Ref. Ares(2024)4683941 - 28/06/2024

biofin-project.eu

BIOFIN-EU

PROTECTING AND RESTORING BIODIVERSITY USING MAINSTREAM FINANCE

D2.1: Categorising Nature-based Solutions to support decision making for financial investments.

Lead Author: Mark van Nieuwstadt (Naturalis)

Funded by the European Union

Grant Agreement No.	101135476
Project Acronym	BIOFIN-EU
Project Title	Protecting and Restoring Biodiversity using Mainstream Finance
Type of action	HORIZON-RIA
Horizon Europe Call Topic	HORIZON-CL6-2023-BIODIV-01-9
Start – ending date	1 January 2024 - 31 December 2026
Project Website	biofin-project.eu
Work Package	WP2: Biodiversity Impacts and Supply of Ecosystem Services from NBS
WP Lead Beneficiary	Naturalis Biodiversity Center (NAT)
Relevant Task(s)	T2.2 Categorizing NbS by organizational, spatial, and thematic data
Deliverable type | Dissemination level	R – Report | Internal
Due Date of Deliverable	30/06/2024
Actual Submission Date	28/06/2024
Responsible Author	Mark G.L. van Nieuwstadt (Naturalis)
Contributors	Mark van Nieuwstadt, Anna Biasin, Wassim Le Lann, Mauro Masiero
Reviewer(s)	John Garvey, Koos Biesmeijer, Christopher Brewster

Document History

Date	Version	Status	Contributor(s)
29/05/2024	0.1	Outline	Mark van Nieuwstadt
20/06/2024	1.0	Draft	Mark van Nieuwstadt, Anna Biasin, Wassim Le Lann, Mauro Masiero
23/06/2024	2.0	Draft	Mark van Nieuwstadt
26/06/2024	2.1	Draft	Koos Biemeijer, John Garvey, Christopher Brewster, Anna Biasin, Wassim Le Lann
28/06/2024	2.2	Draft	Koos Biemeijer, John Garvey
30/06/2024	3.0	Final	Submitted version

Funded by
the European Union

Disclaimer
Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Research Executive Agency (REA). Neither the European Union nor the granting authority can be held responsible for them.

Copyright message
This deliverable contains original unpublished work except where clearly indicated otherwise. Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation, or both. Reproduction is authorized provided the source is acknowledged.

Recommended citation:
BIOFIN-EU; Mark van Nieuwstadt; Anna Biasin; Wassim Le Lann and Mauro Masiero (2024) *Categorising Nature-based Solutions to support decision making for financial investments*. BIOFIN-EU, Deliverable 2.1, interim report, pp. 29.

BIOFIN-EU Consortium			
#	**Organisation name**	**Short name**	**Country**
1	UNIVERSITY OF LIMERICK	UL	IE
2	STICHTING NATURALIS BIODIVERSITY CENTER	NATURALIS	NL
3	GOETEBORGS UNIVERSITET	UGOT	SE
4	UNIVERSITEIT MAASTRICHT	UM	NL
5	RAINNO IDIOTIKI KEFALAIOUCHIKI ETAIREIA	RAINNO	EL
6	SARAJEVSKA REGIONALNA RAZVOJNA AGENCIJA SERDA DOO SARAJEVO	SERDA	BA
7	UNIVERSITA DEGLI STUDI DI PADOVA	UNIPD	IT
8	ETIFOR SRL	ETIFOR SRL	IT
9	THE INSTITUTE OF BANKERS IN IRELAND	IOB	IE
10	SUSTAINABILITY LITERACY TEST	SULITEST	FR
11	INTERNATIONAL LIFE SCIENCES INSTITUTE EUROPEAN BRANCH AISBL	ILSI	BE
12	THE QUEEN'S UNIVERSITY OF BELFAST	QUB	UK
13	COFAC COOPERATIVA DE FORMACAO E ANIMACAO CULTURAL CRL	COFAC	PT

Executive Summary

This report outlines a framework of typologies for Nature-based Solutions (NbS) that will enable BIOFIN-EU to align and integrate NbS approaches with financial decision-making. This is a key preparatory step for enabling mainstream finance towards NbS, which will be achieved through the development of a BIOFIN-EU dashboard.

The concept of NbS is explained, and a concise definition is provided to facilitate its uptake. The report advises BIOFIN-EU to align with existing NbS typologies, to ensure consistency and interoperability with the wider NbS community. The NetworkNature initiative is recommended as the primary framework. NetworkNature uses four main typologies for NbS categorization. BIOFIN-EU will require additional typologies for specific topics. These could include (a) more detailed typologies for specific environments or challenges (such as Urban environment), and (b) typologies for dimensions that have not yet been covered (for example governance, or economic and financial considerations). Given the multidisciplinary nature of BIOFIN-EU, the report proposes an Integrated Assessment Chain for the NbS framework to align with. This will allow for a comprehensive assessment of typologies, tools and standards from biodiversity monitoring, natural capital accounting and ecosystem services valuation to investment decision making.

The report sets the stage for the next step for BIOFIN-EU, the design of a dashboard that will facilitate financial decision making and support the development of new financial products and instruments towards NbS.

Table of Contents

List of Figures

List of Tables

Glossary of terms and abbreviations used.

List of Abbreviations and Acronyms	
CBD	Convention on Biological Diversity
DRR	Disaster Risk Reduction
EC	European Commission
ES	Ecosystem Services
GBF	Kunming-Montreal Global Biodiversity Framework
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IUCN	International Union for Conservation of Nature
MAES	Mapping and Assessment of Ecosystems and their Services
NbS	Nature-based Solutions
NRL	Nature Restoration Law

1. Introduction

BIOFIN-EU aims to unlock financial flows towards reversing biodiversity loss, in alignment with the European Green Deal priorities and in particular the EU Biodiversity Strategy for 2030 and the 2030 Climate Target Plan. The project will enhance the implementation of the sustainable finance taxonomy, thereby mainstreaming biodiversity and ecosystem services into society and the economy. The project will develop financial solutions to address societal challenges, including through innovative funding approaches for Nature-based Solutions (NbS).

A key approach to achieve these goals is by enabling mainstream finance towards NbS through the development of a dashboard that will facilitate financial decision making and support the development of new financial products and instruments. To enable such innovations, there is

a need for a framework of typologies that can provide alignment and integration of NbS approaches and financial decision-making.
This report aims to provide an outline of the current situation for such a framework. It serves as a focus point to engage in a cooperative development process with BIOFIN-EU project partners and, where appropriate, stakeholders from society, business, economics, and the financial world to identify mutual needs, opportunities, and preconditions (Task 2.2, phase 2).

1.1. Nature-based Solutions

Nature-based Solutions (NbS) are an umbrella concept for a type of integrated landscape interventions that aim to achieve sustainable outcomes with benefits for both society and biodiversity (Cohen-Shacham et al. 2016; IUCN, 2020 a, b). In a strict sense, they always relate to the management of a specific landscape or waterscape. They are becoming commonplace in many domains, including agriculture, construction, infrastructure and energy, and other land uses. As such they are part of the broader European strategy to make economic activities sustainable, alongside approaches such as a circular economy, and reducing the unsustainable impacts and dependencies of economic activities on nature (EC, 2021).
Although the concept of NbS has received a lot of attention as an approach to make society and the economy more sustainable and to face problems such as biodiversity loss and climate change, there are still several hurdles that stand in the way of their broad implementation (Biodiversa+, 2024; Somarakis et al., 2019; EC, 2021; El Harrak & Lemaitre, 2023). One is their financing, as highlighted in the so-called biodiversity financing gap (Deutz et al., 2020 (colloquially referred to as the 'Paulson report'); also see Somarakis et al., 2019; Dasgupta, 2020). Currently, NbS are often publicly financed. As public finance alone will not be sufficient to achieve the policy goals that have been set (Seddon et al., 2021), and structural changes in the economy and financial world are needed if the sustainability goals are to be met, authorities seek to encourage private investments in NbS and other sustainable, biodiversity-promoting approaches. In this context, the BIOFIN-EU project was created to develop new financing instruments and approaches to stimulate private financing for NbS.

