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Policy Recommendations for NBS Implementation

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Abbreviations and Acronyms

CSA	Coordination and Support Action
EC	European Commission
ES	Ecosystem Services
EU	European Union
IA	Innovation Action
ICPDR	International Commission for the Protection of the Danube River
IUCN	International Union for Conservation of Nature
NBS	Nature-based solutions
NGO	Non-governmental Organisation
OECD	Organisation for Economic Co-operation and Development
PCT	Project Core Team
SDG	Sustainable Development Goal
UN	United Nations
UNDAF	United Nations Development Assistance Framework
UNEA	United Nations Environment Assembly
WP	Work Package

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Executive Summary

The EcoDaLLi project, dedicated to advancing Nature-Based Solutions (NBS) in the Danube River Basin, focuses on addressing pressing environmental and societal challenges through ecosystem-based governance and innovative solutions. While NBS offer substantial ecological, social, and economic benefits, their implementation faces significant barriers, including a lack of standardized definitions, technical and governance complexities, and limited funding. Traditional grey infrastructure often remains the preferred solution due to short-term financial perceptions and a lack of data on NBS effectiveness.

A standardized, internationally recognized definition of NBS and adaptable technical standards are critical to streamlining implementation and ensuring measurable outcomes. Solutions must be tailored to local contexts, delivering multi-functional benefits while engaging stakeholders through co-creation and co-governance processes. Multi-stakeholder involvement - including policymakers, local communities, and private-sector actors - is essential to build ownership, trust, and long-term sustainability.

The private sector can play a transformative role in NBS adoption by integrating them into corporate strategies, particularly for water management. However, challenges such as unfamiliarity with NBS benefits and concerns about return on investment must be addressed. Demonstrating the financial value of NBS, such as cost savings and carbon sequestration, will help attract private investment. Public authorities must also overcome procurement barriers, including knowledge gaps, risk-averse practices, and funding limitations, by developing standardized typologies, fostering community engagement, and promoting innovative procurement approaches.

Robust monitoring and evaluation frameworks are essential to assess NBS impacts across ecological, economic, and social dimensions. Generating reliable, context-sensitive indicators and empirical evidence will strengthen the case for mainstreaming NBS into governance frameworks. Cross-sectoral collaboration, European-level partnerships, and expanded funding mechanisms are necessary to scale NBS initiatives effectively.

The EcoDaLLi project highlights that overcoming technical, financial, and governance barriers can unlock the full potential of NBS, enhancing resilience, biodiversity, and economic opportunities. By fostering collaboration and addressing gaps, NBS can serve as transformative tools for sustainable water management and ecological restoration in the Danube River Basin and beyond.

1. Project Information

1.1. Introduction – EcoDaLLi Project

The 2030 and 2050 Green Deal goals push the European Union (EU) towards integrated solutions and clear targets. EcoDaLLi, embedded in the EU Mission 'Restore our Ocean and Waters by 2030' will help achieve freshwater targets of the European Green Deal, integrating a systemic approach for restoration, protection and preservation for the entire Danube Basin, provided by coordinated actions.

The main objective of EcoDaLLi is to centralise Danube governance structures in terms of innovative solutions for improved ecological restoration, protection and preservation of the Danube basin and its Delta by fostering a stronger innovation ecosystem within a well-connected Practices Living Lab System, supported by a digital Portal, completely linked to the Mission Implementation Platform and the Mission Charter.

Innovative solutions open new opportunities for better water restoration, taking into consideration social innovation aspects, reducing climate change effects and costs. Nature-based Solutions (NBS) offer clear benefits for mitigating global warming and biodiversity loss but present substantial challenges for policymakers. For NBS to effectively address climate change impacts — such as flooding, urban heat, and biodiversity loss — they must be widely accepted, incorporated into urban planning, and coordinated with other policies. By delivering multiple benefits, NBS can facilitate coordinated services across various policy sectors. However, challenges to NBS implementation include ensuring the long-term sustainability of projects, addressing knowledge gaps, and developing methods for stakeholder engagement. Additional barriers involve the scarcity of practical targeted guidance for evaluating and assessing the diverse benefits of NBS (Giordano et al., 2020; Raymond et al., 2017), the need for action-oriented frameworks to mainstream NBS (Connop et al., 2016), the lack of specific planning guidelines (Mendes et al., 2020), and insufficient data at various stages of NBS implementation.

Figure 1: Danube River Basin Overview Map with EcoDaLLi partner locations.

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1.2. Focus and Importance of this Deliverable D2.3

EcoDaLLi contributes towards all outcomes specified in HORIZON-MISS-2021-OCEAN-02-04 and in the Mission topic providing an interlinked set of work packages (WPs), which address the need for integrated Danube Governance towards the protection and restoration of freshwater ecosystems and biodiversity.

WP2 aims to gather knowledge and best practices regarding the restoration of freshwater ecosystems, with a particular focus on understanding the role of the Danube River ecosystem connectivity restoration at both national and cross-border levels. The NBS assessment will collect relevant evidence from various case studies on the benefits and co-benefits generated by small and large-scale NBS implementations for addressing water-related risks, as well as enhancing longitudinal and lateral connectivity.

The EcoDaLLi's Grant Agreement states:

Previous results will be summarized, and the report on NBS Visions for the entire Danube Region (D2.2) will be written in the form of an Executive Summary. This report will serve as the foundation for developing policy recommendations for NBS implementation, which will be the final outcome of WP2. The policy recommendations (D2.3) will be delivered to all partners and subsequently to regional and national authorities, stakeholders, NGOs, companies, academia, and others.

In European water governance, transboundary cooperation is essential, as countries sharing a river basin are interdependent; rivers act as connectors for various externalities (e.g., pollution, flow regulation) that cross borders. These externalities, whether they are positive or negative, and whether they affect one party or more parties, create complex situations where each party is vulnerable to the actions of the others. Therefore, cooperation within a transboundary river basin, such as the Danube, can be understood as a function of the basin's unique characteristics and the institutional contexts of the countries involved. These contexts influence the interests and incentives of the actors engaged in governance, shaping cooperative efforts (Fenten, 2024).

The Danube River Basin, Europe's second-largest, spans an area of 801,463 km² and is shared by over 80 million people across 19 countries, making it the most internationally connected river basin in the world. All countries with over 2,000 km² in the basin, alongside the European Union, are contracting parties to the International Commission for the Protection of the Danube River (ICPDR). The ICPDR is responsible for coordinating efforts to conserve, improve, and sustainably manage the Danube's waters (ICPDR, 2024).

Based on its gradients, the Danube River Basin can be divided into three sub-regions: the Upper, Middle and Lower Basins (the latter including the Danube Delta). The Upper Basin extends from the source of the Danube in Germany to Bratislava in Slovakia. The Middle Basin is the largest of the three sub-regions, extending from Bratislava to the dams of the Iron Gate Gorge on the border between Serbia and Romania. The lowlands, plateaus and mountains of Romania and Bulgaria form the Lower Basin of the River Danube. Before reaching the Black Sea, the river divides into three main branches, forming the Danube Delta, which covers an area of about 6,750 km² (ICPDR, 2024).

Effective NBS implementation depends on aligning a large geographical area with a cohesive conservation vision, particularly in complex riverine ecosystems. In cases where rivers flow

across multiple national boundaries, such as the Danube, successful NBS implementation demands robust international cooperation to coordinate and align efforts across jurisdictions. NBS are recognized as an overarching concept that encompasses biodiversity and ecosystem services (Nesshöver et al., 2017). Originating within policy dialogues focused on biodiversity and nature conservation, NBS are currently advocated through the European policy agenda, particularly in the areas of innovation and research. The concept has gained significant traction in Europe and aligns closely with other environmentally-focused frameworks, including Green Infrastructure, Ecosystem Services (ES), and Ecosystem-based Adaptation (Nesshöver et al., 2017; Pauleit et al., 2017).

1.3. Structure of this Deliverable D2.3

This deliverable builds on the work and research conducted by EcoDaLLi to date. In particular, the efforts in WP2 contribute significantly to identifying the knowledge gaps and needs that form the foundation for policy recommendations in NBS application. The primary research questions focus on understanding what is lacking and what is needed to support NBS application and its mainstreaming. From this, we derive actionable insights on how policy-makers can enhance the adoption and integration of NBS.

The initial section outlines the methodology and data used, followed by an examination of effective transboundary water governance, focusing on the Danube River Basin. Subsequent chapters present the key findings essential for implementing NBS, including co-creation and co-governance processes, methods for monitoring and evaluating NBS impacts, and strategies for encouraging private and public sector engagement in NBS initiatives. The final sections summarize the main knowledge gaps identified and provide policy recommendations.

2. Methodology

2.1. Research Questions

This section defines the research questions that guided the data collection and analysis processes. The primary objective is to develop actionable policy recommendations for the implementation of NBS.

Research Question 1: *What challenges, as identified in EcoDaLLi WP2, hinder the application of NBS in the Danube Basin?*

This question explores specific barriers and limitations identified in the EcoDaLLi project's WP2 that affect the effective application of NBS within the Danube Basin region. By understanding these challenges, such as socioeconomic, regulatory/governance, or technical factors, we can better assess why NBS may face challenges in their application. The findings will help clarify the conditions and actions necessary to overcome these hurdles, fostering a more supportive environment for NBS application in the region.

Research Question 2: *What factors are essential for successful implementation of NBS?*

This question aims to identify the important factors, including stakeholder engagement, technical expertise, governance frameworks, funding mechanisms, and cross-sectoral collaboration, that contribute to the successful application of NBS. These factors may vary depending on regional contexts but are essential to establishing effective, scalable, and sustainable NBS projects.

Research Question 3: *What actionable policy recommendations can be formulated based on the identified gaps and needs?*

This question focuses on translating identified gaps and challenges into practical policy recommendations that can support the application and sustainability of NBS projects. Based on the insights from the previous research questions, this answer will propose actions for policymakers and planners. These recommendations will address both immediate and long-term needs, aiming to overcome existing barriers, enhance the NBS uptake, and foster a supportive governance structure.

2.2. Data Sources and Analysis

2.2.1. Data Sources and Analysis from EcoDaLLi's WPs

For this deliverable, we consolidated data and information, especially from Work Package 2 (WP2), and used Excel to manage the data for data analysis. Deliverable D2.1 and D2.2's information was divided into two categories:

1) NBS application challenges and knowledge gaps, and
2) Recommendations to overcome these challenges, ways forward.

Furthermore, other deliverables, tasks, and milestones conducted in EcoDaLLi were considered where appropriate. For instance, the milestone related to the task "Stakeholder Mapping" was referenced as an example for identifying different stakeholder groups.

2.2.2. Data Sources and Analysis from Literature Review

In this deliverable, additional literature was reviewed and integrated to address gaps identified during the report's preparation, particularly where the information or references from previous work conducted in EcoDaLLi were insufficient. This included both peer-reviewed scientific publications and grey literature sources. The Scopus database was employed to systematically identify relevant scientific articles focusing on the application of NBS and the associated challenges. Furthermore, grey literature, such as policy documents, project reports, and guidelines published by the European Commission (EC) and other international organizations, was analysed to provide supplementary context and data essential for completing this deliverable. These sources helped ensure a comprehensive understanding of the topic and strengthened the scientific and practical foundation of the report.

