is not necessarily found to be reaching the member states at different levels of governance and policies rarely contain quantitative and measurable targets relating to NBS deployment and quality of NBS⁴⁹, which can present a barrier to the widespread implementation of NBS. Under this lever, R&I can engage in, e.g., the development of common grounds of prioritisation of biodiversity, ecosystem services and NBS at various administrative levels³⁷, as well as provide science-based advice for the implementation and monitoring of binding and non-binding EU policy targets set out, e.g., in the EU Biodiversity Strategy to 2030 and the proposed EU Nature Restoration Law⁷. An example would be providing evidence-based recommendations for assessing the potential and uptake of NBS in the

⁷https://environment.ec.europa.eu/topics/nature-and-biodiversity/nature-restoration-law_en,
https://environment.ec.europa.eu/publications/nature-restoration-law_en

- upcoming national nature restoration plans or in the development and implementation of no net loss approaches addressing urban and rural biodiversity via the urban green plans³.
- **Assess and support the integration of NBS across sectors**, including in particular bioeconomy and circular economy policies and actions, but also forestry, climate, health or agricultural policies^{7,26}, through e.g. cross-sector analyses of NBS incentives or the development of a robust evidence base and science-based targets and governance frameworks for improved coherence across policy objectives and in supporting and implementing NBS. Consequently, results can also contribute to the adaptation of existing funding instruments and policies to promote and support NBS.
 - **Support to the further integration NBS in the EU biodiversity policy** is also an area of R&I identified as important especially in stakeholder feedback, e.g. through the development of a framework for evaluating NBS against the EU Biodiversity Strategy to 2030, or streamlining NBS contributions to achieving its objectives, which could help strengthen systemic views on NBS integration throughout EU policy but also international policy (see 3c).

3b. Enabling supportive conditions and legal frameworks for NBS through R&I

R&I has a key role in identifying and promoting governance and policy frameworks for enabling favourable and supportive conditions for NBS implementation, by:

- **Identifying and developing supportive legal frameworks for innovation with and deployment of NBS**, addressing the challenge of grey, engineered interventions still being the default approach²⁶. Specifically, knowledge gaps relate to availability of information on the policy and financial incentives and instruments for NBS implementation (including legal, economic, collaboration and awareness raising instruments) and their effectiveness, e.g., for urban governments³, or identifying policy instruments to stimulate the demand for NBS, and what criteria to apply in this regard⁷. In addition, stakeholder consultations also highlighted the need for clearer integration of and references to NBS in existing national legislative frameworks, e.g., in national building codes, national energy and climate plans, or national nature and landscape protection legislation, and in agricultural policy and funding. A meaningful implementation of NBS also requires a political commitment at the national as well as the regional and local level, in correspondence with a long-term vision, and supported by appropriate policy instruments, as well as tailored guidance and tools for decision-making⁵⁰.
- **Identifying and developing collaborative governance systems that enable the successful delivery of multiple NBS benefits**, e.g., towards climate goals such as Nationally

Determined Contributions, and actively engaging R&I alongside practitioners, policy makers, NGOs and local residents in the design, planning, implementation and assessment of NBS^{12,22}. Expert consultations also brought forward recommendations for innovative approaches, in developing, e.g., city-to-region food governance systems to overcome administrative, governance and sectorial silos.

3c. EU R&I supporting an ambitious NBS international agenda

EU R&I can support efforts to carry out an ambitious agenda on NBS globally, through:

- **Contributing to the development of a vibrant NBS knowledge-based economy.** This relates to the role of EU R&I in building European standards for characterising NBS, for instance building on current efforts for NBS standards towards integrating these in ISO standardisation (see e.g. work of CEN/CENELEC⁸ with the IUCN Global Standard on NBS – IUCN 2020), helping to prevent misuse of the term, and allowing the identification and assessment of international financing, value-chains and markets underpinning NBS deployment and effectiveness⁷. Expert consultations further highlighted the role of R&I in identifying policy and financial mechanisms detrimental to NBS and raising awareness of their existence (to hopefully suppress them), which is needed for achieving transformative change.
- **Advancing the knowledge base on NBS to further promote the concept in international policy agendas,** providing evidence of multiple benefits' dimensions. This lever builds around streamlining and communicating elements from the others, for example on the advancement of knowledge of links between biodiversity and, the role of biodiversity in supporting the delivery of ecosystem services and the linkages between NBS, biodiversity and climate, health and circular economy. Efforts are required to develop further this knowledge base at global level to help identify effective approaches to the transfer, replication and upscaling of NBS³.
- **Establishing links between NBS and the implementation of international policy concepts and objectives,** such as the Sustainable Development Goals^{3,12} and, moreover, the Global Biodiversity Framework is already the subject of some work⁵¹ and can be further developed to promote NBS in international agendas. R&I should also contribute to the design and implementation of relevant and emerging policy initiatives such as the UN