1.2. Biodiversity

Biodiversity refers to the variety and variability of life forms within a given ecosystem, biome, or the entire Earth. It encompasses the diversity of species, genetic variation within species, and the range of ecosystems that house these organisms. Biodiversity is both dependent on, and crucial for ecosystem stability and resilience. Healthy, resilient ecosystems are in turn essential to provision the ecosystem services that are vital for human well-being.
Biodiversity is under pressure: recent time has seen alarming declines in species richness and ecosystem integrity around the world (IPBES, 2019). This loss is caused by human influences such as habitat destruction, climate change, pollution, overexploitation of natural resources, and invasive species. The progressive loss of biodiversity threatens the functions and services

of ecosystems and in this way affects, for example, food security, water quality and climate, ultimately threatening human well-being.

1.3. Policy agenda

Steps are being taken at a global level to reverse the ongoing loss of biodiversity. The global biodiversity policy agenda is mainly guided by the Convention on Biological Diversity (CBD, 2004), an international treaty aimed at conserving biological diversity, promoting sustainable use of its components, and ensuring fair and equitable sharing of benefits. The Kunming-Montreal Global Biodiversity Framework (GBF), adopted in 2022 at COP15, outlines new targets to halt and reverse biodiversity loss by 2050. The GBF emphasises the integration of biodiversity considerations into broader policies and international cooperation to address the multifaceted causes of biodiversity loss.

The European Commission's Biodiversity Strategy for 2030 (EC, 2020), proposed in 2020, serves as the EU's contribution to the Global Biodiversity Framework (GBF). In June 2024, the European Counsel formally adopted a version of the Nature Restoration Law (NRL). This law aims to put measures in place to restore at least 20% of the European Union's land and sea areas by 2030, and all ecosystems in need of restoration by 2050. It sets specific, legally binding targets and obligations for nature restoration, including for free-flowing rivers, agricultural, forest and urban ecosystems, and the protection of pollinators. The regulation aims to mitigate climate change and the effects of natural disasters. It will help the EU to fulfil its international environmental commitments, and to restore European nature.

As a type of intervention to achieve the goals that have been set, NbS are explicitly mentioned in the European Green Deal (EC, 2019) and recent major European policy initiatives, such as the EU Biodiversity Strategy 2030 (EC, 2020) and the new EU Climate Change Adaptation Strategy (EC, 2021). The EU Biodiversity Strategy 2030 highlights the potential of NbS in the fight against biodiversity loss and climate change. NbS are expected to make a significant contribution to the goals in the NRL. For a more comprehensive description of the policy context of NbS refer to *Evaluating the Impact of Nature-based Solutions: A Handbook for Practitioners* (EC, 2021).

2. Key concepts for Nature-based Solutions

2.1 The concept of Nature-based Solutions

The term "Nature-based Solutions" (NbS) emerged in the late 2000s as a novel approach to mitigating and adapting to climate change while simultaneously safeguarding biodiversity and promoting sustainable livelihoods. The International Union for Conservation of Nature (IUCN) introduced the concept in a position paper for the United Nations Framework Convention on Climate Change (2009), and the European Commission further developed it under the Horizon 2020 Framework Programme (2015).

In recent years, various definitions of NbS have been proposed (Maes and Jacobs, 2017; van der Jagt et al., 2017; Short et al., 2019; Albert et al., 2019; Cohen-Shacham et al., 2016; Kronenberg et al., 2017). However, the absence of a universally accepted definition has led to confusion about what qualifies as an NbS (Dorst et al., 2019), highlighting the need for clearer explanations and distinctions from pre-existing nature-related concepts such as natural solutions (Dudley et al., 2010), natural systems agriculture (Jackson, 2002), and ecological engineering and green infrastructure (Benedict and McMahon, 2006).

The IUCN considers NbS an umbrella concept encompassing these approaches, but there are calls for a different definition (Sarabi et al., 2019; Dorst et al., 2019; Nesshöver et al., 2017). Clarifying the concept is essential to stimulate discussion and innovation, facilitate communication among science, policy, and practice communities (Abson et al., 2014), and ensure socio-environmental impacts are properly evaluated (Bennett et al., 2009; Nesshöver et al., 2017).

Efforts to standardize NbS terminology include classification proposals by Eggermont et al. (2015) and Depietri and McPhearson (2017), categorizing NbS into three types: use of natural ecosystems, managed or restored ecosystems, and creation of new ecosystems, which can be implemented alone or with other solutions to societal challenges (see section 3.2).

A systematic review by Sarabi et al. (2019) identified two commonly cited definitions by the IUCN and the EU, with the latter being more widely adopted. This aligns with Nesshöver et al. (2017), who emphasize that NbS should explicitly state their development goals, acknowledging that ecosystem services may not always correlate with biodiversity outcomes.

The most recent harmonization effort was the UNEA-5 resolution in 2022, defining NbS 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, resilience, and biodiversity benefits” (UNEA, 2022). Additionally, several frameworks and guidance documents for NbS have been published (Nesshöver et al., 2017; Frantzeskaki, 2019; Sarabi et al., 2019; Morello et al., 2019), including the IUCN's Global Standard for NbS launched in 2020, which provides eight criteria and 28 indicators for assessing NbS and guiding adaptive management (IUCN, 2020a,b).

2.2 A working definition for the ‘narrow’ interpretation of NbS.

An important impediment for the adoption of NbS stems from both the broad scope and the inherent complexity of the concept. NbS cover a wide range of interventions, from explicitly landscape or seascape related, to activities that are ‘inspired by’ or ‘mimic’ natural phenomena. The former type aligns with the definition by the IUCN (2016, 2020a, b), whereas the definition in use by the EC is broader in scope. For clarity purposes, a distinction is suggested between a ‘narrow’ and a ‘broad’ interpretation of NbS. Since the Learning Sites that are part of the BIOFIN-EU project all fall under the narrow definition, a working definition

was developed for the 'narrow' type of NbS that facilitates communication with parties not familiar with the concept.
The working definition that is suggested for use by BIOFIN-EU aligns with the definition by the IUCN (2016, 2020a,b), but collates some of the topics under the same header. The result is an easier way to communicate definition of NbS that comprises four key elements (Figure 1).

An NbS… :

1. follows an **integrated approach**, taking into account different spatial scales and all essential societal, economic, and ecological aspects, which includes engagement and consent of Indigenous Peoples and local communities.
2. is **area specific** and always concerns a particular location, e.g. a landscape or waterscape.
3. has **benefits for nature**, such as sustaining or increasing ecosystem resilience in the wake of climate change, allowing for natural dynamics, improving environmental conditions for nature, and protecting biodiversity.
4. has **human benefits**, both social and economic, which can usually be expressed in the form of Ecosystem Services (ES).