The desk research and literature analysis were guided by a systematic approach to identifying relevant literature. Specific search terms were employed to ensure a focused exploration of the topic. These keywords included “Nature-Based Solutions” combined with terms such as “implementation”, “co-creation”, “application”, and “co-governance”. These terms were selected to capture a broad yet targeted range of literature addressing various aspects of NBS, including their design, implementation, collaborative processes, and governance frameworks.

3. Societal Challenges

The expert working group of the EKLIPSE project (Raymond et al., 2017) conducted an extensive literature review and engaged in consultations with experts both within and outside the group. This process led to the identification of 10 key challenges related to NBS. These challenges were informed by the priorities outlined by DG Research and Innovation (European Commission, 2016) and insights from a recent review of NBS frameworks (Kabisch et al., 2016).

a. Water Management
b. Natural and Climate Hazards
c. Green Space Management
d. Biodiversity Enhancement
e. Air Quality
f. Place Regeneration
g. Knowledge and Social Capacity Building for Sustainable Urban Transformation
h. Participatory Planning and Governance
i. Social Justice and Social Cohesion
j. New Economic Opportunities and Green Jobs

From these, D 2.1 selected the **challenges of interest for the EcoDaLLi project** (Martinov et al., 2024):

- Water management
- Green space management (incl. enhancing urban biodiversity)
- Participatory planning and governance
- Public health and well-being
- Potential for new economic opportunities and green jobs

NBS offer a way to address these challenges, but knowledge gaps and implementation difficulties remain. The following sections delve into the potential of NBS, the obstacles they may encounter during implementation, and examples of strategies to overcome these challenges.

3.1. Effective Transboundary Water Governance – The Danube River Basin

Effective water governance reforms are essential to ensuring the sustainable management of water resources. Such reforms play a critical role in addressing interrelated objectives, including poverty reduction, biodiversity conservation, economic development, and fostering international cooperation. By establishing robust institutional frameworks and equitable policies, water governance reforms can harmonize competing demands, promote resource efficiency, and support long-term sustainability across social, environmental, and economic dimensions (Lindelien et al., 2024).

The BRIDGE project (Building River Dialogue and Governance) highlights the importance of water governance processes, emphasizing how stakeholders organize themselves through a combination of policies, laws, and institutions. These governance frameworks are structured around formal and informal rules designed to allocate, use, and protect water resources effectively. A critical component of water governance is transboundary cooperation, which is

conceptualized as a continuum ranging from minimal collaboration to joint ownership and management of water resources. The project found that states are more likely to engage in cooperative arrangements when the perceived net benefits of cooperation outweigh those of non-cooperation (IUCN, 2020).

Achieving such shared benefits requires diplomacy. Traditionally, water diplomacy has been characterized by high-level dialogues between governments, often involving ministries or foreign affairs representatives. However, more recently, approaches emphasize the need for agreements that include and are shaped by the various water users themselves. This shift acknowledges the importance of inclusive, multi-stakeholder engagement in fostering sustainable water governance (Fenten, 2024).

To ensure effective governance, a diverse array of agreements is necessary. These agreements span from formal intergovernmental treaties and extend to a mix of formal and informal arrangements. They involve a broad spectrum of stakeholders, including local communities, municipal governments, technical agencies, economic sectors, and representatives of water-dependent groups such as those in tourism. This comprehensive approach is essential for addressing the complex and interlinked challenges of water management, ensuring equitable access, sustainable use, and resilience of water resources across multiple scales (Fenten, 2024).

OECD (2011) defines **multi-level governance** as follows: “the explicit or implicit sharing of policy-making authority, responsibility, development, and implementation at different administrative and territorial levels i.e.; i) across different ministries and/or public agencies at central government level (upper horizontally); ii) between different layers of government at local, regional, provincial/state, national and supranational levels (vertically); and iii) across different actors at the sub-national level (lower horizontally).

Ineffective water governance can lead to the over-allocation and pollution of water resources, as well as the degradation of ecosystem services essential for water security. Addressing these challenges requires coordinated efforts across multiple scales: basin, national and local level (see Figure 2):

Figure 2: Scales of water governance.

Water governance is inherently a multiscale process, requiring coordination and alignment across basin, national, and local levels. To achieve effective governance, substantial investment is necessary in consultation, training and capacity building of actors to create a shared understanding of and agreed consensus on joint water security.

The development of tools, capacity building, and facilitation of consultations and dialogues are essential steps for enhancing newly established institutions, treaties, and policies. These efforts aim to strengthen governance structures, foster stakeholder engagement, and ensure the effective implementation of water management frameworks (Fenten, 2024).

Effective water governance requires flexibility and adaptability, incorporating principles of adaptive management to respond to evolving challenges. A more indirect and demand-driven approach is essential, focusing on identifying the specific needs of authorities and stakeholders at each stage of the process to enhance cooperation across different levels. Spaces for informal dialogue, such as multistakeholder events and creative workshops, are crucial in fostering collaboration. These platforms provide opportunities for testing ideas, building relationships among stakeholders, and coalescing around shared priorities without imposing undue pressure on individuals. This inclusive and iterative process helps to align diverse interests and drive collective action toward sustainable water management (IUCN, 2020).

D2.1 has also summarised the importance of effective governance frameworks and the need for innovation (Martinov et al., 2024):

The implementation of NBS is critically dependent on effective governance frameworks that support the NBS policy process. Despite a growing number of NBS applications, significant research gaps persist, particularly at the governance level. Identifying governance models that effectively stimulate innovation remains a key research priority.

An analysis of NBS projects for flood risk management and mitigation by Zingraff-Hamed et al. (2021) highlights the absence of a universal governance model but identifies polycentric governance as a common feature. They observe:

“As a federal state, Germany is characterized by a hierarchical share of competencies, and state governments of the 16 states are responsible for policy implementation. The state governments have much flexibility in the NBS planning process, making Germany an interesting field for investigating the design and implementation of NBS under different regional governance models.”

This finding underscores the importance of collaborative governance approaches for the successful realization of NBS. The European Union also promotes NBS implementation through polycentric governance frameworks. However, local, historical, and cultural variations in governance approaches often complicate collaborative planning efforts. Additionally, context-specific conditions significantly influence the governance models applied (Martinov et al., 2024).

To address these challenges, systematic analysis of governance models in NBS research is essential. Future governance structures must adapt traditional models to accommodate large-scale solutions involving a diverse array of stakeholders.

Martin et al. (2021) have outlined critical governance enablers for NBS, including:

- **Polycentric governance**: Novel administrative arrangements involving multiple institutional scales and sectors.
- **Co-design processes**: Participatory approaches that actively engage stakeholders in shaping NBS.
- **Pro-NBS interest groups**: Advocacy coalitions that support NBS adoption.
- **Financial incentives**: Mechanisms to finance community-based NBS implementation and monitoring.

Their findings also emphasize essential preconditions for advancing NBS agendas, such as legal mandates, favorable political conditions, and criticisms of traditional infrastructure approaches. They further note:

“Furthermore, a catastrophic event (or a model predicting one) appeared key for opening a window of opportunity for existing pressure groups or sympathetic state authorities. Perhaps the most indispensable precondition was the existence of earmarked budgets or availability of funds, without which an NBS could not have been envisaged.”

Martin et al. (2021) also illustrate how NBS can drive innovative governance arrangements, such as cross-sector and cross-scale collaborations enabled by polycentric administrative structures. Mainstreaming NBS into policy agendas, as demonstrated in their case studies, requires these governance arrangements to bridge institutional divides effectively.

Finally, the transition from traditional infrastructure to NBS often involves resolving conflicts of interest and values. Governance frameworks must find compromises that enable the adoption of hybrid solutions that integrate both traditional and nature-based approaches (Martinov et al., 2024).

Hence, effective water governance is the base for mainstreaming sustainable NBS implementation. The following report outlines important aspects and identifies existing gaps in effective water governance for NBS implementation. The next chapter describes the development and importance of NBS in the context of the EU.

Examples of Important Actors for the Danube and EcoDaLLi

The International Commission for the Protection of the Danube River (ICPDR) manages the Danube River at a basin-wide level through an integrated approach that emphasizes cooperation among all 14 countries in the basin. It develops comprehensive management plans, such as the Danube River Basin Management Plan (DRBMP), which address key water issues like pollution, flood risks, and biodiversity protection. These plans align with the EU Water Framework Directive and aim for sustainable use of water resources. The ICPDR facilitates coordination, data sharing, and harmonized measures across countries, ensuring transboundary issues are jointly addressed. Public participation and stakeholder input are integral to its planning process, fostering transparency and inclusivity.

Since EcoDaLLi is part of the European Missions "Restore our Ocean and Waters by 2030", this report is also referencing the Mission itself in regard to the implementation of NBS.

The role of the European Union – Examples from the European Missions "Restore our Ocean and Waters by 2030"

The European Missions "Ocean and Waters 2030" initiative embodies the EU's ambitious agenda to restore, protect, and sustainably manage its vital water resources. Recognizing the interconnectedness of oceans, seas, and inland waters, the mission adopts a holistic and systemic approach to counter the multifaceted challenges that threaten these ecosystems.

Key drivers of degradation, including unsustainable exploitation, pollution, climate change, and insufficient citizen engagement or knowledge gaps, are deeply intertwined. Addressing one without the others risks undermining the mission's goals.

The Mission's strategic objective is "to restore the health of our ocean and waters by 2030" with three specific objectives:

1. Protect and restore marine and freshwater ecosystems and biodiversity,
2. Prevent and eliminate pollution of our ocean, seas and waters, and
3. Make the sustainable blue economy carbon-neutral and circular.

To support the three objectives, the Mission has put in place two enablers:

i) Digital ocean and water knowledge system, with monitoring services to better understand, monitor, and forecast the health of the hydrosphere
ii) Participatory governance based on public mobilisation and engagement, empowering citizens to take action and drive the transitions through deliberative democracy, social innovation citizen science and awareness campaigns.

The Mission will unfold in two phases. The first phase (2022–2025) focuses on development and piloting, laying the groundwork for achieving the Mission's goals. This

includes piloting transformative solutions for ecosystem restoration, pollution reduction, and circular, carbon-neutral blue economy activities. Efforts will also target biodiversity mapping, citizen science, education, and training. "Lighthouses" will be established as demonstration sites to mobilize collaboration across EU sea and river basins.

To achieve rapid impact, lighthouses will focus on specific Mission objectives, building on established activities and delivery models. Guided by principles of replicability and scalability, they will share solutions and advice across the EU, enabling broad adoption and replication of innovations Union-wide.

By 2030, all lighthouses will address the three Mission objectives, delivering tangible outcomes. Scalable research and innovation solutions, digital knowledge systems, integrated governance, and a robust investment ecosystem will support their implementation.

EcoDaLLi is the CSA project for the Danube lighthouse, which focuses on the Mission Objective 1 "Protect and restore marine and freshwater ecosystems and biodiversity".