⁸ E.g. <https://www.cencenelec.eu/news-and-events/news/2022/press-release/2022-05-24-standards-for-climate/> consulted on 02/06/22

Decade in Ecosystem Restoration, the post-2020 global biodiversity framework as well as future processes driven by multilateral agreements (e.g. CBD, UNFCCC, UNCCD).

Pillar 4 – Exchange, capacity building and awareness

4a. Raising awareness and empowering society on NBS

R&I has a strong responsibility and role to play in raising societal awareness on NBS, in particular, but not limited to, citizens' awareness, through information sharing, co-development of knowledge and identifying approaches to NBS design and implementation that empower stakeholders²⁹. Co-development of knowledge and solutions can also advance their acceptability¹², and more generally promote citizen and stakeholder engagement in NBS implementation and adaptive management²², as well as help clarify NBS beneficiaries and accessibility for different groups^{3,32}. This aspect often appears key in expert consultations for successful NBS implementation, also because public opinion is a powerful driver of narrative change and influence on policy and business. In particular, R&I can:

- Contribute to raising the awareness of citizens and other societal actors regarding NBS, for example, by identifying awareness-raising factors¹⁹ and developing participatory approaches and governance systems that bring together multiple perspectives, e.g. from public administrations to residents²², or academics, practitioners, policy makers, NGOs and local residents in the design and assessment of NBS³, and can support the resolution of conflicts such as perceived disservices of NBS or conflicting land uses¹².
- Involve citizens in knowledge co-creation and NBS implementation, by, e.g., developing effective and easy to apply methods and approaches to engage communities in knowledge development, and advancing citizen science in NBS monitoring and management³⁸. Furthermore, ways and means need to be found to integrate such methods and approaches into government processes and decision-making (where appropriate) as well as into research and implementation projects, also reflecting equity and addressing inclusiveness (e.g., genre, geographic, socio-economic...).

4b. Enabling transdisciplinary dialogue and local knowledge integration

Transdisciplinary approaches to NBS design, implementation and related R&I are of strategic importance in multiple perspectives, ranging from the wide spectrum of stakeholders affected by the implementation of NBS and their co-benefits (as well as trade-offs). This requires participative design and governance of NBS, and related indicators, to NBS that incorporate

local and traditional knowledge and are coherent with the local socio-ecological context. In particular, this lever relates to:

- Providing space and developing methods for the co-production of NBS for the integration of scientific disciplines and the engagement of stakeholders in knowledge development and implementation. This includes the development of processes for the engagement of stakeholders in NBS design^{12,22}, including at the landscape level and across different socio-ecosystems (e.g. urban-rural) and in the longer-term³. It also entails the development of novel approaches in R&I such as open innovation processes to advance the co-production of NBS and secure the active and ongoing participation of stakeholders across sectors in NBS projects⁷, although the regional and cultural component of securing this participation should be recognised, both as a potential opportunity for cross-learning across regions and as a potential barrier for transposing successful processes. In addition, treating NBS dimensions in isolation, whether it be in a perspective of multi- or transdisciplinary, can render negative trade-offs between biodiversity, carbon sequestration and wood production in forest management⁵², calling for increased investment in inter- and transdisciplinary R&I for achieving the co-benefits of NBS.
- Better integrating diverse perspectives, values and needs of stakeholders in assessing NBS, closely linked to the development of valuation methods that take account of NBS co-benefits and the multiple values of nature, including relational, intrinsic and instrumental values, is crucial for advancing the understanding of the delivery of benefits and trade-offs in the complex socio-ecological context of NBS^{12,14,22}. This includes mixed-method R&I designs that balance the need for qualitative and quantitative assessment of NBS impacts, but also the relative variation of costs and benefits of NBS in different settings which highlight the challenge for R&I to work with varying perspectives at scale and the need for contextualised and place-specific assessments and indicators of NBS performance³.