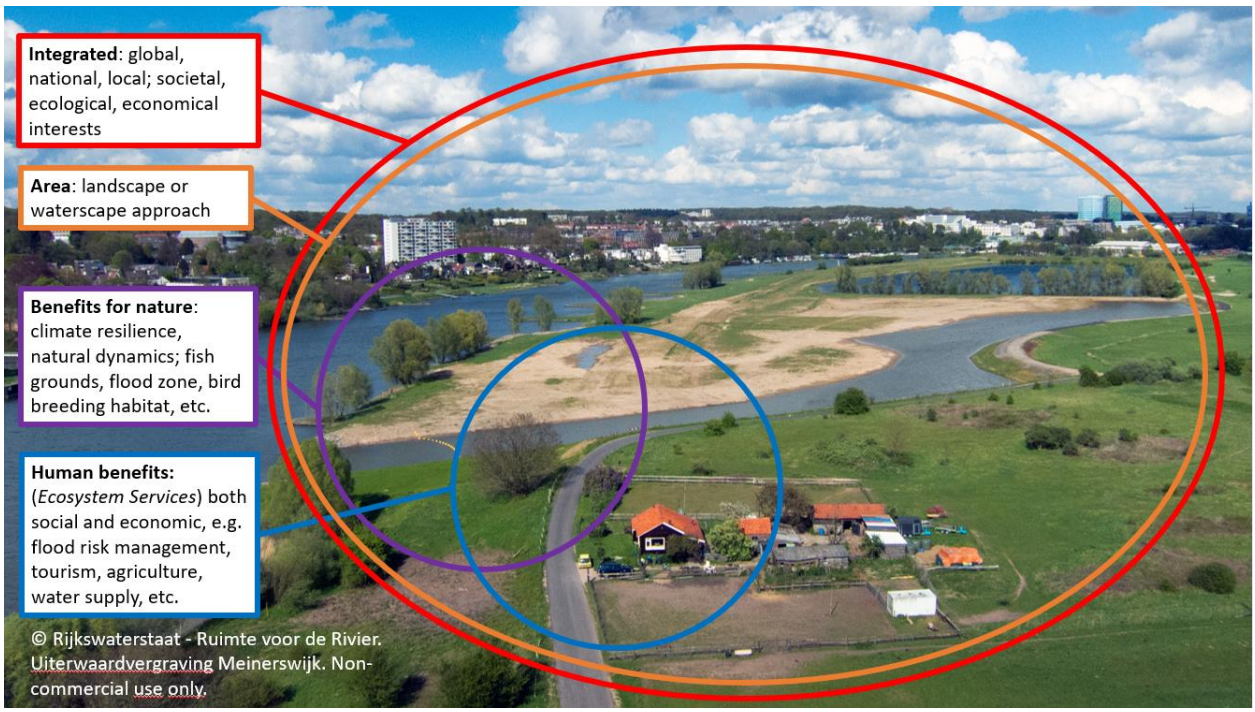


Figure 1. Operationalization of the 'narrow' definition of Nature-based Solutions. Image: Floodplain along the river Rhine in the Netherlands. © Rijkswaterstaat| Ruimte voor de rivier. With permission, non-commercial use only.

All the so-called Learning Sites that are part of the BIOFIN-EU project can be considered NbS in this narrow sense. BIOFIN-EU has been using the working definition in internal and external communications and it appears to a facilitate a quick uptake of what a Nature-based Solution is.

3. A commonly accepted framework of NbS typologies

3.1 Use criteria

Various typologies have been drawn up over the years to categorise NbS (see reviews by Almassy et al., 2018; Biodiversa+, 2024; Castellar et al., 2021; Somarakis et al., 2019; El Harrak & Lemaitre, 2023). For optimal interoperability of BIOFIN-EU with the existing NbS landscape, it is recommended that the project align with authoritative and mainstream typologies and frameworks, as this will both allow for easier uptake of the BIOFIN-EU output by the NbS community, and it will ensure that BIOFIN-EU contributes to the growing consensus on NbS typologies.

Although there is not officially any recognized NbS typology or set of typologies to use, the application of categorisations by authoritative organisations is creating a growing consensus on the framework to operate within. Currently the most wide-ranging initiative at European level for promoting and implementing NbS is NetworkNature. This science-based repository of evidence on NbS is underpinned by an NbS policy roadmap to 2030 which provides explicit justification for the choices that were made regarding the NbS typologies that are being used (El Harrak & Lemaitre, 2023). The selected typologies themselves are well-established in the NbS stakeholder community. The NetworkNature outline was therefore selected as the most promising NbS framework for BIOFIN-EU to align with and will be further explained in the following paragraphs.

The innovative approach of the BIOFIN-EU project may necessitate additional typologies for other dimensions of NbS. These could include more detailed typologies related to specific dimensions, such as the type of environment (for example urban environments) or societal challenges (for example disaster risk reduction). Some dimensions of NbS are not covered in the basic NbS framework, for example those related to governance and finance. Chapter 4 of the current report maps existing reviews that have explored these topics. These typologies are essential mechanisms for actors within the financial system to activate financial flows. These flows can be realised by integrating NbS in a variety of decision-making settings including financial contracting (e.g. commercial lending) or defining how actions are taken in sustainability reports (e.g. under the EU Green Bond Standard) to name two.

A subsequent co-creation workshop for WP2 will explore and map the needs for BIOFIN-EU regarding additional dimensions and typologies. These may adopt existing typologies or require new categorizations. WP2 of BIOFIN-EU will prepare a proposal for phase 2 of Deliverable 2.1.

3.2 The NetworkNature framework of typologies

The EU-funded NetworkNature platform is a resource for the NbS community that aims to synthesise and strengthen the NbS evidence base, and to accelerate the uptake of NbS across

science, business, policy, and practice. NetworkNature has mapped European research, policy, projects and market-based tools and resources, which are collated in the Knowledge Database. Four dimensions of NbS form the core of the NetworkNature classification (Table 1). The typologies that were developed for each of these four dimensions are derived from authoritative publications and are widely used in the community. In some cases, El Harrak & Lemaitre (2023) used updated versions of the typologies, presumably to better suit the needs of the portal or to reflect new insights gained after publication of the original typologies. While we endorse the use of the same dimensions as selected by NetworkNature, we do not agree with all the suggested changes; in two cases we will argue for the use of the original typologies. Moreover, in case of the typology by Eggermont et al. (2015) we will argue to use only the primary dimension that they proposed, e.g. the degree of ecosystem engineering.

Table 1. Four typologies selected for common use by NetworkNature. Source: El Harrak & Lemaitre, 2023.

Dimension	Source
Type of NbS	Eggermont et al., 2015
Types of approaches studied	An adaptation of the IUCN typology in Cohen-Shacham et al., 2016
Type of environment	Derived from Maes et al., 2020
Types of societal challenge(s) tackled	Derived from the EC and IUCN (2016) typologies

3.2.1 Typology for the type of NbS

Eggermont et al. (2015) proposed a widely recognized typology that delineates three types of NbS, primarily delineated by the degree of ecosystem engineering (Table 2). Importantly, the distinctions between these three types are not rigid: the scheme allows for hybrid solutions that may transition from one category to another over time.

While we endorse the use of these three degrees of ecosystem engineering, we do not recommend the use of the oft-reproduced graph that goes along with the typology (e.g. Figure 1 in the original publication by Eggermont et al., 2015). This figure suggests the existence of a relationship between the level of ecosystem engineering and both the enhancement of ecosystem services, and the number of stakeholders involved. While there is indeed proof for the existence of a correlation between the enhancement of ecosystem services by NbS and the number of stakeholders involved (Howe et al., 2014), to our knowledge the implied correlation with the degree of ecosystem engineering has never been established. In any case, these two additional variables will not be highly relevant for the design of the BIOFIN-EU NbS framework. It is therefore recommended that BIOFIN-EU use only the fundamental grouping, e.g. the degree of ecosystem engineering, and ignore the other two dimensions. As a consequence, a simple table representation should be preferred over the often-reproduced graph. This choice has actually the added advantage that this dimension of the NbS concept becomes easier to understand.

Table 2. Type of NbS, following the typology developed by Eggermont et al. 2015.

Type	Solutions that involve:
Type 1	Improved use of existing natural ecosystems and protected natural areas
Type 2	Improved use of managed or restored ecosystems
Type 3	Design and management of new ecosystems

Type 1 encompasses minimal to no intervention in ecosystems and aims to maintain or enhance the delivery of various ecosystem services (ES) within and beyond the area under management. This type of NbS aligns with concepts such as biosphere reserves, which integrate core protected areas for conservation with buffer and transition zones where sustainable human activities occur.

Type 2 involves the management approaches that develop sustainable and multifunctional ecosystems and landscapes, either extensively or intensively managed. These approaches aim to enhance the delivery of specific ecosystem services compared to conventional methods. Examples include innovative planning of agricultural landscapes to boost multifunctionality and strategies to increase tree species and genetic diversity for greater forest resilience to extreme events. This type NbS is closely linked to concepts such as natural systems agriculture.