Specific Objectives

Objective 1: Protect and restore marine and freshwater ecosystems and biodiversity

Output:

The Mission will establish two basin-scale restoration lighthouses: one in the **Danube River basin and another on the Atlantic and Arctic coast**. Additionally, an EU-wide "Blue Parks" platform will be launched to support the conservation, protection, and restoration of marine areas.

These lighthouses will demonstrate large-scale aquatic ecosystem restoration by reducing pressures such as fishing, pollution, extraction, and barriers like dams. They will employ ecosystem-based management and nature-based restoration measures, including blue reforestation, to enhance coastal resilience against climate change.

Research and innovation:

Knowledge: Enhance understanding of biodiversity and ecosystem dynamics by testing locally adapted restoration solutions, collaborating with local research institutions, and studying species interrelations and human impacts on ecosystems. Activities include mapping marine biodiversity (DNA sequencing and microbiomes), analysing ecological processes, and monitoring biodiversity changes driven by climate change and human activities.

New Technologies: **Develop and implement nature-based solutions for ecosystem restoration**, river flow recovery, and coastal resilience. Solutions will address climate change mitigation (e.g., blue carbon sequestration, blue reforestation), reduce pressures from tourism and harmful fishing practices, and ensure sustainable sediment management. Innovations will include scalable monitoring technologies for fisheries and aquaculture traceability and blue biotechnology to restore marine ecosystems.

Business Innovation: Create new revenue-generating models from restored ecosystems, such as blue carbon farming, aquaculture-based restoration, and tidal management. Explore blue biotechnology opportunities and sustainable practices in inland and near-shore waters.

Social Innovation and Governance: Drive transitions towards holistic ecosystem management that integrates natural, social, and cultural elements. Develop strategies for involving local communities in ecosystem restoration and protection, leveraging social innovations and inclusive governance models for sustainable and systemic change.

Investment opportunities and economic impact:

The Mission will create a **pipeline of revenue-generating conservation opportunities**, such as eco-friendly tourism, leisure, and biotechnology, which can attract impact investment or be tied to licensing requirements. A community of impact investors and philanthropic donors will be established to support these efforts.

Investments will be mobilized from socio-economic actors benefiting from ecosystem services, and financial schemes will enable private investment in blue carbon sequestration. Licensing and authorization processes will align with better regulation principles, ensuring accessibility for SMEs to participate in the Mission's initiatives.

3.2. Importance of NBS for Biodiversity Enhancement and Challenges in Defining the Concept

NBS have connections to multiple policy areas and play a critical role in environmental strategies. For instance, the EU Biodiversity Strategy sets a goal to restore at least 25,000 kilometres of European rivers by 2030. This ambitious task involves reestablishing the natural connectivity of rivers through the restoration of vital ecosystem processes and the application of NBS (Stoffers et al., 2024).

The implementation of NBS is a cornerstone of the European Green Deal, a comprehensive framework for guiding Europe toward environmental sustainability and economic competitiveness. The Green Deal emphasizes the importance of collaboration across various sectors, requiring unified efforts to meet climate targets. This approach calls for balancing diverse societal needs and adopting multifunctional solutions, as land and water use decisions cannot be dominated by limited interest groups. Properly restored ecosystems offer more than just biodiversity benefits—they provide critical services that enhance societal well-being and create economic incentives. For instance, improved ecosystem services in river systems can encourage industries to support restoration projects.

Case study from Van Wesenbeeck et al. (2021)

Economic rationale of floodplain restoration in the Danube: During the communist era, the natural character of the Danube has been severely altered with extensive embankments, dams, and drainage works to allow for intensive agriculture in the floodplains: to this day, only a small percentage of floodplains remain in natural condition (75% in the lower Danube and 28% in the Danube Delta). These developments came at the cost of severe ecological degradation, with many river species endangered, drastically changed soil regimes in the floodplains and changes in hydrological and geomorphological regimes, leading to increased flood probability and a disturbed sediment balance. Today, many embankments in the lower Danube are in disrepair. Facing climate change, high embankment restoration costs, and many river species severely endangered, now is the time to reconsider floodplain management in the lower Danube and Danube Delta.

A large-scale investment programme (estimated at € 7 billion) restoring 4000 km² floodplains will have many economic benefits:

- If no new policy is adopted, an estimated €572 million in investments are required to preserve the current flood protection level in the lower Danube by restoring and maintaining degraded embankments. Large-scale floodplain restoration can reduce these costs by €230 million.
- If the current protection level is maintained, flood risk is expected to increase due to climate change, estimated in total around €3.3 billion by 2100. Reinforcing the current protection system will lead to a technical and institutional lock-in—limiting the potential to shift to a different flood risk management strategy (e.g., floodplain restoration) in the future. Floodplain restoration will reduce flood risk in the long term by €1.36 billion and bring more flexibility in flood management strategies in the long term.

- Supporting economic recovery from the Covid-19 crisis through providing an estimated 250,000 jobs in the short term (to compare: New Zealand is currently using a $1 billion budget to create 11,000 nature jobs to support economic recovery).
- Under the current system, regional economies in the Danube's floodplains will remain largely agricultural and little diversified, making them sensitive to economic and climatic shocks—already yields are declining due to salinization and aridification. Although floodplain restoration will see reduced agricultural yields in the floodplain, the resulting ecosystem services will support diversification of the local economy (-€766 million), bringing €1,150 million in tourism and €140 million in fishery benefits.
- Under current management, ecological degradation of the Danube will continue, with consequent loss in ecosystem services and possibly penalties for non-compliance with EU Habitat and Water Framework Directives—or high opportunity costs required to meet objectives. Floodplain restoration will contribute to improving ecological quality, restoring hydrological and morphological processes, water quality, and biodiversity.

Although undoubtedly a costly affair, the benefits of floodplain restoration closely fit the objectives of the EU Green Deal and long-term recovery budget: supporting a greener, more resilient Europe with climate change and biodiversity protection at its core.

*Numbers based on stylized, quick-scan CBA using coarse assumptions.

The global challenge of climate change pushed the development of innovative approaches for governing natural resources and the environment. One such approach, NBS, emerged in the international policy discourse during the 2000s (Salcedo-La Viña et al., 2023).

Since the concept of NBS was introduced, the International Union for Conservation of Nature (IUCN) has played an important role in defining and operationalizing it. The IUCN's Global Programme has been pivotal in developing and clarifying the terms and concepts associated with NBS. According to the IUCN, NBS are defined as:

"Actions to protect, sustainably manage, and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits" (Cohen-Shacham et al., 2016).

This definition is widely accepted and referenced by researchers and scientists globally, as it underscores the importance of managing natural resources in a progressive and integrated manner that promotes both biodiversity and human well-being.

On the international level, NBS are integral to the objectives of the United Nations' Sustainable Development Goals (SDGs) and the Sendai Framework for Disaster Risk Reduction.

To establish itself as a global leader in NBS research and application, the EU has invested heavily in knowledge generation and collaboration. Efforts documented by Davies et al. (2021) illustrate how the EU is working to create a society that is inclusive, economically dynamic, and ecologically resilient. These efforts are supported through initiatives such as Horizon 2020 (2012–2024), which funds projects that explore and promote NBS across Europe. Davies et al. (2021) categorized the European Commission's NBS activities into three main areas: expert publications, including technical reports and conference proceedings; project outcomes,

mainly stemming from Horizon 2020; and the integration of NBS into strategic policies that address both environmental and societal needs (Davies et al., 2021).

The EU defines NBS 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" (European Commission, 2015).

The EU's commitment to NBS is evidenced by its support for over fifty projects, which serve as case studies and benchmarks for the international community. The adoption and promotion of NBS by the EU and other organizations led to the formal definition of NBS by the Fifth Meeting of the United Nations Environment Assembly (UNEA-5) in 2022. UNEA-5 recognized NBS as a vital strategy for addressing biodiversity and climate change issues, further solidifying its importance in global environmental governance.

The evolution of NBS highlights the growing recognition of the need for innovative, nature-inspired solutions to address complex environmental challenges. The definitions provided by the IUCN and the EU, along with the formal recognition by UNEA-5, underscore the critical role of NBS in promoting sustainable development and resilience in the face of climate change.

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, resilience, and biodiversity benefits, and recognizes that nature-based solutions … respect social and environmental safeguards " (UNEA, 2022).

Conclusively, the IUCN has primarily emphasized the preservation and restoration of ecosystems to safeguard biodiversity and human well-being. The EU has advocated for efficient and multifunctional NBS that provide combined benefits for the environment, society, and economy. The UNEA definition explicitly mentions ecosystem services and social and environmental safeguards, as outlined in the Convention on Biological Diversity, the United Nations Convention to Combat Desertification, and the United Nations Framework Convention on Climate Change. These safeguards include protections for local communities and indigenous peoples (UNEA, 2022).

Deliverable D2.1 has compiled diverse perspectives on the definitions of NBS (Martinov et al., 2024), referencing the following statement by Cohen-Shacham et al. (2016):

“NBS is a relatively ‘young’ concept, still in the process of being framed. There is a need now to deepen our understanding of NBS and confirm the principles upon which NBS is based, in order to move towards an operational framework that can guide applications of the NBS concept.”

Sowińska-Świerkosz & García (2022) offer a compelling critique on assessing the relevance of projects and interventions related to NBS, citing:

"Although NBS have been promoted as a key tool for solving diverse environmental and societal problems, the concept and its practical applications remain unclear. This ambiguity is linked to the fact that the NBS concept has emerged from the integration of multiple scientific fields. In addition, there has been a delay in establishing clear standards for NBS, hence a number of actions that today would be seen as complementary or related measures, are frequently branded as NBS. These definitions, however, are somewhat general and blurry and fail to clearly indicate which green and blue solutions should be regarded as NBS. As a result, there is a constant debate on the scope and types of interventions that can be classified as NBS. Furthermore, the concept's ambiguity has already been stressed by many researchers; United Nations Environmental Programme. Such results first from the fact that any definition of NBS involves integrating multiple scientific fields and experts with different backgrounds think about NBS from the point of view of their own base discipline."

A **universal definition for NBS** is crucial to clarify and address the challenges posed by the diverse range of existing definitions. This definition should encompass hybrid solutions that integrate natural and engineered approaches, recognizing them as valid forms of NBS. However, the abundance of definitions and the lack of consensus on the specific characteristics unique to NBS have created significant confusion within the NBS community regarding what qualifies as an NBS. Moreover, the framing of the NBS concept often overlaps with other established environmental approaches—such as ecological engineering, green infrastructure, urban green (and blue) spaces, and ecosystem-based adaptation—making it challenging to distinguish NBS as a distinct framework despite shared core elements.(Albert et al., 2019; Castellar et al., 2021).