4c. Developing skills and investment capacities for NBS implementation

Relating to the development of the evidence base and knowledge transfer, this lever draws on the role of R&I in:

- Supporting the development of skills for the implementation and assessment of NBS, with a recognised need for further transfer of technical knowledge on NBS, for example, in assessing trade-offs and synergies and optimising the use of technical solutions^{3,11}, and also related to issues in access to information and evidence, e.g. issues in communicating thermal tolerance data to local stakeholders in a meaningful way³ or difficulties in

accessing information on legal instruments and requirements for NBS implementation³. The overload with existing information and potential indicators also appears to be significantly hindering stakeholder capacities for NBS implementation^{43,45,53}, suggesting a potential for R&I in further accompanying stakeholders in doing so.

- Supporting the development of an investment case for NBS, which is closely linked with the valuation of NBS benefits and understanding of NBS design for socio-economic and environmental performance. In particular, there is a recognised opportunity for R&I to support the development of comparisons of NBS between NBS and “grey” or “hybrid” solutions on timescales compatible with global change^{3,30,44}, e.g. by helping clarify investment needs through the use of scenarios combining blue-green infrastructure and grey infrastructure or different levels of implementation of blue-green infrastructure⁴⁸. In addition, advancing the operational understanding of NBS economics appears to be a key component of this lever, from developing financial models for NBS and clarifying NBS benefits in cost-benefit analysis approaches for investment feasibility (Seddon et al. 2020; Grace et al. 2021), to better understanding cost structures and maintenance costs of NBS, or advancing national and EU-wide data and market analyses on emerging and more mature NBS market sectors⁷.

Next steps towards finalisation and implementation

Section under development

Discussions are on-going with the research community and other stakeholders around the development of the new EU R&I roadmap on NBS. This stakeholder engagement will be further strengthened in preparation for the final roadmap in May 2023. Widespread stakeholder engagement around the roadmap development strengthens its relevance and quality and enables the initiation of discussions on its implementation with key organisations and initiatives supporting NBS R&I and implementation.

1. R&I and implementation programmers and funders

First dialogues with European programmers and funders were initiated during a workshop organised in November 2021 by NetworkNature for the development of the roadmap. This workshop provided the opportunity to present and discuss the mapping of EU R&I projects on NBS with representatives from several of the programmes studied, which showed adhesion to the conclusions of the mapping, and sparked interest in its further use and development. Most importantly, it initiated the discussion and reflection on the aim of different programmes, and possible synergies between them in the context of the EU R&I roadmap and its implementation.

This dialogue will be continued with Horizon Europe (including EU Missions), Life and Interreg and Biodiversa+, with other European Partnerships in preparation (Driving Urban transition, Water4All, Agroecology, Blue Economy...), including their national members, and at the international level by mobilising relevant R&I programming and funding initiatives such as the Belmont Forum.

Initial positive signals toward the implementation of the roadmap can already be seen, for example, in the development of a Flagship programme on NBS, Biodiversa+ is organising a Horizon scan exercise, where the draft roadmap is already foreseen as an important background document guiding reflections.

2. Engaging with R&I performers

Consultation with R&I experts on NBS was conducted during the development of this draft roadmap by targeting specific research experts, as well as the European Commission Task Forces on NBS around the development of the knowledge gaps database and the roadmap. Such consultations will be continued and expanded through further targeted as well as open online consultations to reach a wide array of views.

This engagement is already leading to the use of the results of the mapping of EU projects on NBS by researchers, as a good input to use in terms of knowledge gathering and for analysing or mobilising the R&I landscape in Europe.

3. Engaging with policy and society

Policy experts have been involved in these first discussions, notably representatives from the Directorate General for Research and Innovation and the Directorate General for Environment. The engagement of other DGs is also anticipated in developing the final version of the roadmap.