Type 3 involves more highly intrusive ecosystem management or the creation of new ecosystems, such as artificial ecosystems to mitigate urban heat. This type is associated with concepts like green and blue infrastructure and aims to restore heavily degraded or polluted areas. Novel approaches explore how to integrate biodiversity conservation with landscape architecture.

Type 1 is in full concordance with the IUCN framework. Types 2 and 3 also align with the definition, provided they contribute to preserving biodiversity and the sustainable management and restoration of ecosystems while at the same time delivering certain ecosystem services. For agro-ecosystems and inner-city green spaces, it is therefore crucial to consider ecological complexity and connectivity with surrounding ecosystems that aim to enhance biodiversity benefits.

This scheme, classifying NbS according to the degree of intervention and level and type of engineering, can be refined in many subcategories, a concise elaboration of which was developed by Somarakis et al. (2019, 'ThinkNature report'). Main examples of each type of NbS are given in Table 3.

Table 3. Examples of intervention by type of NbS. (Source: Somarakis et al., 2019).

Type 1 – Better use of protected/natural ecosystems
• Protection and conservation strategies in terrestrial (e.g. Natura2000), marine, and coastal areas (e.g. mangroves) ecosystems
Type 2 – NBS for sustainability and multifunctionality of managed or restored ecosystems
• Agricultural landscape management

• Coastal landscape management
• Extensive urban green space management
• Monitoring
Type 3 – Design and management of new ecosystems
• Intensive urban green space management
• Urban planning strategies
• Urban water management
• Ecological restoration of degraded terrestrial ecosystems
• Restoration and creation of semi-natural water bodies and hydrographic networks
• Ecological restoration of degraded coastal and marine ecosystems

3.2.2 Typology for the types of approaches studied.

NbS are, as mentioned above, an umbrella concept that covers a range of ecosystem-related approaches; many of these approaches actually predate the emergence of NbS. They share similarities, particularly regarding the ecosystem services they address and the types of interventions they involve. El Harrak & Lemaitre (2023) recognize eleven types of approaches (Table 4).

Table 4. Types of approaches studied, from El Harrak & Lemaitre (2023), an adaptation of the IUCN typology by Cohen-Shacham et al. 2016. * Are elements added or modified from the original typology.

Broad categories	**Types of Approaches**
Ecosystem restoration approaches	Ecological restoration
Ecosystem restoration approaches	Ecological engineering
Issue-specific ecosystem-related approaches	Ecosystem-based adaptation
Issue-specific ecosystem-related approaches	Ecosystem-based mitigation
Issue-specific ecosystem-related approaches	Ecosystem-based disaster risk reduction (DRR)
Infrastructure-related approaches	Green infrastructure
Ecosystem-based management approaches	Ecosystem-based water management*
Ecosystem-based management approaches	Ecosystem-based fisheries management*
Ecosystem-based management approaches	Ecosystem-based forest management*
Ecosystem-based management approaches	Ecosystem-based agricultural management*
Ecosystem protection approaches	Area-based conservation approaches

Cohen-Shacham et al. (2016) provide an overview of definitions from the literature to clarify the types of NbS approaches, a summary of which is presented in Annex 1.

3.2.3 Typology for the types of environments

The environments (or 'ecosystem types') in the typology used by NetworkNature (Table 5) are based on the comprehensive JRC policy report by Maes et al. (2020). The NetworkNature classification is a slightly adapted version of 'MAES level 2', notably by the addition of 'Mountains' and 'Multiple [environments]'. However, since these types of environments are in fact based on the very well-established concept of CORINE land cover classes, and 'Mountains' are a topographic feature instead of a land cover, its addition to this typology is not recommended. On the other hand, NbS will frequently incorporate a matrix of land covers, and the class of 'Multiple [environments]' is therefore considered useful.

Table 5. Typology for types of environments, based on the original typology of Maes et al. (2020), with one addition (marked with n Asterix) by El Harrak & Lemaitre (2023) .

Type of environment
Coastal, shelf and open ocean
Cropland
Forest
Grassland
Inland wetland
Marine inlets and transitional water
Rivers, lakes and ponds
Sparsely vegetated land
Urban ecosystem
Multiple*

The comprehensive MAES typology is a suitable starting point for an ecosystem typology to be used for an interdisciplinary approach such as BIOFIN-EU. However, it should be remembered that the MAES typology focusses on ecosystems in the European Union and may therefore need refinement if BIOFIN-EU takes a global approach. MAES in several cases does not distinguish between natural and semi-natural biodiverse landscapes versus intensely managed and impoverished landscapes, for example in the case of grasslands and forests. This could become an issue when implicit values are attached to these concepts in the context of the BIOFIN-EU dashboard. While it may not be a great concern in the general interface through which users interact with the BIOFIN-EU dashboard, a refined classification could be needed if BIOFIN-EU is to offer spatially explicit assessments. Several more refined land classifications and hierarchical approaches are available (Chapter 4). Within the context of the needs and uses for BIOFIN-EU, further recommendations will be developed in the workshop that is planned for Phase 2 of Task 2.2.

3.2.4 Typology for the types of societal challenges

The NetworkNature typology of societal challenges integrates the typology by the IUCN (2020) and the European Commission (El Harrak & Lemaitre, 2023)(Table 6). Due to advancing insight, it takes the finer categories from each typology that are missing from the other, except for the merging of 'Human health and well-being' and 'Air quality' into a single category.
The result is a robust typology that aligns well with the major existing approaches. It is thus recommended to follow the typology by NetworkNature, with the exception however of the merging of 'Human health and well-being' and 'Air quality.' The rationale for not merging these two types being that Air quality is a large and complex biophysical topic that is the subject of a specific set of European Directives (The Ambient Air Quality Directives; EC, n.d.) and requires specific interventions and monitoring methods; as such its separate categorization is expected to improve the focus of the typology.

Table 6. Typology for the types of societal challenges, derived from NetworkNature (Source: El Harrak & Lemaitre, 2023)

Type of societal challenges
Climate Resilience
Water Management
Food Security
Social Justice and Social Cohesion
New Economic Opportunities and Green Jobs
Participatory Planning and Governance
Natural and Climate Hazards (= Disaster Risk Reduction*)
Human health and Well-being*
Air Quality*
Green Space Management
Place Regeneration
Knowledge, and Social Capacity Building for Sustainable Transformation
Biodiversity Enhancement

*: Adaptations of the NetworkNature typology.

BIOFIN-EU can use the typology of societal challenges to align NbS with both financial decision-making approaches and policy objectives. Implementing the typology will highlight how different NbS can address specific societal challenges, thus facilitating targeted interventions and the development of sustainable investment opportunities. Starting from the NetworkNature typology, BIOFIN-EU will develop a comprehensive framework that maps societal challenges to specific NbS interventions, highlighting their primary benefits as well as potential co-benefits. By clearly demonstrating how NbS can address key societal challenges, both investors and policymakers will be able to better recognize the value and multifaceted impacts of these solutions. This approach will serve as a means to integrate NbS into the financial decision-making tools that BIOFIN-EU will develop.

4. Typologies for other dimensions of NbS

BIOFIN-EU will develop a framework of financial instruments that targets NbS in a broad environmental and societal context. The primary need is therefore for the high-level typologies that distinguish NbS on the key issues that were outlined in the previous chapter. As the project evolves toward more specific topics, a need for more detailed typologies may arise. The exact goals of the Dashboard need to be determined in more detail before a targeted selection can be made, and in this context the specific needs of the project are to be regularly reviewed as the program takes shape.

Al the same, usable leads can already be provided to anticipate these future developments, since detailed typologies for specific topics are available, both in the form of an extensive body of literature, as well as comprehensive reviewing reports by previous research projects and some of the larger stakeholders. However, there is no universal consensus, let alone standardisation, on which frameworks to use. Once the strategic choices for BIOFIN-EU have been made, it is recommended as best practice that the project seek strategic alignment with existing authoritative and actively maintained typologies and frameworks.