Grey Infrastructure vs Hybrid Infrastructure vs NBS

D2.1 further elaborates on the difficulty in differentiating between grey infrastructure and NBS (Martinov et al., 2024). Kabisch et al. (2017) discuss the types of infrastructure, categorizing them from an engineering perspective as green, blue, and grey. Green infrastructure relies on vegetation, blue infrastructure focuses on water systems, and grey infrastructure refers to traditional materials like concrete. Additionally, hybrid infrastructures combine elements of all three. Chapter 6 includes the following statement:

"This chapter explores the role of grey, green, and blue infrastructure and in particular hybrid approaches for disaster risk reduction and climate change adaptation to shed light on available sustainable adaptation opportunities in cities and urban areas. We highlight the dependence of cities on ecosystems as a key component of climate resilience building through case studies and literature review. At the same time, we highlight the limitation and drawbacks in the adoption of merely grey or merely green infrastructures. We suggest that an intermediate 'hybrid' approach, which combines both blue, green and grey approaches, may be the most effective strategy for reducing risk to hazards in the urban context."

By using NBS, grey should be eliminated or reduced to a minimal possible extent. However, this is sometimes difficult. The problem of reduction or elimination of grey infrastructures has been discussed in many references. Besides the problem of functionality, there is also the question of costs. It is still not clear whether one grey infrastructure, that deals very efficiently with many challenges, e.g. biodiversity (fish passes), can be validated as NBS. Or, which is,

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for the validation, the highest share of grey in one hybrid solution? This is illustrated in the following comment from the World Bank (2017):

“Working with natural processes and green solutions both represent nature-based flood risk management solutions. Green-grey solutions refer to hybrid solutions that combine traditional infrastructure such as dikes with ecosystem restoration or other natural solutions. Only if there is no other option available, traditional (grey) solutions can be selected.”

In the same publication, the problem of costs is discussed. In many cases, e.g. flood protection, grey solutions costs are considerably lower (Martinov et al., 2024).

Example for NBS Classification from DANUBE4all

The DANUBE4all “D4.1 Manual on Nature-based Solutions” outlines NBS strategies for mitigating human pressures and natural risks in the Danube basin, while enhancing ecosystem services and economic opportunities. The manual begins with an overview of the benefits of using NBS in river and floodplain management. It then summarizes suitable NBS approaches from scientific and grey literature, prior EU projects, and ecological mitigation strategies for dams and hydropower plants. Building on this foundation, it evaluates the measures identified in DANUBE4all Deliverable 2.1 for enhancing river connectivity, assessing to which extent they qualify as NBS.

The manual includes a synoptic matrix categorizing river and floodplain management measures based on their alignment with NBS. While some measures incorporate significant elements of grey infrastructure and only partially meet NBS criteria, the manual provides a nuanced classification. Measures are assessed and categorized as fully, highly, fairly, poorly, or minimally pertinent NBS, with detailed evaluations explaining their degree of alignment with NBS principles.

The manual includes an overview matrix tailored to different river types, such as mountainous and lowland rivers, and considers varying levels of human-induced hydro-morphological changes. This matrix serves as a foundation for developing scenarios to enhance economic opportunities. Recognizing that water management challenges vary by location, the manual provides additional support through a multifunctionality matrix that evaluates management options based on their ecosystem service benefits. For instance, measures addressing both flood protection and habitat quality can be identified for their combined impact. To further assist practitioners, the manual features a decision tree guiding users from specific challenges to appropriate NBS solutions suited to the local context. Overall, it offers comprehensive guidance for integrative river and floodplain management amid global change (Pusch et al., 2024).

3.3. Planning and Governance for Sustainable NBS Implementation

As mentioned in the previous chapter, effective water governance needs cooperation and the inclusion of various stakeholders. NBS governance frameworks play a significant role in understanding the positive and negative outcomes related to the implementation of NBS. Challenges influencing the implementation of NBS can include insufficient governance structures or inadequate capacity building for citizen involvement. Flaws in planning, implementing, and maintaining NBS can lead to unwanted side effects and negative impacts, such as increasing inequity.

3.3.1. Co-creation and Co-governance

To overcome these challenges, NBS co-creation can be beneficial. Co-creation involves the collaborative development of NBS with the active participation of stakeholders, ensuring that the solutions are well-suited to the specific needs and conditions of the community.

Co-creation is defined as the "process of participation, interaction, collaboration, or co-production with citizens, political representatives, public officers, private stakeholders, and researchers". By engaging with multiple actors with different knowledge and backgrounds in a reflective way, it strengthens and supports the design and implementation process of NBS (Martinov et al., 2024).

Successful co-creation is defined by the extent to which diverse actors are engaged in a reflective manner, fostering a common understanding of challenges and aligning various, often differing, interests while adapting NBS to the local context. This process aids in empowering stakeholders within the decision-making process. Additionally, collaborative governance (co-governance) further facilitates stakeholder empowerment in decision-making. Society is driven to address complex environmental problems to achieve more sustainable solutions. Collaborative governance highlights the benefits of addressing societal problems, from local to global scales, while tackling environmental challenges.

Collaborative governance refers to a governing arrangement that sees the engagement of different actors at all levels of governance characterised by a multi-phased, iterative, inclusive, flexible, and adaptable process which applies forms of reflexivity for a continuous deepening of participation of stakeholders to enable adaptation to currently be faced challenges (European Commission, 2023b).

NBS processes include some features and principles that are linked to a successful implementation of co-creation:

I. Iterative process,
II. Learning by doing process
III. Good and open communication, formal and informal
IV. Locally adapted participatory process
V. A creative and collaborative effort of a variety of disciplines
VI. Thinking across boundaries
VII. Transdisciplinary
VIII. Interdisciplinary participation approaches

NBS offer numerous co-benefits for the environment, society, and the economy. However, capturing the full value of NBS is challenging due to its multifaceted nature. Some benefits are immediate, local, and direct, while others are long-term, widespread, and may only materialize indirectly. Social benefits include enhanced social cohesion, well-being, and health. Environmental benefits arise from NBS supporting biodiversity and natural ecosystems, as well as improving the quality of air, water, and soil. The specific needs and contributions of NBS depend on the stakeholder group involved (European Commission, 2023b).

Through co-creation, a sense of ownership is fostered among stakeholders, integrating their specific needs into the solution. This inclusion increases their openness and interest in the services generated by NBS, thereby raising the demand for and value of the outputs. The quality and level of integration of NBS in communities are directly connected to the attitudes, decisions, and agendas of various stakeholders, including policymakers, experts, researchers, citizens, entrepreneurs, companies, and NGOs (European Commission, 2023b).

The extent to which different stakeholders, with diverse knowledge and experiences, participate in designing and implementing NBS significantly influences the potential for value creation through innovation. It also enhances stakeholders' willingness to utilize the co-benefits offered by NBS. The co-creative process builds co-ownership of the implemented solutions, increasing long-term commitments and trust. Additionally, specific expertise can support the development of new skill sets for the successful engagement of actors, as referenced in the Living Labs of the EcoDaLLi project (WP4).

Co-creation is closely linked with co-governance. Avritzer (2020) describes informal governance as the recent trend of valuing citizens' contributions to decision-making processes, involving multiple stakeholders in public policy-making and introducing more horizontal forms of action. Collaborative dialogue helps adapt the policy context, promoting a shift towards a new governance paradigm. This new model aims to make systems more adaptable and versatile, addressing the complexity of environmental management more effectively (Avritzer, 2020).

The following has been noted from the research conducted in D2.1 (Martinov et al., 2024):

The EU project RECONECT (Regenerating ECOsystems with Nature-based solutions for hydro-meteorological risk rEduCTion, www.reconect.eu) emphasizes that:

“No single NBS can solve all problems, and NBSs are not yet easy to implement in practice. The most suitable solution will depend on local necessities and characteristics. To improve acceptance and implementation of NBSs, decision support tools can be used by considering multiple stakeholders’ views, trade-offs, and feasible measures. A flexible decision tool capable of integrating multiple objectives is thus required.”

Citizens’ engagement is also highlighted as a key component of the EU Mission Ocean & Waters. Effective stakeholder involvement, which must be well-defined and integrated into NBS projects, is essential for ensuring long-term success (Martinov et al., 2024).

Example for Co-Creation and Co-Governance Tools and Activities in EcoDaLLi – WP4: EcoDaLLi Living Labs

The EcoDaLLi project, particularly through WP4's Living Labs, provides valuable examples of co-creation and co-governance tools and activities.

According to the D1.2 Scoping Paper of EcoDaLLi, Living Labs are described as "open innovation ecosystems in real-life environments using iterative feedback processes throughout a lifecycle approach of an innovation to create sustainable impact" (Schlichenmaier, 2024).

These "Labs" represent a novel approach that emphasizes open and participative innovation by highlighting co-creation, user involvement, the 4Ps (Public-Private-People-Partnerships), and sustainability.

Five key attributes define Living Labs:

i) Co-creation
ii) Real-life setting
iii) Multi-method approach
iv) Multi-stakeholder participation
v) Active user involvement

EcoDaLLi connects various target groups and covers a wide range of European networks, Danube structures, initiatives, and cross-cutting areas of digitalization and social innovation. The Living Labs within EcoDaLLi discuss open innovation processes to support the Mission Ocean Goals. By combining knowledge co-creation with a deep understanding of local, national, and European policy processes, business decision-making, and public discussions on technical topics, the Living Labs organized by EcoDaLLi help identify innovations and co-design solutions related to biodiversity, water, climate, and innovation ecosystems.

This approach has led to the mobilization of stakeholders and structured dialogue across all Danube countries. EcoDaLLi has successfully created bridges between various types of stakeholders, which will improve communication and governance in the long term. The focus is on creating synergies with innovation actions under the Danube Lighthouse, thereby enhancing the overall impact and sustainability of the initiatives.

Further, deliverable D2.1 in WP2 of the EcoDaLLi project outlines the steps and activities necessary for assessing and realizing an NBS project. One of the key activities described in the report is the establishment of the Project Core Team (PCT). The PCT, in collaboration with various stakeholders and citizens, is responsible for visioning. This process involves working with stakeholders to transform a commonly perceived

unsatisfactory situation by defining a shared vision for the future (Martinov et al., 2024). As stated in the report:

"*By working with stakeholders, visioning would seek to transform a commonly perceived unsatisfactory situation by defining a shared vision for the future*", Martinov et al. (2024)

This visioning process is crucial for aligning the goals and expectations of all involved parties, ensuring that the NBS project addresses the needs and aspirations of the community.

The importance of visioning is also emphasized in the United Nations Development Assistance Framework (UNDAF) report. The first step in the UNDAF process involves the UN Vision 2030, which provides strategic prioritization and defines the UN system's primary contributions to supporting national attainment of the SDGs. This alignment with the UN Vision 2030 underscores the significance of establishing a clear and shared vision as a foundational step in the successful implementation of NBS projects.

3.3.2. Gender Dimension in NBS

The participation of diverse stakeholder groups from various sectors and regions is important but insufficient on its own. It is crucial to incorporate a gender-inclusive approach (De Siqueira et al., 2021).

The relevance of gender to environmental research has been recognized for several decades, beginning in the 1980s with the ecofeminist movement and theories. These theories have evolved from an essentialist approach, which emphasizes women's unique connection with the environment, to a broader perspective that includes participation and decision-making. Gender equality and the empowerment of all women and girls are explicitly promoted by the UN's SDG 5. Understanding the gender-environment nexus is crucial not only for addressing social and environmental inequities and barriers to sustainable development but also for unlocking transformative actions that can mainstream the UN Decade on Ecosystem Restoration (De Siqueira et al., 2021).