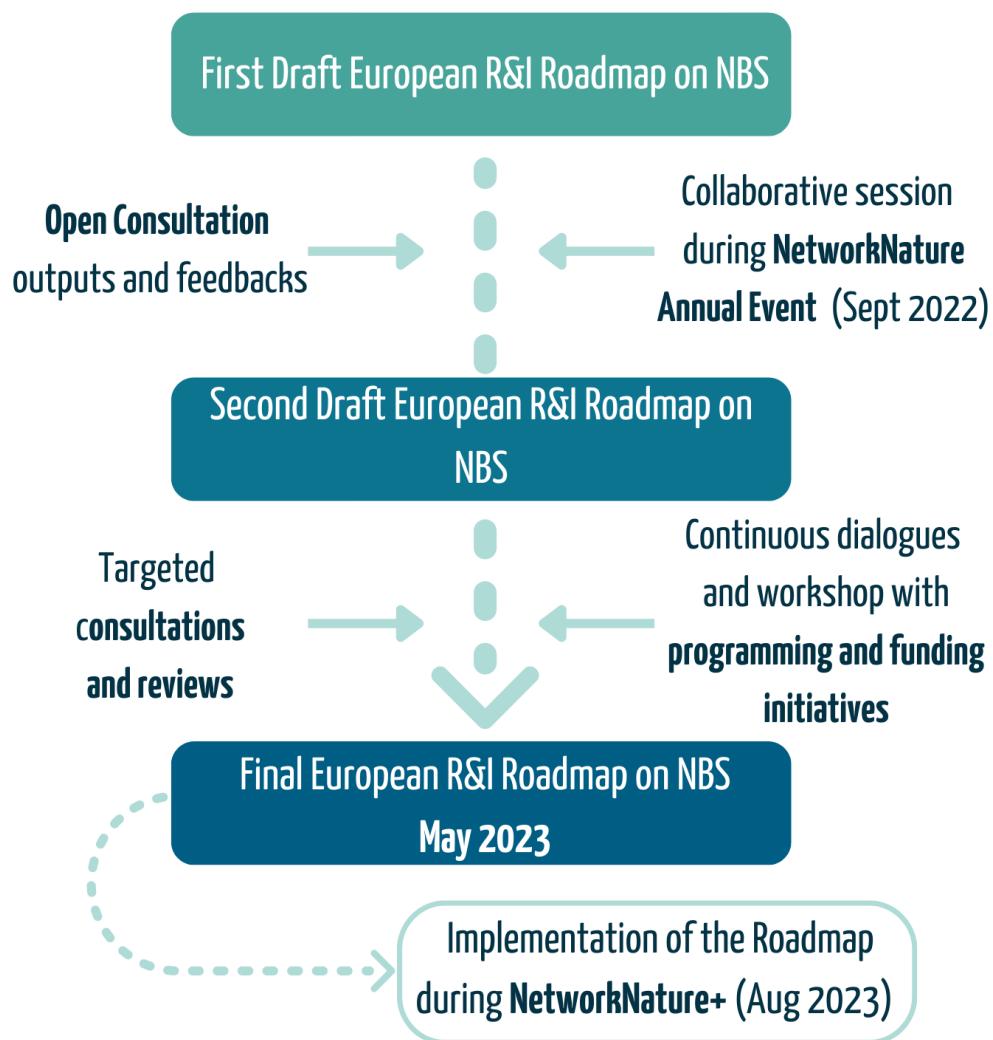
One of the main objectives, for these actors, is to specify the implementation of this roadmap toward policy and particularly around the engagement and the articulation of R&I with the needs and activities of policy and society. This objective will be addressed partly with the organisation of public consultation, as well as through specific dialogues with interested organisations and initiatives, and through the mobilisation of the stakeholder bodies of NetworkNature and its members (e.g., Biodiversa+ advisory board).

Finally, interest in the mapping exercise and use of its outcomes have already been sought from the policy side. For example, the European Investment bank used these results in a study on NBS under development in 2022.

As NetworkNature finishes after the publication of the final roadmap, the implementation is foreseen in the follow-up consortium, NetworkNature+ with activities on evidence and knowledge generation, policy integration, dialogue with programmers and funders, policymakers, as well as with the EC NBS Task Forces.

Next steps in practice

Thank you for your interest in the development of the European roadmap for R&I on NBS. Would you be interested to contribute to its development, please find below a figure describing the next steps towards the **final development of the Roadmap**.



Would you wish to provide inputs and feedbacks for consideration in this roadmap's development, please consider:

- [Reviewing the first draft](#) and sharing your view via the open consultation process running until the **18th of September 2022**.
- [Joining the NetworkNature annual event](#) on **September 27th** in Brussels, with a specific session planned on the co-development of the European roadmap for R&I on NBS
- [Joining the NetworkNature community](#) to be kept informed of the latest developments and opportunities to contribute to this activity and several others.