The additional developments and refinements for the project will relate to three core areas:

1) First, for several dimensions of NbS that are covered by the basic typologies in the NetworkNature framework, more detailed typologies are available, focussing on specific environments (for example Urban environment, or Agricultural landscape) and societal challenges (for example Water management, Climate mitigation & adaptation, or Disaster risk reduction).
2) Second are dimensions of NbS that are currently not, or less well cover by the NetworkNature framework, but that may prove essential for BIOFIN-EU. In this case, it may be necessary to modify existing typologies or develop new ones. The topics of interest are Governance and policy making; Economics and investment solutions; the Scaling of NbS in space and time; Social context (e.g. Sustainable Development Goals (UN, 2016)), and other topics as they may arise.
3) Third, BIOFIN-EU will seek to integrate and align the NbS framework with biodiversity monitoring, Natural Capital accounting, and Ecosystem Services (see chapter 5).

Tables 7 and 8 provide a collection of comprehensive review papers on these core areas, developed by major partakers. These are all recommended reading and may serve as a starting point for future discussions and developments and will allow the BIOFIN-EU partners to efficiently arrive at well-founded choices once the details of the direction in which the project will develop have taken shape.

Table 7. Overview of comprehensive reviews of NbS: Several NbS related dimensions that for which EU-BIOFIN may require further elaboration.

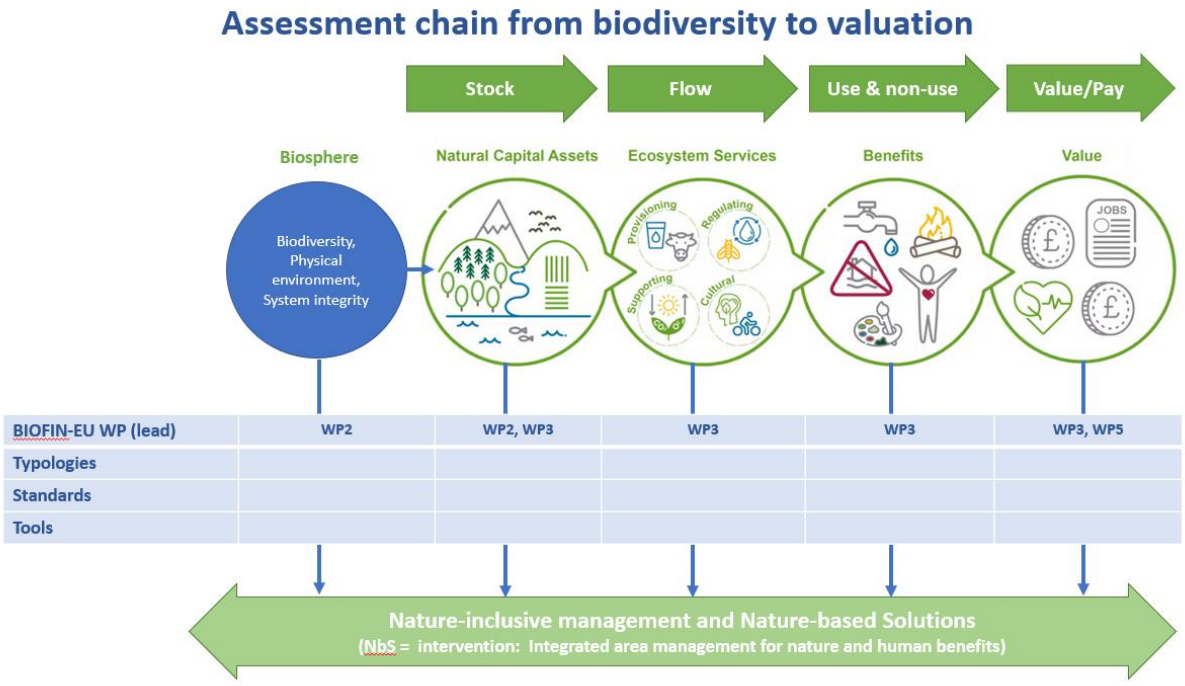
			NbS related dimension											
Short reference	**Authority**	**Explanatory note**	**NbS typology (detailed)**	**NbS case study portfolio**	**Biodiversity**	**Ecosystem Services (human benefits)**	**Governance & policy**	**Financing**	**Societal challenges**	**Monitoring, data collection, indicators, impact assessment**	**Implementation guidelines; interventions; decision & design support**	**Data standards**	**Survey (interviews)**	**Spatial and temporal scaling**
Biodiversa+ (2024)	Biodiversa+	EU research infrastructure on biodiversity	O	Y	Y	O	O	N	N	N	N	N	N	Y
Dumitru & Wendling (EC) (2021a, b)	EC	European Commission	O	Y	O	O	Y	O	Y	Y	Y	Y	Y	Y
Ferreira, Lupp, Mahmoud (2023)	EC	European Commission	N	Y	N	N	Y	N	N	Y	Y	N	Y	N
EEA (2021)	EEA	European Environmental Ageny	N	Y	N	Y	Y	Y	Y	O	Y	N	N	Y
EIB (2023)	EIB	European Investment Bank	O	Y	N	Y	N	Y	N	O	N	Y	Y	Y
Martire et al (ETA, EEA) 2022	ETC-AA, EEA	European Topic Centre Climate Change Adaptation	N	Y	N	Y	O	Y	N	N	N	N	N	Y
Iseman et al. (FAO)(2021)	FAO	Food and Agriculture Organization of the United Nations	O	Y	N	Y	Y	Y	Y	O	O	N	N	O
IPBES (2019)	IPBES	Intergovernmental Panel on Biodiversity and Ecosystem Services	N	N	Y	Y	Y	N	Y	Y	N	N	O	N
IUCN (2020a, b)	IUCN	International Union for the Conservation of Nature	Y	Y	N	N	Y	N	Y	N	Y	N	N	Y
Maes et al. (2020a, b)	JRC, EC	European Joint Research Center	Y	N	Y	Y	Y	N	Y	Y	N	Y	N	Y
MEA (2005)	MEA, WRI	Millenium Ecosystem Assessment, World Resource Institute	N	N	Y	Y	O	N	Y	N	N	N	N	O
Almassy et al. (2018)	Naturvation	Former EC funded EU research project.	O	Y	N	Y	Y	Y	Y	Y	Y	N	Y	Y
McQuaid et al. (2021)	NetworkNature	Coordinating initiative for NbS by EC	O	N	N	O	Y	Y	N	N	O	N	N	N
El Harrak & Lemaitre (2023)	NetworkNature	Coordinating initiative for NbS by EC	Y	Y	O	O	Y	Y	O	N	Y	N	Y	O
Eiselin et al. (2022)	RVO	Netherlands Enterprise Agency	Y	Y	N	O	O	Y	O	N	Y	N	Y	O
Somarakis et al. (ThinkNature)(2019)	ThinkNature	Former EC funded EU research project.	Y	Y	O	Y	Y	Y	Y	(Y)	Y	N	Y	Y
UNaLab (2022)	UnaLab	EU research project on Urban NbS	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y
UNEP (2021)	UNEP	United Nations Environment Programme	N	N	N	N	Y	Y	Y	N	N	N	N	N
Castellar et al., 2021		Peer-reviewed paper	Y	N	N	Y	N	N	Y	Y	O	O	Y	O
Nehren et al. (2023)		Peer-reviewed paper	Y	N	N	Y	N	N	Y	Y	N	N	N	Y
Simelton et al. (2021)		Peer-reviewed paper	Y	N	N	Y	O	O	N	N	N	N	N	Y

Table 8. Overview of comprehensive reviews of NbS: Type of environment.