Environmental degradation and the benefits of restoration, and therefore also NBS, do not affect all people equally. Institutions, governance structures, and anthropogenic assets regulate the impacts of ecosystem degradation and restoration on human well-being (Caswell & Jang, 2024). A critical issue for NBS is not only identifying the positive outcomes of a project but also determining who benefits from it. For example, women and children are often the primary victims of the extreme adverse impacts of climate change and are more likely to become climate change refugees. Therefore, climate change mitigation through NBS could be more beneficial to women than men. Similarly, vulnerability to water scarcity is also influenced by gender and age. NBS projects focused on climate change mitigation and adaptation, as well as water and energy security, that consider gender issues would directly benefit women. Women and other vulnerable groups should not only be beneficiaries but also active participants in NBS projects. Effective social participation can promote a change in values regarding the relationship between particular social groups and nature (De Siqueira et al., 2021). The gender dimensions of NBS design and implementation have received limited

attention to date. The benefits of NBS are often presented as advantages for households as a whole, without adequately addressing intrahousehold power dynamics (Caswell & Jang, 2024).

Gender mainstreaming

Therefore, the participation of various actors in NBS projects should prioritize the inclusion of women and youth representatives from various sectors. Gender mainstreaming, a globally accepted strategy for promoting gender equality, involves integrating gender considerations into legislation, policies, and programs across all areas and levels. Gender analysis, the cornerstone of gender mainstreaming, should be the first step in the gender integration process. This analysis provides a strategic socio-economic framework to understand gender roles and relations in different dimensions of social life, such as access to assets, beliefs and perceptions, participation, legal instruments and policies, and power and influence (De Siqueira et al., 2021).

Gender analysis models are valuable for appraising gender inequality, promoting the effective participation of women, and can be incorporated into the stakeholder engagement process. Several gender analysis frameworks can guide the analysis of gender-relevant information, each based on a set of assumptions about how gender is constituted and how an understanding of gender can lead to better outcomes and greater equality. A well-established gender analysis framework adopted by the EU classifies levels of engagement as gender-blind, neutral, sensitive, and positive.

Example for Gender-inclusive NBS approach by the World Bank Group (Trohanis et al., 2023)

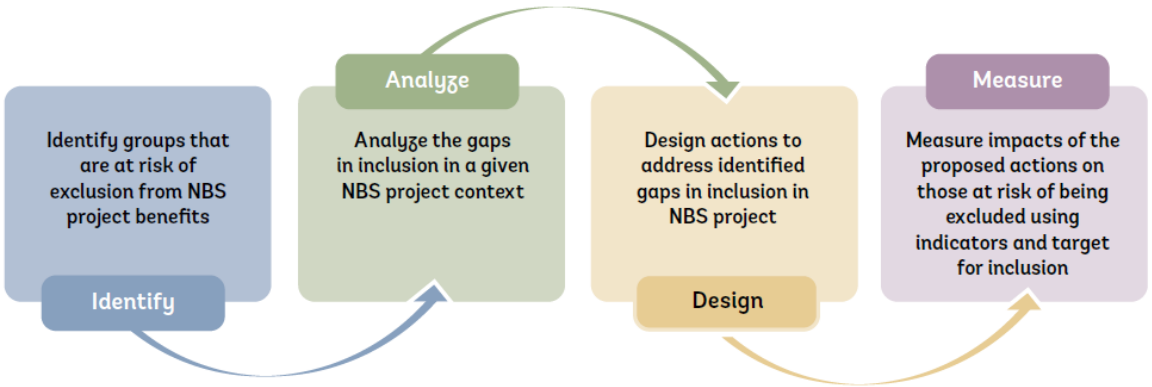

Figure 3: Steps to incorporate gender and social inclusion considerations into NBS (Trohanis et al., 2023)

3.3.3. Mainstreaming NBS to Enhance Co-creation and Co-governance

Ultimately, mainstreaming NBS into governance will rely on flexible, polycentric frameworks that align administrative bodies and address the complexities of stakeholder involvement.

To effectively mainstream NBS, it is essential to integrate them as mandatory measures within land use policies and comprehensive planning frameworks. This can be further reinforced by protecting NBS on both public and private lands through mechanisms such as municipal ordinances, byelaws, or permit systems. Additionally, planning guidance and standards - such

as those addressing green space provision, environmental quality, and ecosystem services - can play a pivotal role in ensuring their adoption and sustained implementation (more in chapters 3.4.1 and 3.4.2) (Van Der Jagt et al., 2023).

International laws and regulations can significantly shape municipal practices, as demonstrated by initiatives like the proposed EU Nature Restoration Law, which includes urban greening targets. Other policy tools, such as no-net-loss regulations, participatory planning processes, sectoral strategies, and management plans, can help set objectives and guidelines for nature-inclusive practices and the evaluation of ecosystem services. At the national level, policies are instrumental in establishing benchmarks that drive municipalities toward nature-based innovation. Additionally, public procurement systems offer an effective means to promote NBS by incorporating pro-environmental requirements into application and tender processes (Van Der Jagt et al., 2023).

Key fundamental takeaways to enhance co-creation and co-governance processes for NBS implementation and mainstreaming are (European Commission, 2023b):

1. **Planning the action**: a well-established co-creation and co-governance protocol is useful for the implementation action (see chapter on co-creation and co-governance).
2. **Budgetary allocation**: a study on the financial resources to be executed should be planned in advance.
3. **Knowledge** broker expertise for NBS is needed for the foundation of the planning procedure.
4. **Engagement mechanisms** and recognition of contributions from diverse stakeholder participation (see chapter on co-creation and co-governance).
5. Follow-up mechanisms, set-up for **evaluation and monitoring processes** (see chapter on evaluation and monitoring).
6. Intermediation methods for co-creation intervention and short-term NBS interventions to facilitate the raising of awareness and ownership (see chapter on co-creation and co-governance).
7. **Capacity building**; break silos from within local authorities and decision-makers.
8. Embedding **co-creation** into urban planning and urban regeneration.
9. Encourage cities, communities and regions to adopt **strategic planning frameworks for NBS**, supporting regeneration for inclusivity and community social cohesion.
10. Remove possible obstacles for **co-creation integration, knowledge gaps and research gaps** in regulatory frameworks and policies.
11. Create **partnerships** between government, knowledge brokers, private sector, universities and civil society to build creative frameworks for **collaboration**.

3.3.4. Summary

Co-creation and co-governance through stakeholder involvement are crucial in addressing societal and environmental challenges. They foster a **common understanding of issues** while aligning diverse and often conflicting interests, ensuring that NBS are tailored to the **local context**. This approach empowers stakeholders by actively involving them in decision-making and **promoting collaboration**.

By addressing complex environmental problems, co-creation and co-governance contribute to more sustainable solutions. These efforts build long-term **trust** and commitment among participants, ensuring continued engagement in tackling societal challenges. Furthermore, integrating stakeholders' specific needs into solutions fosters a **sense of ownership**, which enhances their openness to and demand for the services generated by NBS, thereby increasing the value of these outputs and services.

Further, it is recommended to adopt a gender-responsive perspective in designing gender-inclusive NBS. This approach will help advance social justice and foster greater equity.

This inclusive process also **supports the adaptation of policy frameworks**, driving a shift toward new governance structures. Moreover, it helps **increase social justice** by addressing inequities and promoting fairness within societal and environmental systems. Ultimately, co-creation and co-governance strengthen resilience and generate more impactful and equitable solutions.

3.4. New economic opportunities

3.4.1. Private Sector for Investing in NBS

As companies increasingly pursue sustainable practices, NBS are emerging as an integral component of corporate environmental strategies, particularly in the area of water management. The integration of NBS into corporate operations offers a promising pathway for companies to achieve sustainability goals, manage water risks, and contribute positively to local ecosystems and communities. This chapter explores the growing interest of the private sector in NBS, discusses the barriers they face in implementation, and highlights the potential benefits of NBS for the private sector (Brill et al., 2021).

According to Brill et al. (2021), the corporate water management approach typically progresses through several stages, beginning with internal water management, extending across the value chain, and culminating in collaborative projects with external stakeholders to address water risks in priority watersheds.

1. **Internal Water Management**: Companies initially focus on efficient water use within their operations, developing policies and practices to manage water sustainably in their facilities.
2. **Value Chain Water Management**: Expanding beyond internal practices, companies aim to influence water stewardship throughout their supply chains, setting ambitious targets and implementing strategies to reduce water risks.
3. **Collaborative Watershed Projects**: The final step involves partnerships with other stakeholders, such as governments, NGOs, and local communities, to undertake projects that address water-related risks in key watersheds, where NBS can play a critical role.

NBS projects fit within each stage of the water management process. These solutions can contribute directly to water management goals within company operations, throughout supply chains, and across watersheds by offering nature-based approaches that support ecosystem health and resilience. As a subset of water management projects, NBS initiatives can help address both corporate and community water-related challenges, aligning private-sector interests with broader environmental and social objectives (Brill et al., 2021).

3.4.1.1. Barriers and Limitations to NBS Adoption in the Private Sector

Despite the growing interest, companies often encounter barriers to integrating NBS into their corporate strategies. Key challenges include:

- Resistance within the corporate culture can inhibit the adoption of NBS, as traditional, infrastructure-based solutions may still be perceived as more reliable or economically advantageous.
- Many companies are hesitant to invest heavily in NBS due to unfamiliarity with their long-term benefits and concerns about the return on investment, especially compared to conventional grey infrastructure solutions.

Overcoming these barriers requires a shift in corporate mindset and a stronger emphasis on the long-term and multi-dimensional benefits that NBS can offer. Awareness-raising, robust impact assessments, and clear evidence of NBS effectiveness in risk reduction and resilience-building can help foster internal buy-in and encourage investment.

Further limitations are:

Context-Dependent Effectiveness: The ability of NBS to achieve specific benefits in a given location is highly variable, depending on local environmental conditions, project scale, and timing. This variability highlights the **need for diverse examples and types of NBS interventions across different settings** to better understand how context influences outcomes.

Lack of Universal Indicators and Calculation Methods: Due to the diversity of habitats and the tailored nature of many NBS interventions, it is difficult to create universally applicable indicators or calculation methods for every potential benefit. This **context-specific nature complicates efforts to standardize assessment methodologies across projects.**

Insufficient Data for Quantifying NBS Benefits: Many NBS benefits are not well-documented or quantified due to a lack of data, which limits the ability to analyze and compare project outcomes comprehensively. Field-based studies are essential to generate the evidence needed to support NBS implementation and to provide concrete investment examples.

Sahay (2025) also identified that the lack of evidence regarding the cost-effectiveness, long-term efficacy, and sustainability of NBS remains a significant barrier to their integration. There is an urgent need to generate robust evidence on the effectiveness and economic feasibility of NBS to support informed decision-making for their adoption. A critical limitation is the absence of a standardized economic evaluation framework for NBS.