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Annex

Annex 1: List Keywords for “Biodiversity”

agroecolog*	ecological invader	habitat diversity	pollinator
agrosystem	ecological network	husbandry	population dynamics
aquatic environment	ecological	interspecific	protected area
arable plant	speciation	intraspecific	reef
biocenosis	ecology	invasive plant	river
biodiversity	ecosystem	invasive species	seed
bioecological	fauna	invertebrate	speciation
biogeograph	flora	ipbes	specie
biological adaptation	food web	mangrove	taxa
biological	forest	marine	taxon
conservation	fragmentation	meadow	terrestrial
biological diversity	fragmented habitat	native species	environment
biological indicator	functional diversity	natura 2000	tree
biological invasion	functional ecology	natural capital	tropical system
biological monitoring	functional group	natural environment	urban environment
biological productivity	functional redundancy	natural habitat	vegetation
biosphere	functional trait	natural heritage	weed
blue infrastructure	functional type	nature-based	wetland
breed	genetic diversity	nbs	wildlife
bycatch	grassland	nature improvement	woodland
canopy	grazing	nature reserve	
coast	green	ocean biology	
cultivar	infrastructure	pasture	
diversity	green roof	peatland	
ecological	green space	permanent plots	
ecological gen*	habitat adaptation		
	habitat		
	conservation		

Annex 2: List Keywords “Services and approaches.”

adaptation to climate change agri-environmental measures agroecolog* agroforestry area-based conservation assisted natural regeneration biocontrol biodiversity resilience bioremediation blue infrastructure building with nature climate adaptation service climate adaptation strategy climate change adaptation climate change mitigation climate resilient climate-resilient disaster resilient disaster risk management disaster risk reduction disaster resilience ecological engineering ecological restoration ecosystem management ecosystem-based * erosion risk management erosion risk reduction flood risk management flood risk reduction forest based green infrastructure green space management high-nature value land restoration landscape management management of ecosystem management of erosion risk	management of flood risk management of green space management of landscape management of natural resource management of urban biodiversity management of water resources mitigation of climate change natural areas natural engineered natural infrastructure natural resource management natural treatment processes natural water retention natural-engineered nature based nature forestry nbs protected area re-naturing reforestation resilience management resilience to climate change resilience to disaster resilient to climate change resilient to disaster restoration rewilding river basin plans soil fertility soil rehabilitation soil remediation sustainable risk reduction urban biodiversity management urban greening urban heat island water resource management
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Annex 3: List of publications used in the Knowledge gaps desk Study

Cohen-Shacham, E. et al. Core principles for successfully implementing and upscaling Nature-based Solutions. *Environmental Science & Policy* **98**, 20–29 (2019).

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Somarakis, G., Stagakis, S. & Chrysoulakis, N. ThinkNature / Nature-Based Solutions Handbook. (2019) doi:[10.26225/JERV-W202](https://doi.org/10.26225/JERV-W202).

UNEP-IEMP. Research on Ecosystem-based Adaptation (EbA): A reference guide. (2019).