			Type of environment										
Short reference	**Authority**	**Explanatory note**	**Coastal, shelf and open ocean**	**Cropland**	**Forest**	**Grassland**	**Inland wetland**	**Marine inlets and transitional water**	**Mountains***	**Rivers, lakes and ponds**	**Sparsely vegetated land**	**Urban ecosystem**	**Multiple* (Mosaic)**
Biodiversa+ (2024)	Biodiversa+	EU research infrastructure on biodiversity	O										
Dumitru & Wendling (EC) (2021a, b)	EC	European Commission	O	O			O		Y	Y		Y	
Ferreira, Lupp, Mahmoud (2023)	EC	European Commission							Y			Y	
EEA (2021)	EEA	European Environmental Ageny	Y	Y	Y	Y		Y		Y		Y	
EIB (2023)	EIB	European Investment Bank	Y	Y	Y	Y	Y	Y		Y		Y	
Martire et al (ETA, EEA) 2022	ETC-AA, EEA	European Topic Centre Climate Change Adaptation		Y	Y	Y	Y			Y	Y	Y	
Iseman et al. (FAO)(2021)	FAO	Food and Agriculture Organization of the United Nations		Y		Y							
IPBES (2019)	IPBES	Intergovernmental Panel on Biodiversity and Ecosystem Services	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
IUCN (2020a, b)	IUCN	International Union for the Conservation of Nature											
Maes et al. (2020a, b)	JRC, EC	European Joint Research Center	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
MEA (2005)	MEA, WRI	Millenium Ecosystem Assessment, World Resource Institute	Y	Y	Y	Y	Y	Y	Y	Y	Y	O	O
Almassy et al. (2018)	Naturvation	Former EC funded EU research project.										Y	
McQuaid et al. (2021)	NetworkNature	Coordinating initiative for NbS by EC											
El Harrak & Lemaitre (2023)	NetworkNature	Coordinating initiative for NbS by EC											
Eiselin et al. (2022)	RVO	Netherlands Enterprise Agency	Y					Y					
Somarakis et al. (ThinkNature)(2019)	ThinkNature	Former EC funded EU research project.	O		O					O		Y	
UNaLab (2022)	UnaLab	EU research project on Urban NbS										Y	
UNEP (2021)	UNEP	United Nations Environment Programme	Y		Y	Y	Y				Y		
Castellar et al., 2021		Peer-reviewed paper										Y	
Nehren et al. (2023)		Peer-reviewed paper	Y	Y	Y	Y	Y	Y	O	Y	O	Y	
Simelton et al. (2021)		Peer-reviewed paper		O		O						X	O

5 Integration: Assessment chain from biodiversity to valuation

As explained in Chapter 2, Nature-based Solutions are a type of intervention that can be assessed from several different perspectives. Being a highly interdisciplinary project, the assessments that BIOFIN-EU will make will crosscut a range of these perspectives, from biodiversity, via Natural Capital and Ecosystem Services, to monetary valuation. In other words, the BIOFIN-EU dashboard may need to cover the full range of decisions users are expected to make (although the details are uncertain until the precise functionalities of the dashboard have been defined). This approach is illustrated in Figure 2, which summarizes the 'assessment chain', consisting of a sequence of perspectives that crosscut the BIOFIN-EU approach and the various work packages. In the future dashboard and toolbox that BIOFIN-EU will develop, each perspective may require its own typologies, standards, and assessment tools. The assessment chain is recommended as a framework for a next developmental step for BIOFIN-EU (Phase 2 of Task 2.2, and other WPs), to ensure a good coverage, alignment and interoperability of typologies, standards, and analytical approaches across the BIOFIN-EU workflow.



Adapted from: LUC (landuse.co.uk)

Figure 2. Assessment chain from biodiversity to valuation. Stakeholders require different assessments and therefore the Dashboard will need to develop methods across the assessment chain. Adapted from LUC, n.d.

6 Conclusions

This interim report outlines a framework for categorizing Nature-based Solutions (NbS) to support decision-making for financial investments in the BIOFIN-EU project.

6.1 Recommendations

The key recommendations are:

- **Align with existing NbS typologies**: It is recommended that BIOFIN-EU align with existing, well-established typologies for NbS. This ensures consistency and facilitates interoperability with the wider NbS community.
- **Use NetworkNature for the primary framework**: It is recommended to use the NetworkNature framework as the primary basis for NbS categorization in BIOFIN-EU. NetworkNature is a science-based resource, endorsed by the EU, which aggregates information on NbS and offers a widely accepted set of NbS typologies.
- **NetworkNature uses four main typologies for NbS categorization**:
  - Type of NbS: This classifies NbS based on the degree of intervention.
  - Types of approaches studied: This identifies various ecosystem-related approaches that fall under the NbS umbrella.
  - Type of environment: This categorizes NbS based on the targeted ecosystem.
  - Types of societal challenges tackled: This classifies NbS based on the societal challenges they address.
- **Additional typologies for specific needs**: While NetworkNature provides a solid foundation, BIOFIN-EU might require additional typologies for specific aspects, depending on the interdisciplinary needs of the project. Additional typologies could include:
  - **More detailed typologies for specific environments or challenges**: Depending on BIOFIN-EU's focus areas, more detailed typologies within categories like urban environment or disaster risk reduction might be useful.
  - **Typologies for dimensions that have not yet been covered**: For aspects like governance, economic considerations, or scaling NbS, BIOFIN-EU might need to adapt other existing typologies or develop new ones. Often no accepted standards are available, leaving room to explore solutions for optimal functionality, alignment, and interoperability.
- **An integrated assessment chain from biodiversity to valuation**: BIOFIN-EU, being an interdisciplinary project, should consider aligning its NbS framework with an Integrated Assessment Chain. This would allow for a comprehensive assessment approach from biodiversity monitoring, natural capital accounting and ecosystem services valuation to investment decision making.

- **Communication about alignment and interoperability**: It is recommended that BIOFIN-EU be explicit about the alignment and interoperability of its output with existing typologies and frameworks.

6.2 Outlook

In concurrent processes, BIOFIN-EU is working on a variety of topics, including mapping the stakeholder landscape, the development of personas representing future users of the dashboard, different narratives to outline the form the dashboard can take, an assessment of tools for the economic valuation of Ecosystem Services, and the development of innovative financial instruments. Now that the basic framework for NbS has been established, the next step that will be taken is to further define the requirements for the Dashboard. This means aligning and elaborating the NbS framework with the needs of the other work packages.
To this end, a participatory process, including a co-creation workshop with BIOFIN-EU partners, and where needed with external experts and/or the advisory board, will be organised to tailor the NbS framework to the needs of the sustainable finance domain. The final outcomes will be presented in Deliverable 2.1 Phase 2, due in month twenty-four. The focus will be on the following five topics.
Goals for Task 2.2, D2.1 Phase 2:

- Identify synergies with other work packages and map the needs for the BIOFIN-EU dashboard for additional and/or more specific NbS typologies (with WP3, 4, 5, 6)
- Align with typologies and methodologies for *Ecosystem Services* (with WP3)
- Align with typologies and approaches for *valuation methods* (with WP3)
- Identify gaps and select or develop a typology of *investment-related NbS parameters* for the financial domain (with WP3, 4, 5)
- Recommendations on *data standards* for the assessment of NbS (with WP4)

Additionally, the results from Task 2.2 will inform the other tasks of WP2, first of all Task 2.1: *Develop recommendations on tools and standards for biodiversity and environmental assessments and monitoring*.

References

Abson, D. J., von Wehrden, H., Baumgärtner, S., Fischer, J., Hanspach, J., Härdtle, W., Heinrichs, H., Klein, A. M., Lang, D. J., Martens, P., & Walmsley, D. (2014). Ecosystem services as a boundary object for sustainability. Ecological Economics, 103, 29–37. https://doi.org/10.1016/j.ecolecon.2014.04.012.

Almassy, D., Pinter, L., Rocha, S., Naumann, S., Davis, M., Abhold, K. and Bulkeley, H. (2018). Urban Nature Atlas: A Database of Nature-Based Solutions Across 100 European Cities. Naturvation Project.

Albert, C., Schröter, B., Haase, D., Brillinger, M., Henze, J., Herrmann, S., Gottwald, S., Guerrero, P., Nicolas, C., Matzdorf, B. (2019). Addressing societal challenges through nature-based solutions: How can landscape planning and governance research contribute? Landsc. Urban Plan. 182, 12–21. https://doi.org/10.1016/j.landurbplan.2018.10.003.