Some key resources for NBS evidence include:

- *Oxford University's NBS Evidence Platform* (Nature-Based Solutions Evidence Platform), which provides data on various NBS outcomes and effectiveness across contexts.
- *The Nature Conservancy's AgEvidence* (AgEvidence), which offers insights on agricultural NBS and best management practices to improve sustainability in agricultural landscapes.
- *EU project MERLIN* case study portal (https://project-merlin.eu/cs-portal.html): 18 best-practice case studies in terms of innovative restoration measures, types of governance and financing frameworks.

These resources provide valuable case studies and data, but additional research and data collection efforts are necessary to build a comprehensive understanding of NBS impacts across diverse ecosystems and contexts.

3.4.1.2. Economic Valuation of NBS Benefits

To further promote the integration of NBS into business and governmental strategies, additional work is needed to determine the economic value of potential NBS benefits. By quantifying the financial impacts of NBS—such as cost savings from reduced infrastructure maintenance, increased water quality, or improved carbon sequestration—companies, national governments, and other stakeholders can estimate the economic returns on NBS investments.

Understanding the economic value of NBS benefits can:

Support Business Strategy Integration: Quantifying NBS benefits in monetary terms allows companies to incorporate NBS into their sustainability strategies more effectively, helping them justify and optimize investments in NBS relative to traditional infrastructure.

Facilitate Sustainable Funding and Financing: Demonstrating the economic return on NBS investments can help companies and governments attract sustainable financing for NBS projects. Evidence of financial savings or revenue generation from NBS can appeal to investors and funders, enhancing the likelihood of securing long-term support for these initiatives.

Overall, advancing economic valuation methods for NBS benefits will help bridge the gap between environmental objectives and financial decision-making, fostering greater adoption and scalability of NBS across sectors.

D2.1 (Martinov et al., 2024) highlighted a critique of cost-effectiveness evaluations for NBS as discussed in Seddon et al. (2020):

"The problem with current evidence for the cost-effectiveness of NBS is that appraisals in general do not use an appropriate framework, and as a result underestimate the economic benefits of working with nature, especially over the long term."

Seddon et al. (2020) identified four key issues related to the evaluation of cost-effectiveness for NBS:

- **Multifunctionality with a wide range of benefits**: NBS are often praised for delivering diverse benefits, such as food and water security, carbon sequestration, and recreational spaces, benefiting both local and global communities. However, these benefits are rarely included in evaluations due to challenges in monetization or uncertainty regarding their non-market value.
- **Trade-off assessment**: Assessments seldom address trade-offs between different interventions, ecosystem services, or stakeholder groups. Costs and benefits of NBS can vary among stakeholders, depending on their dependence on natural resources, which is often overlooked.
- **Temporal changes in ecosystem service provision**: Climate change and other stressors can alter ecosystem service delivery over time. While engineered solutions often offer predictable benefits within a specific timeframe, NbS provide flexible, long-term benefits that may not align with immediate costs or political cycles. Balancing future benefits with current costs remains a significant challenge.
- **Cost-effectiveness of NBS**: Estimating the cost-effectiveness of nature-based approaches relates to the different levels of protection they offer. Hence, the response of ecosystems and the costs for NBS are much harder to predict than engineered/grey infrastructure.

Despite these challenges, Seddon et al. (2020) express optimism, suggesting that consensus among ecologists, engineers, and managers is emerging, with the recognition that combining green and grey infrastructure may often yield the best outcomes.

The authors concluded:

1. High uncertainty around the cost-effectiveness of NBS, compared to alternatives, arises from challenges in measuring and predicting their effectiveness.

2. Poor financial models and flawed economic appraisals contribute to underinvestment in NBS.
3. Inflexible, highly sectoral governance systems continue to favor grey, engineered solutions as default approaches to climate adaptation and mitigation.

Addressing these issues requires:

- systemic change, including interdisciplinary research,
- institutional reform, and
- a shift in economic thinking.

Fully integrating NBS into responses to the climate and biodiversity crises demands moving away from the paradigm of infinite economic growth and toward recognizing the need to keep human activity within safe biophysical limits (Martinov et al., 2024).

Example from MERLIN project

The MERLIN Marketplace (https://merlin.market/) is an online platform aimed at fostering collaboration between suppliers and users of innovative solutions for ecological restoration, particularly focusing on freshwater ecosystems. Developed as part of the MERLIN project under the EU's Horizon 2020 program, the marketplace connects businesses and organizations to support the adoption of nature-based solutions (NBS) that address climate and biodiversity crises. Suppliers can advertise their products and services to a global audience, while users can explore diverse offerings to enhance their restoration efforts, improve efficiency, and adopt best practices. The platform also promotes visibility for emerging solutions through features like the annual MERLIN Innovation Awards.

The marketplace features a variety of companies and organizations that offer solutions aimed at environmental sustainability and restoration.

Some of the companies and products providing their services there are: IDRO Group (water treatment solutions), Origami Solar Panel (portable energy solution) or United Biopolymers (production of biodegradable materials).

3.4.1.3. Summary

The private sector holds significant potential to invest in NBS, offering a promising pathway for companies to achieve sustainability goals, manage water-related risks, and contribute positively to local ecosystems and communities. By addressing both corporate and community water challenges, NBS can align private-sector interests with broader environmental and social objectives. However, barriers to greater private-sector engagement remain, stemming from both perception and practical challenges.

One of the biggest barriers is the lack of internal buy-in within companies. Traditional, infrastructure-based (grey) solutions are often perceived as more reliable or economically advantageous, leading to limited corporate investment in NBS. This is due to the unfamiliarity with the long-term benefits of NBS and concerns about return on investment, particularly in comparison to conventional grey infrastructure.

To overcome these barriers, targeted actions are needed. **Raising awareness** and conducting robust **impact assessments** are crucial to demonstrating the effectiveness of NBS in reducing risks and building resilience. Providing **clear and standardized evidence** can foster internal buy-in and encourage investment. A **diverse range of examples and case studies across various contexts** is essential to illustrate how local conditions influence outcomes. Standardized methodologies for assessing NBS impacts across projects will enhance comparability and credibility. Additionally, field-based studies are important for generating actionable evidence and offering concrete investment examples.

Economic valuation also plays a critical role in scaling NBS investments. Quantifying the financial benefits of NBS—such as reduced infrastructure maintenance costs, improved water quality, or enhanced carbon sequestration—enables companies, national governments, and other stakeholders to better estimate the economic valuation of these investments. By addressing these gaps and providing tangible evidence of value, the private sector can be motivated to embrace NBS as an impactful strategy for sustainability and resilience.

3.4.2. Public Procurement to Deliver NBS

Public authorities are increasingly interested in implementing NBS to address environmental and social challenges. However, many public authorities report significant challenges when attempting to use public procurement processes for NBS projects. These challenges stem from barriers related to knowledge gaps, classification issues, community engagement difficulties, institutional and legal constraints, risk-averse procurement practices, and limited funding. Addressing these barriers is essential to facilitate the successful integration of NBS into public infrastructure projects and community development initiatives (European Commission, 2020). Figure 4 summarizes the key factors, enablers and barriers for Nature-based enterprises.

3.4.2.1. Key Challenges in NBS Procurement

The European Commission (2022) identified the following key challenges in NBS procurement:

Knowledge and Experience Gaps: A major barrier to NBS uptake is the general lack of familiarity and experience with these solutions among public authorities. Unlike traditional infrastructure, NBS projects have complex, multi-dimensional benefits that are difficult to quantify consistently, resulting in a lack of consensus on reliable performance measures. Although NBS can offer broader ecological and social benefits over a wider area than conventional engineering projects, these benefits are often challenging to measure and translate into economic terms. Without robust data on costs and benefits, procurement officers may struggle to justify NBS investments. Targeted support and training on NBS benefits, costs, and performance metrics could increase confidence among procurement officers and aid in decision-making.

Need for a Standardized NBS Typology: The lack of a simple, standardized typology for NBS complicates the procurement process. NBS have a wide array of approaches and technologies tailored to specific environmental and community needs. This diversity makes it challenging to develop a systemic classification, which limits the ability of procurement processes to specify or standardize requirements for NBS. A well-defined typology would provide public authorities with clearer guidelines for identifying, evaluating, and implementing suitable NBS solutions across different project contexts.

Challenges in Community Engagement: Engaging communities in NBS projects is essential for project success; however, many communities have experienced negative or ineffective

engagement with public authorities in the past. This can foster scepticism about the commitment of public bodies to incorporate community values into NBS projects, leading to "consultation fatigue." A lack of trust in authorities' commitment to deliver projects that reflect local needs can hinder community participation, which is often essential for co-designed and locally relevant NBS initiatives. Building trust through genuine, transparent engagement processes is crucial to overcoming this barrier.

Institutional and Legal Constraints: Institutional and legal challenges pose further barriers to NBS implementation. Many public bodies face strict budgetary constraints and limited political or institutional support for NBS, which are often perceived as non-essential or secondary to traditional infrastructure projects. Additionally, maintenance responsibilities for NBS projects can become contentious if budgets and responsibilities are not clearly defined in advance. Without clear legal frameworks or institutional support, NBS projects risk being sidelined in favor of conventional projects with more predictable funding and maintenance structures.

Risk-Averse Procurement Practices: Public procurement officers, tasked with responsibly managing taxpayer funds, tend to favor low-risk, predictable solutions. With a limited track record and history of NBS success, officers may view these projects as high-cost and high-risk, particularly when sustainability and innovation-driven criteria are incorporated into the tendering process. NBS project proposals can thus face reputational concerns, with procurement officers worried about project outcomes and cost overruns, leading to a preference for established, conventional solutions. Building a stronger evidence base for NBS effectiveness and cost-efficiency can help mitigate these concerns, making NBS a more viable option within public procurement.

Limited Funding Access for NBS: NBS projects often require dedicated funding due to their specialized nature and potential for higher upfront costs. However, limited funding availability and stringent budget allocations can prevent NBS projects from being prioritized, especially if they are perceived to increase project costs. As NBS compete with traditional infrastructure projects for limited funds, authorities may be less likely to allocate resources to projects perceived as experimental or resource-intensive.

3.4.2.2. Recommendations for Public Authorities

To facilitate the integration of NBS within public procurement processes, a multi-faceted approach is needed (European Commission, 2022):

Build Knowledge and Capacity: Provide training and resources for public procurement officers to build expertise in NBS, including robust metrics for evaluating costs and benefits. Workshops, toolkits, and case studies can improve understanding and confidence in the viability of NBS.

Develop a Standardized NBS Typology: Establish a typology to classify NBS solutions by function, scale, and context, enabling a more systematic approach to procurement specifications and requirements.

Strengthen Community Engagement Strategies: Implement transparent, participatory engagement processes that actively involve local communities in NBS planning and decision-making, fostering trust and reducing consultation fatigue.

Enhance Institutional Support and Legal Frameworks: Advocate for clearer policies and funding allocations specifically for NBS, and establish maintenance responsibilities and budgetary frameworks upfront to avoid conflicts.

Encourage Risk-Tolerant Procurement Practices: Promote flexibility within procurement practices to allow for innovation and sustainability considerations. Encourage authorities to pilot NBS projects and collect outcome data to build a track record for NBS.