Annex 4 : Detailed Graphs of the mapping of NBS projects

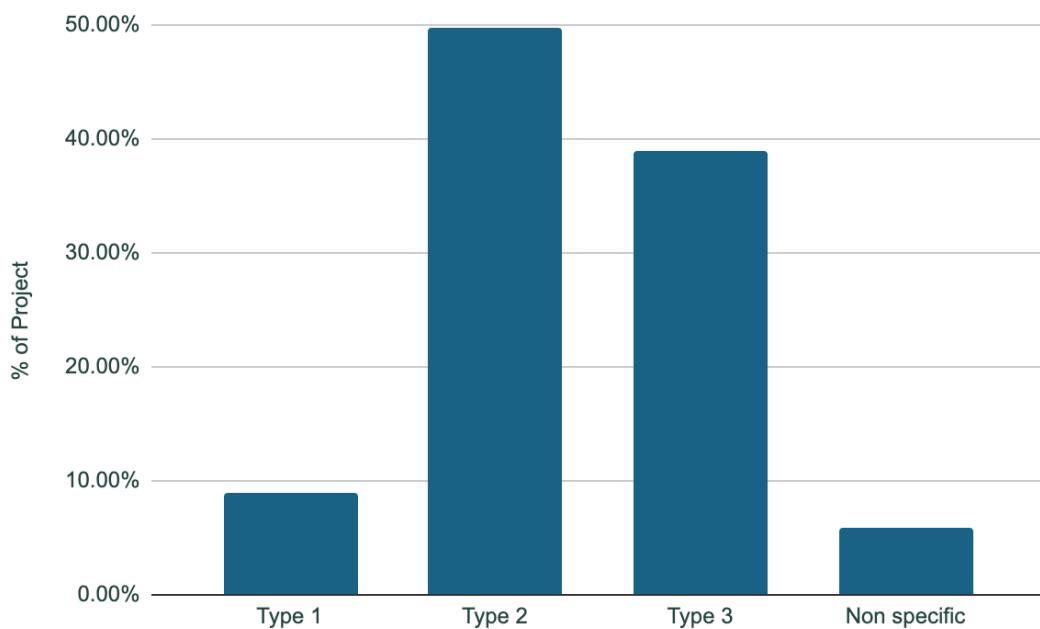


Figure 1 : Types of NBS (Sum > 100% 1 project could be categorized in multiple categories)

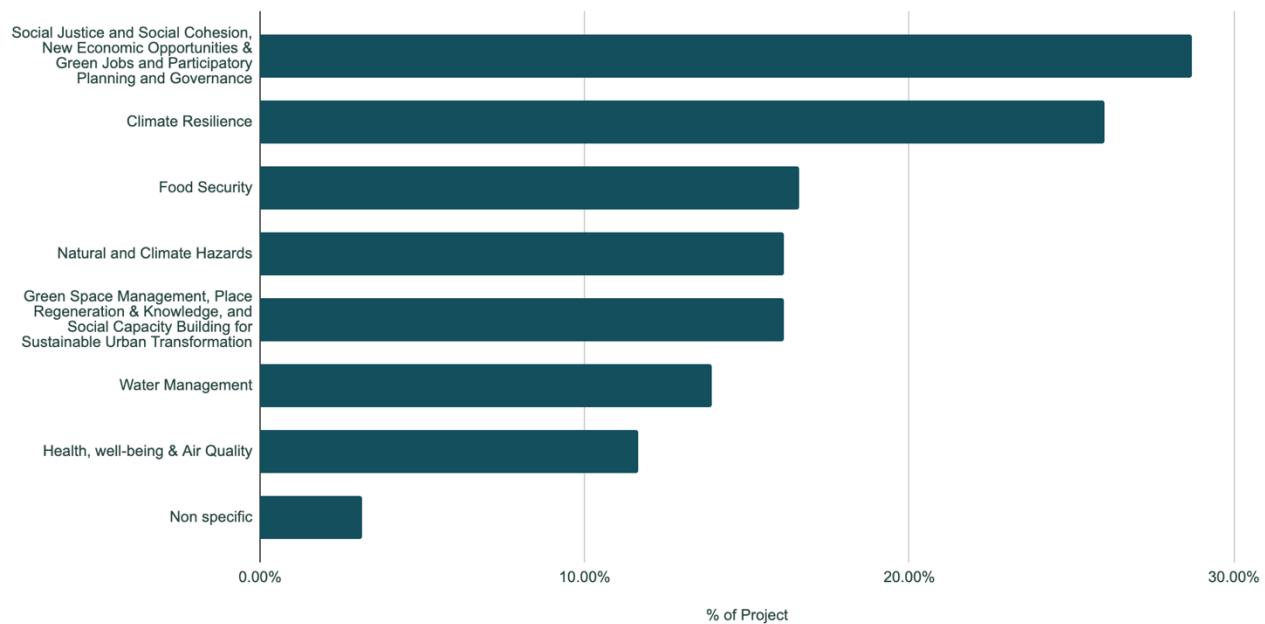


Figure 2 : Types of Societal Challenges (Sum > 100% 1 project could be categorized in multiple categories)