Anderson, V., W.A. Gough (2022). A Typology of Nature-Based Solutions for Sustainable Development: An Analysis of Form, Function, Nomenclature, and Associated Applications. Land 2022, 11, 1072 . https://doi.org/10.3390/land11071072.

Benedict, M., McMahon, E., Mark, A. (2006). Green Infrastructure: Linking Landscapes and Communities. The Conservation Fund Island Press, 2006. Cloth: 978-1-59726-027-5 | Paper: 978-1-55963-558-5 | eISBN: 978-1-59726-764-9.

Bennett, E.M., Peterson, G.D., Gordon, L.J. (2009). Understanding relationships among multiple ecosystem services. Ecol. Lett. 12, 1394–1404. https://doi.org/10.1111/j.1461-0248.2009.01387.x.

Biodiversa+ (2024). Possible Ways to Foster the Uptake of Nature-Based Solutions. Chiara Catalano, Alessandro Campiotti, Chiara Baldacchini , Biodiversa+, MS69, https://www.biodiversa.eu/2024/04/29/how-to-foster-the-uptake-of-knowledge-on-nature-based-solutions/.

Castellar, J. A. C., Popartan, L. A., Pueyo-Ros, J., Atanasova, N., Langergraber, G., Säumel, I., Corominas, L., Comas, J., & Acuña, V. (2021). Nature-based solutions in the urban context: Terminology, classification and scoring for urban challenges and ecosystem services. Science of The Total Environment, 779, 146237. https://doi.org/10.1016/j.scitotenv.2021.146237.

CBD (Convention on Biological Diversity) (2009). Connecting Biodiversity and Climate Change Mitigation and Adaptation. Report of the 2nd Ad Hoc Technical Expert Group (AHTEG) on Biodiversity and Climate Change. Technical Series No. 41, Montreal, Canada.

CBD (Convention on Biological Diversity) (2004). The Ecosystem Approach (CBD Guidelines). Montreal: Secretariat of the Convention on Biological Diversity. 50 pp.

CBD (Convention on Biological Diversity) (2010). X/33 Biodiversity and climate change, Decision Adopted by the Conference of the Parties to the Convention on Biological Diversity at its Tenth Meeting; UNEP/CBD/COP/DEC/x/33; 29 October 2010, Nagoya, Japan.

Cohen-Shacham, E., Walters, G., Janzen, C. and Maginnis, S. (eds.) (2016). Nature-based Solutions to address global societal challenges. Gland, Switzerland: IUCN. xiii + 97pp.

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

Dasgupta, P. (2021). The Economics of Biodiversity: The Dasgupta Review: Full Report. London: HM Treasury. https://www.gov.uk/government/publications/final-report-the-economics-of-biodiversity-the-dasgupta-review.

Depietri, Y., & McPhearson, T. (2017). Integrating the Grey, Green, and Blue in Cities: Nature-Based Solutions for Climate Change Adaptation and Risk Reduction. https://doi.org/10.1007/978-3-319-56091-5_6.

Deutz, A., Heal, G. M., Niu, R., Swanson, E., Townshend, T., Zhu, L., Delmar, A., Meghji, A., Sethi, S. A., and Tobin-de la Puente, J. (2020). Financing Nature: Closing the global biodiversity. financing gap. The Paulson Institute, The Nature Conservancy, and the Cornell Atkinson Center for Sustainability.

Directorate-General for Research and Innovation (European Commission), Ingrid Andersson, Isabel Ferreira, Alessandro Arlati, Sean Bradley, Arjen Buijs, Beatriz Caitana, et al. (2023). Guidelines for Co-Creation and Co-Governance of Nature-Based Solutions: Insights Form EU Funded Projects. LU: Publications Office of the European Union. https://data.europa.eu/doi/10.2777/157060.

Dorst, H., van der Jagt, A., Raven, R., Runhaar, H. (2019). Urban greening through nature-based solutions – Key characteristics of an emerging concept. Sustain. Cities Soc. https://doi.org/10.1016/j.scs.2019.101620.

Dudley, N. *et al.* (2010). Natural solutions: Protected areas helping people cope with climate change. Gland, CH: Worldwide Fund for Nature(WWF). wwf.panda.org/about_our_earth/all_publications/?uNewsID=183021.

Dumitru & Wendling (2021a) Evaluating the Impact of Nature-Based Solutions: A Handbook for Practitioners. European Commission. https://op.europa.eu/en/publication-detail/-/publication/d7d496b5-ad4e-11eb-9767-01aa75ed71a1.

Dumitru & Wendling (2021b) Evaluating the Impact of Nature-Based Solutions: A Handbook for Practitioners. Appendix of Methods. European Commission. https://op.europa.eu/en/publication-detail/-/publication/6da29d54-ad4e-11eb-9767-01aa75ed71a1.

EEA (2021). Nature-Based Solutions in Europe: Policy, Knowledge and Practice for Climate Change Adaptation and Disaster Risk Reduction. European Environmental Agency. EEA Report No 01/2021. doi: 10.2800/919315. https://www.eea.europa.eu/publications/nature-based-solutions-in-europe.

Eggermont, H., Balian, E., Azevedo, J.M.N., Beumer, V., Brodin, T., Claudet, J., Fady, B., Grube, M., Keune, H., Lamarque, P., Reuter, K., Smith, M., Ham, C. Van, Weisser, W.W., Roux, X. Le, (2015). Nature-based Solutions : New Influence for Environmental Management and Research in Europe 243–248.

EIB (2023). Investing in Nature-Based Solutions. European Investment Bank. https://doi.org/10.2867/031133.

Eiselin, M.; S. Schep, C. Duinmeijer, J. van Pul (2022). Financing Nature based Solutions for Coastal Protection. A practical review of blended finance approaches with carbon credits from blue carbon sources. Netherlands Enterprise Agency (RVO).

El Harrak M. & Lemaitre F. (2023). European Roadmap to 2030 for Research and Innovation on Nature-based Solutions. NetworkNature.

European Commission (2013). Green Infrastructure (GI) — Enhancing Europe's Natural Capital. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions., Brussels, Belgium.

European Commission (2019). The European Green Deal (COM/2020/380 final). European Commission. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=PI_COM:C(2021)2800.

European Commission (2020a). EU Biodiversity Strategy for 2030. Bringing nature back into our lives (COM(2020) 380 final). https://eur-lex.europa.eu/resource.html?uri=cellar:a3c806a6-9ab3-11ea-9d2d-01aa75ed71a1.0001.02/DOC_1&format=PDF.

European Commission (2020b). Forging a climate-resilient Europe - the new EU Strategy on Adaptation to Climate Change (COM/2021/82 final). https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2021%3A82%3AFIN&qid=1614783912498.

European Commission (2021). Evaluating the Impact of Nature-Based Solutions: A Handbook for Practitioners. Directorate General for Research and Innovation. LU: Publications Office. https://data.europa.eu/doi/10.2777/244577.

European Commission (n.d.). Air Quality. Accessed 26 June 2024. https://environment.ec.europa.eu/topics/air/air-quality_en.

Frantzeskaki, N. (2019). Seven lessons for planning nature-based solutions in cities. Environmental Science and Policy, 93(December 2018), 101–111. https://doi.org/10.1016/j.envsci.2018.12.033.

Garcia, S.M., Zerbi, A., Aliaume, C., Do Chi, T. and Lasserre, G. (2003). The Ecosystem Approach to Fisheries: Issues, Terminology, Principles, Institutional Foundations, Implementation and Outlook. FAO Fisheries Technical Paper. No. 443, Rome, Italy: Food and Agriculture Organization.

Howe, C., H. Suich, B. Vira, and G.M. Mace (2014). Creating Win-Wins from Trade-Offs? Ecosystem Services for Human Well-Being: A Meta-Analysis of Ecosystem Service Trade-Offs and Synergies in the Real World. Global Environmental Change 28: 263–75. https://doi.org/10.1016/j.gloenvcha.2014.07.005.