Increase Access to NBS Funding: Develop funding mechanisms or incentive programs specifically for NBS, ensuring these solutions receive the financial support needed to compete with traditional infrastructure.

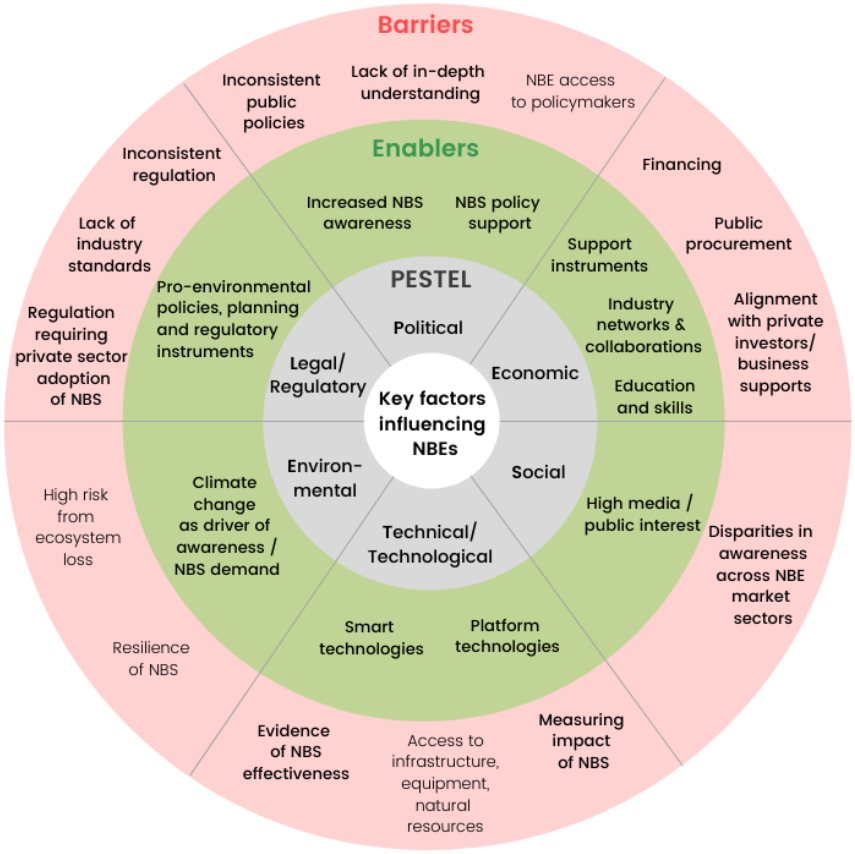

Figure 4: Key factors influencing Nature-based Enterprises (European Commission, 2022).

Additionally, the analysis in D2.1 reveals that the reviewed publications frequently lack a strong emphasis on the importance of implementing or developing innovative solutions (Martinov et al., 2024).

Technology is crucial in enhancing the planning, delivery, and management of NBS. As a major driver of economic growth, technology offers tools to shift from conventional growth models—often associated with increased resource consumption and ecosystem degradation—toward an economic approach that aligns with environmental sustainability.

- **Technology's Role in NBS Development**: Technology influences every stage of NBS implementation, from planning to stewardship, helping establish the base for successful NBS initiatives.
- **Economic Potential of Technology in NBS**: Technology can drive economic growth by optimizing NBS implementation and providing the shift toward an economy that values ecosystem health alongside economic gain.
- **Need for Responsible Growth**: While technology has traditionally accelerated resource use, integrating technology into NBS strategies can help balance economic and environmental goals, fostering biodiversity and ecosystem resilience rather than contributing to their decline.

Spatial and Temporal Variations in the Danube River Basin

D2.1 highlights critical insights regarding local variations in the temporal and spatial scope of projects within the Danube River Basin, as discussed in (European Commission, 2023a). These findings are particularly relevant to EcoDaLLi and provide valuable conclusions and recommendations for Lighthouse work (Martinov et al., 2024).

The analysis from European Commission (2023a) reveals:

"Currently running and planned projects concerning river restoration in the Danube River Basin vary strongly in their temporal and spatial scope. In general, there are over-proportionally more activities and projects with regard to river restoration and river connectivity in the upper part of the Danube River Basin (e.g., Germany, Austria). This can be explained on the one hand by the distribution of alterations in the Danube and on the other hand by lack of budgets in many downstream countries."

Key recommendations derived from D2.1 (Martinov et al., 2024):

Focus on the Lower Danube:

- To address the imbalance, prioritize financial support and project replication efforts in the lower Danube region.
- Transfer learnings from upstream projects to future downstream initiatives.

Coordination of Restoration Plans:

- Assuming the proposed nature restoration regulation is enacted, Member States will need to prepare national restoration plans.
- The International Commission for the Protection of the Danube River (ICPDR) should actively coordinate these plans, focusing on reducing ecosystem fragmentation and enhancing connectivity across Danube countries.
- Strengthen indicators to enable comparative assessments across river sections and ensure accountability among countries.

Addressing Funding Challenges:

- River restoration projects often face funding difficulties, particularly for extensions or unforeseen additional measures.
- Financing should involve a mix of contributions and mechanisms to cover unexpected costs, ensuring project continuity.
- Access to EU or international funds is vital for large-scale projects.

Streamlining Funding Access:

- The diversity of funding sources requires project developers to invest significant time in matching ideas with appropriate funding schemes. This often involves extensive discussions with multiple institutions.
- To simplify this process, a “one-stop-shop” approach at the Member State level could be implemented. Points of Single Contact, as e-government portals, would provide centralized access to necessary information and streamline administrative procedures. However, such structures would necessitate new government frameworks in many countries.

Wherever feasible, the application of NBS should be prioritized. Integrating NBS into river restoration efforts aligns with sustainable development goals, enhancing ecological and socio-economic benefits (Martinov et al., 2024).

These recommendations underline the need for collaborative approaches, strategic financial planning, and innovative governance to address disparities and challenges in implementing NBS in the Danube River Basin.

Conflicts between NBS and the agriculture sector are influenced by competing land use needs, economic considerations, and regulatory frameworks. For instance, NBS, such as wetland restoration or agroforestry, often require land that may already be allocated for intensive farming or urban infrastructure, leading to disputes over land use and tenure rights. Legal challenges can arise when NBS initiatives interfere with existing agricultural or infrastructural commitments. This is particularly problematic in regions where land tenure is poorly defined, creating barriers to the adoption of NBS (Demozzi et al., 2024).

Economic priorities further exacerbate these conflicts. Farmers and policymakers frequently favor grey infrastructure, such as irrigation systems and drainage networks, for their immediate and predictable impact on agricultural productivity. In contrast, NBS benefits, including improved biodiversity and climate resilience, often manifest over longer timeframes. The lack of comprehensive economic analyses comparing the long-term cost-effectiveness of NBS to grey infrastructure contributes to resistance among stakeholders (Miralles-Wilhelm, 2023). Governance and policy issues also contribute to conflicts. Many regulatory frameworks favor grey infrastructure, which is perceived as more reliable and easier to integrate into existing agricultural systems. This policy bias can hinder NBS implementation, especially when governance structures are not equipped to support the cross-sectoral collaboration required for NbS projects. Additionally, some NBS initiatives may reduce the amount of land available for intensive agriculture, leading to pushback from farming communities and even legal disputes against conservation-focused interventions (Demozzi et al., 2024; Miralles-Wilhelm, 2023; Simelton et al., 2021).

To effectively address intersectionality and achieve procedural justice, decision-makers should ensure equal opportunities for diverse stakeholders in policy-making, planning, analysis, management, and decisions related to urban nature. This includes considerations for potential locations, user amenities, safety measures, and neighbourhood-level analysis and policies. Inclusive, equitable, transparent, and responsive stakeholder participation can align top-down strategies with diverse, and sometimes conflicting, place-based needs and preferences, thereby legitimizing and empowering urban communities. Achieving procedural justice requires

an iterative approach that questions who benefits and who loses across various spatial and temporal scales (Van Der Jagt et al., 2023).

Fair representation of diverse perspectives in the development of NBS is essential for equitably distributing environmental benefits and burdens. Marginalized communities often experience limited access to public green spaces, lower-quality greenspaces, and restricted access to private greenspaces. These communities are also more vulnerable to climate hazards, such as urban heat islands, erosion, and flooding, and have limited access to mitigating infrastructure like stormwater systems or heat island mitigation measures. To address these inequities, some advocate for restorative justice, suggesting increased investment in NBS within historically disadvantaged communities. However, this must be balanced against the risk of environmental gentrification, which could displace lower-income residents. Deliberating the long-term socio-spatial effects of NBS during their design and planning stages is crucial to avoid such unintended consequences (Van Der Jagt et al., 2023).

3.4.2.3. Summary

The public sector plays an important role in investing in NBS to address environmental and social challenges. However, several barriers hinder the adoption and effective implementation of NBS. One challenge is the valuing of NBS. Many of these **solutions function as "public goods"** or "common pool resources", providing benefits that are widely shared but **difficult to monetize**. This lack of clear monetization potential can make NBS investments appear less attractive to the public sector compared to traditional infrastructure, which typically offers clearer revenues.

Further, significant **knowledge gaps in NBS implementation and financing** complicate investment decisions. The **effectiveness** of NBS can **vary significantly** depending on local climate conditions, which are becoming increasingly unpredictable due to climate change. In contrast, grey infrastructure has a well-established track record with clear cost-benefit analyses and defined financing pathways, often making it the default choice for decision-makers. Furthermore, the **limited availability of robust data on NBS monitoring and outcomes** hinders the ability to demonstrate measurable benefits, creating uncertainty and reducing confidence in the scalability and reliability of these solutions.

Incorporating technology into NBS offers transformative potential for sustainable growth by enhancing data collection, decision-making, and impact measurement. By establishing strong standards and investing in adaptable tools, NBS can achieve broader acceptance and effectiveness. Through thoughtful integration of technology and community-centered standards, NBS can foster an economic model that aligns growth with ecological resilience and community well-being, positioning NBS as essential to future urban and environmental planning.

4. Monitoring and Evaluation Challenges of NBS

Realizing the full potential of NBS requires a comprehensive understanding of their outcomes, synergies, trade-offs, and the pathways by which they achieve impact. Monitoring and evaluation play a crucial role in building this understanding and ensuring that NBS initiatives deliver intended benefits, meet strategic objectives, and contribute meaningfully to policy and practice. This chapter outlines the significance of monitoring and evaluation in the application of NBS, describing how robust impact assessment frameworks can support effective NBS planning, implementation, and policy integration (European Commission, 2021).

D2.1 emphasizes that the majority of analyses focus on the applications of NBS in urban environments, as exemplified by Bosch and Sang (2017), and their impacts on health and human well-being. These impacts appear to be more evident compared to the direct or indirect influences of NBS applications in other habitats, such as river basins (Martinov et al., 2024).