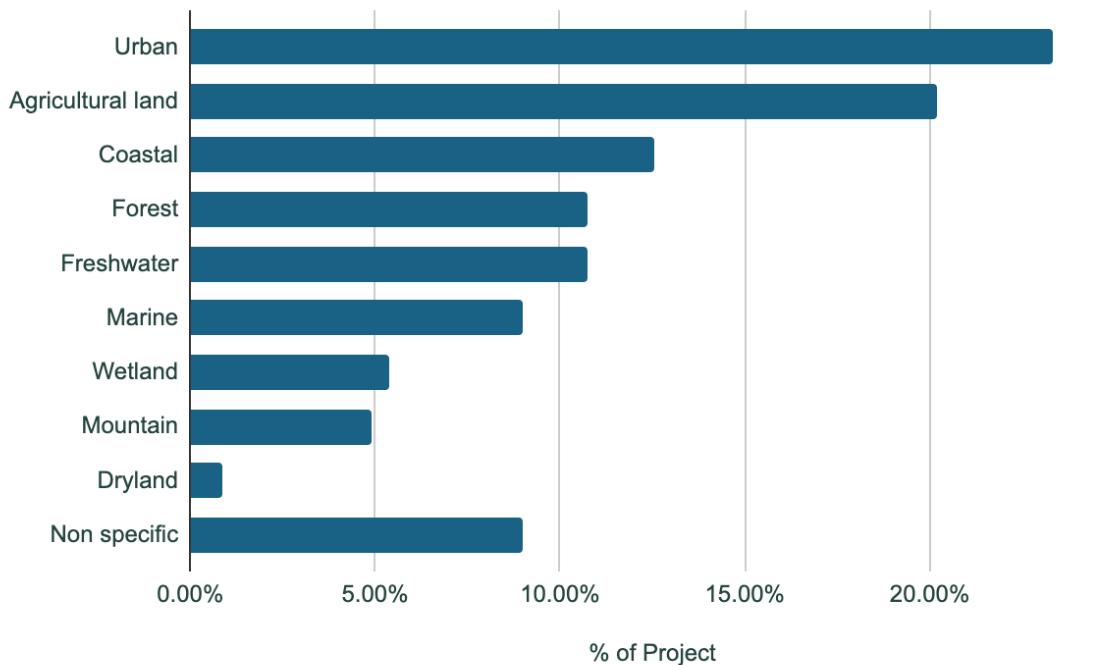


Figure 5 : Types of Environement (Sum > 100% 1 project could be categorized in multiple categories)

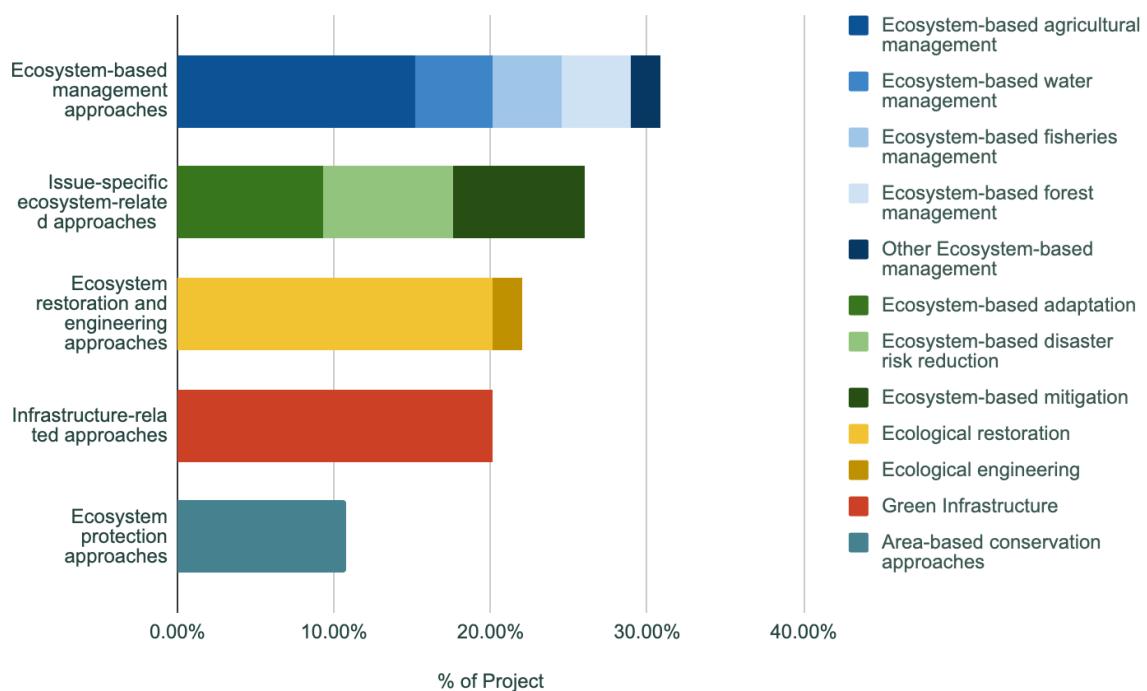


Figure 6 : Types of approaches (Sum > 100% 1 project could be categorized in multiple categories)



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