IPBES (2019). Global assessment report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Brondízio, E. S., Settele, J., Díaz, S., Ngo, H. T. (eds). IPBES secretariat, Bonn, Germany. 1144 pages. ISBN: 978-3-947851-20-1.

Iseman, T. and Miralles-Wilhelm, F. (2021). Nature-based solutions in agriculture – The case and pathway for adoption. Virginia. FAO and The Nature Conservancy. https://doi.org/10.4060/cb3141en.

IUCN (2020a). IUCN Global Standard for Nature-based Solutions. A user-friendly framework for the verification, design and scaling up of NbS. First Edition. Gland, Switzerland: International Union for the Conservation of Nature. Available from https://www.iucn.org/theme/nature-based-solutions/iucn-global-standard-nbs.

IUCN (2020b). Guidance for Using the IUCN Global Standard for Nature-Based Solutions: First Editions. 1st ed. IUCN, International Union for Conservation of Nature, 2020. https://doi.org/10.2305/IUCN.CH.2020.09.en.

Kappel, C., Martone, R.G. & Duffy, J.E. (2006). Ecosystem-based management. Encyclopedia of Earth, pp.1–4. http://www.eoearth.org/view/article/152249.

Maes, J., Jacobs, S. (2017). Nature-Based Solutions for Europe's Sustainable Development. Conserv. Lett. 10, 121–124. https://doi.org/10.1111/conl.12216.

Maes, J., et al. (2020a). Mapping and Assessment of Ecosystems and their Services: An EU ecosystem assessment. European Commission, Joint Research Centre. EUR 30161 EN, Publications Office of the European Union, Ispra, ISBN 978-92-76-17833-0, doi:10.2760/757183, JRC120383.

Maes, J., et al. (2020b) Mapping and Assessment of Ecosystems and their Services. An EU ecosystem assessment. Supplement (Indicator fact sheets). European Commission, Joint Research Centre. https://data.europa.eu/doi/10.2760/519233.

Martire, S., et al. (2022). Understanding the scaling potential of Nature-based Solutions. ETC/EEA.

McQuaid, Siobhán, Mary-Lee Rhodes, Thomas Andersson, Edoardo Croci, Marianne Feichtinger-Hofer, Matthieu Grosjean, Alina Lueck, et al. (2021). From Nature-Based Solutions to the Nature-Based Economy - Delivering the Green Deal for Europe. Draft White Paper for Consultation. Nature-Based Economy Working Group of EC Task Force III on Nature-Based Solutions. https://doi.org/10.5281/ZENODO.5055605.

Millennium Ecosystem Assessment (2005). Ecosystems and Human Well-being: Biodiversity Synthesis. World Resources Institute, Washington, DC.

Mitsch, W.J. (2012). What is ecological engineering? Ecological Engineering, 45: 5–12.

Morello, E., Mahmoud, I., & Colaninno, N. (2019). Catalogue of Nature-Based Solutions for Urban Regeneration Pre-Final Report, 107.

Nehren, Udo, Teresa Arce Mojica, Ali Barrett, J Cueto, Nathalie Doswald, Sally Janzen, Wolfram Lange, et al. (2023). Towards a Typology of Nature-Based Solutions for Disaster Risk Reduction. https://www.sciencedirect.com/science/article/pii/S2772411523000095.

Nesshöver, C., Assmuth, T., Irvine, K. N., Rusch, G. M., Waylen, K. A., Delbaere, B., Haase, D., Jones-Walters, L., Keune, H., Kovacs, E., Krauze, K., Külvik, M., Rey, F., van Dijk, J., Vistad, O. I., Wilkinson, M. E., & Wittmer, H. (2017). The science, policy, and practice of nature-based solutions: An interdisciplinary perspective. Science of the Total Environment, 579, 1215–1227. https://doi.org/10.1016/j.scitotenv.2016.11.106.

PEDRR (2010). Demonstrating the Role of Ecosystems-based Management for Disaster Risk Reduction. Partnership for Environment and Disaster Risk Reduction.

Sarabi, S. E., Han, Q., Romme, A. G. L., & Vries, B. De (2019). Key Enablers of and Barriers to the Uptake and Implementation of Nature-Based Solutions in Urban Settings: A Review.

Seddon, Nathalie, Alison Smith, Pete Smith, Isabel Key, Alexandre Chausson, Cécile Girardin, Jo House, Shilpi Srivastava, and Beth Turner (2021). Getting the Message Right on Nature-

based Solutions to Climate Change. Global Change Biology 27, no. 8: 1518–46. https://doi.org/10.1111/gcb.15513.

Short, C., Clarke, L., Carnelli, F., Uttley, C., Smith, B. (2019). Capturing the multiple benefits associated with nature-based solutions: Lessons from a natural flood management project in the Cotswolds, UK. L. Degrad. Dev. 30, 241–252. https://doi.org/10.1002/ldr.3205.

Simelton, Elisabeth, Jeremy Carew-Reid, Miguel Coulier, Beau Damen, John Howell, Chloe Pottinger-Glass, Hung Viet Tran, and Marlies Van Der Meiren (2021). NBS Framework for Agricultural Landscapes. Frontiers in Environmental Science 9: 678367. https://doi.org/10.3389/fenvs.2021.678367.

Society for Ecological Restoration (2004). Ecological Restoration Primer www.ser.org/resources/resources-detail-view/ser-international-primer-on-ecological-restoration.

Somarakis, G., Stagakis, S. and Chrysoulakis, N. (2019). ThinkNature Nature-Based Solutions Handbook. ThinkNature. DOI: 10.26225/jerv-w202.

UNaLab (2022). Nature-Based Solutions Implementation Handbook. UnaLab Deliverable 5.5. https://unalab.eu/en/documents/d55-nbs-implementation-handbook.

UNEA (2022). United Nations Environment Assembly of the United Nations Environment Programme 3–5.

UNEP (2021). State of Finance for Nature 2021. UNEP - UN Environment Programme. http://www.unep.org/resources/state-finance-nature-2021.

United Nations (2016). Sustainable Development Goals; UN: San Francisco, CA, USA.

Van der Jagt, A.P.N., Szaraz, L.R., Delshammar, T., Cvejić, R., Santos, A., Goodness, J., Buijs, A., (2017). Cultivating nature-based solutions: The governance of communal urban gardens in the European Union. Environ. Res. 159, 264–275. https://doi.org/10.1016/j.envres.2017.08.013.

Annexes

Annex 1

Overview of definitions from the literature to clarify the types of approaches, summarised from Cohen-Shacham et al., 2016.

Types of Approaches	Definition
Ecological restoration	The process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed (Society for Ecological Restoration, 2004).
Ecological engineering	The design of sustainable ecosystems that integrate human society with its natural environment for the benefit of both (Mitsch, 2012).
Ecosystem-based adaptation	The use of biodiversity and ecosystem services as part of an overall adaptation strategy to help people to adapt to the adverse effects of climate change (CBD, 2009).
Ecosystem-based mitigation	Enhance the benefits for, and avoid negative impacts on biodiversity from reducing emissions, considering the need to ensure the full and effective participation of Indigenous and local communities in relevant policymaking and implementation processes, where appropriate. Enhance the conservation, sustainable use and restoration of marine and coastal habitats that are vulnerable to the effects of climate change, or which contribute to climate-change mitigation (CBD, 2010).
Ecosystem-based disaster risk reduction (DRR)	The sustainable management, conservation, and restoration of ecosystems to provide services that reduce disaster risk by mitigating hazards and by increasing livelihood resilience (Pedrr 2010).
Green infrastructure	GI is a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services. It incorporates green spaces (or blue if aquatic ecosystems are concerned) and other physical features in terrestrial (including coastal) and marine areas. On land, GI is present in rural and urban settings (European Commission, 2013).
Ecosystem-based management	Integrated, science-based approach to the management of natural resources that aims to sustain the health, resilience and diversity of ecosystems while allowing for sustainable use by humans of the goods and services they provide (Kappel et al., 2006; Garcia et al., 2003).