However, there is no comprehensive review that examines both the positive and negative outcomes of NBS interventions on human well-being across various habitats. There remains a significant gap in knowledge regarding the monitoring and impact evaluation of NBS benefits, particularly in terms of human health and well-being, especially when NBS are applied in non-urban areas. Very often the impacts of NBS on health and well-being are expressed in qualitative ways that require high expertise in psycho-social research and cannot be done ad hoc (Martinov et al., 2024).

Monitoring and evaluation provide critical insights that underpin successful NBS application at every stage, from initial planning through implementation and ultimately to achieving policy impact. By systematically assessing the outcomes of NBS initiatives, monitoring builds a strong evidence base that can inform both current and future projects. This evidence is essential for identifying effective approaches, refining methodologies, and understanding the contexts in which NBS are most successful. The core contributions of monitoring and evaluation in NBS application are as follows (European Commission, 2021):

Establishing Evidence for Outcomes and Processes: NBS are often celebrated for their multi-dimensional benefits; however, empirical evidence on the range of outcomes they deliver, the synergies and trade-offs they bring, and the mechanisms that drive these outcomes remains limited. Robust impact assessment frameworks provide the structure needed to collect this evidence systematically. Monitoring and evaluation can show the diverse effects of NBS, highlighting positive outcomes while identifying areas where results fall short or reveal unintended impacts.

Informed Planning, Investment, and Policy Decision-Making: A well-constructed monitoring framework can support decision-makers in planning and prioritizing investments in NBS by providing clear evidence of their impacts across ecological, social, and economic dimensions. When policymakers have access to data on NBS effectiveness, they can make informed choices that balance short-term needs with long-term resilience and sustainability goals. In the long term, monitoring can contribute to evidence-based planning, ensuring that both NBS and traditional (grey) infrastructure solutions are evaluated consistently and rigorously.

Enhancing Strategic Learning and Adaptive Management: As living systems, NBS often respond to local conditions, making it essential to adapt approaches over time based on

observed outcomes. Through continuous monitoring, practitioners can better understand the strengths and weaknesses of various NBS approaches, allowing them to refine methods, reallocate resources, and shift objectives as needed. Monitoring and evaluation frameworks enable this adaptive management approach by providing feedback loops that inform ongoing improvements.

Building Stakeholder Trust and Engagement: Stakeholder involvement and ownership are vital to the success of NBS. Monitoring and evaluation processes foster transparency, giving stakeholders a clear view of how projects progress and what impacts are realized. This engagement helps build trust and can lead to greater community support, enhancing the overall sustainability of NBS initiatives.

How to develop a robust monitoring and evaluation plan for NBS

(European Commission, 2021; Martinov et al., 2024)

A robust monitoring and evaluation framework for NBS includes several key components that start from the formulation of a Theory of Change to the implementation and dissemination of findings. Each stage in the monitoring and evaluation process is essential for building a comprehensive understanding of how NBS operate and achieve impact.

Constructing a Theory of Change

Developing a Theory of Change is the foundation of any monitoring and evaluation framework for NBS. The Theory of Change should identify the specific challenges in the local context that the NBS seeks to address, outline the objectives of the NBS, and ensure alignment with strategic goals.

Engaging stakeholders in the Theory of Change development process is crucial. By involving relevant community members, policymakers, and technical experts, the Theory of Change can foster a sense of ownership and shared commitment to the NBS objectives. This collaboration helps ensure that the project remains relevant to local needs and has the support necessary for sustained impact.

Mapping the Results Chain

The results chain represents the causal pathways by which the NBS implementation is expected to achieve its strategic objectives. This mapping helps outline expected effects and any changes that are desirable and explicitly targeted, as well as unintended impacts or negative outcomes.

Mapping synergies and trade-offs in the results chain are particularly important for NBS, as these projects often aim to produce co-benefits (e.g., biodiversity enhancement, climate mitigation, and social benefits) that may interact in complex ways. By identifying these interactions, practitioners can anticipate potential trade-offs and optimize the design of NBS interventions.

Defining Evaluation Questions

Evaluation questions should address the dynamics between NBS actions and their outcomes, considering both the intended and unintended impacts. These questions provide the foundation for determining whether the NBS has achieved its goals and identifying other factors that may influence the outcomes.

Evaluation questions also facilitate an adaptive approach to monitoring and evaluation, enabling practitioners to reconsider assumptions, evaluate the relevance of certain actions, and adjust strategies as new information and data are being collected.

Selecting Indicators and Data Gathering Methods

Selecting appropriate indicators is essential for assessing both performance and process. Indicators should be tailored to the specific objectives of the NBS and be sensitive enough to capture changes over time. A diverse range of indicators may be needed to assess ecological, social, and economic outcomes.

Choosing appropriate impact evaluation methods (e.g., before-after analysis, matched control studies) ensures that the data collected are robust and comparable. Developing a local monitoring and data collection plan, which includes identifying the sources of data and the frequency of collection, helps establish a sustainable and consistent approach to impact monitoring.

Implementing the Impact Monitoring and Evaluation Plan

The success of a monitoring and evaluation framework depends on its practical implementation. This phase includes training local stakeholders, conducting regular data collection, and maintaining ongoing communication with all actors involved.

Effective implementation also requires adaptability, allowing practitioners to adjust methodologies and resources in response to unforeseen challenges or evolving conditions.

Disseminating Results and Achieving Policy Impact

Sharing monitoring and evaluation results with a broader audience is crucial for maximizing the impact of NBS initiatives. Dissemination strategies include publishing reports, engaging with policy networks, and hosting workshops. These activities help integrate findings into policy discussions, where evidence from monitoring and evaluation can inform broader environmental planning and policy frameworks.

Achieving policy impact requires translating monitoring and evaluation findings into actionable insights that are accessible to policymakers. This process may involve presenting monitoring and evaluation data in formats tailored to policy audiences and illustrating the long-term benefits of evidence-based NBS investments.

D2.1 also states that assessing the impact of NBS remains challenging, particularly when attempting to integrate these assessments with the implementation of NBS projects (Martinov et al., 2024).

The identified publication in D2.1 by Raymond et al. (2017) concludes with an "Application Guide for the Assessment of the Effectiveness of NBS Projects". The final paragraph states:

"In fact, how to integrate NBS impact assessment with NBS implementation remains another important research gap. Impact assessment and implementation have traditionally occurred separately, but coproduction processes are needed for bridging these two fields. This may involve considering the specific types of capitals (e.g., natural, built, financial), capabilities, and agency that are required to implement specific types of NBS alongside the environmental, social, and economic co-benefits of NBS."

A **key challenge** in effectively monitoring and evaluating NBS lies in the **lack of standardized approaches for assessing their impacts across diverse environments and scales**. This issue is particularly evident in areas like biodiversity net-gain - an approach to development, land, and marine management designed to leave biodiversity in a measurably improved state post-intervention. The absence of consistent, integrated standards complicates efforts to evaluate NBS outcomes, limits comparability, and impedes scaling across contexts. Addressing these challenges requires a multi-tiered approach, encompassing the development of adaptable standards, robust accreditation systems, and supportive policies that encourage uptake across sectors and scales.

Recommendations for various stakeholder groups to achieve standardized approaches for impact assessment (European Commission, 2021)

Policymakers

Policy-level recognition of the importance of standards and accreditation in upscaling NBS is essential. Policymakers should prioritize the development of international standards and accreditation systems within global sustainability agendas and support their integration into national frameworks. At the national and regional levels, targeted policy instruments are necessary to encourage the uptake of these standards within local contexts, thereby enhancing the consistency and scalability of NBS implementations.

Public Sector

Awareness-raising and capacity-building initiatives are critical for promoting standards uptake across NBS value chains. This can involve training programs targeting different NBS stakeholders, particularly investors, to enhance understanding of standards' benefits and applications. For smaller enterprises, tailored measures such as discounted access to training or accreditation fees should be implemented to prevent market exclusion and support broad-based adoption of NBS standards.

Public-sector conformity assessment service providers, such as government bodies, can increase trust in NBS standards, although their involvement does not guarantee automatic acceptance of certificates. Governments can also support compliance by providing training and capacity-building resources, ultimately promoting widespread adoption of standards without disadvantaging smaller players.

Public procurement strategies can promote standards compliance by requiring that NBS solutions used in public projects adhere to recognized standards. By incorporating standards into procurement criteria, governments encourage firms and entrepreneurs to adopt national and international NBS standards. Ensuring public sector procurers are well-informed about standards development and accreditation is crucial for consistent implementation. Public procurement requirements should carefully consider potential discrimination against smaller market players to ensure inclusive access to opportunities.

Industry

The NBS sector's value chains involve a variety of stakeholders, including architects, developers, and local communities, who all influence purchasing and implementation decisions. Industry-specific awareness and capacity-building programs are essential for

embedding standards into procurement processes in a manner that respects environmental objectives and avoids perpetuating harm. Industry associations play a key role in standards development, promoting awareness, and supporting new and existing standards uptake. Industry awards or recognition programs that celebrate excellence in standards implementation can further incentivize adherence.

Citizens, Community Groups, and NGOs

Community organizations and NGOs can enhance public and political awareness around NBS standards, advocating for adherence to these standards in planning, execution, and maintenance. Through community outreach, NGOs can empower citizens to demand high standards of environmental and social responsibility from NBS providers, thereby influencing project quality and sustainability.

Researchers

Ongoing research is needed to evaluate the effectiveness of standards and accreditation across different NBS types, scales, and contexts. Specifically, research should examine how standards impact uptake, the degree to which they support sustainability objectives, and any unintended consequences they may introduce across different actors. Through such studies, researchers can provide valuable insights into the value of standards, inform their refinement, and guide future iterations to maximize positive outcomes across NBS applications.

Example: Monitoring Framework by the EU Missions "Restore our Ocean and Waters 2030"

Dynamic, real-time monitoring will be crucial to maintaining urgency, fostering a sense of achievement, and sustaining motivation within the Mission. It will also enable informed and flexible adjustments to the Mission as needed. To this end, a comprehensive monitoring framework will be established during the initial implementation phase. This framework will include a set of indicators, a reporting structure, and an institutional framework to facilitate continuous assessment of progress. Its development will involve consultation with the JRC and other Commission services by 2022, leveraging Horizon Europe's Key Impact Pathways framework and other relevant existing systems and indicators. The monitoring framework will operate under the Mission Implementation Platform, guided by the Mission manager and secretariat, and will rely on annual progress reporting managed by the platform.

- Output indicators: measure the progress of Mission implementation for the key Mission activities (e.g. number of regions involved in the lighthouse, number of citizens involved in Mission citizen outreach and engagement activities)
- Result (outcome) indicator: measure the degree of achievement of the three Mission objectives throughout the EU (e.g. volume of EU, national and private financing mobilised towards Mission objectives, number of citizen awareness and literacy projects, number of participator research and citizen science projects)
- Impact indicators: measure the actual real-time progress of ocean and water restoration based on Green Deal, biodiversity restoration targets and on the upcoming EU Nature restoration targets (e.g. area of protected and restored ecosystems, degree of achievement of the Good Ecological Status under the WFD).

Evaluation Framework by the EU Missions "Restore our Ocean and Waters 2030"

1. Evaluation of the Mission under Article 7(3) HE Regulation
2. Mid-term review in 2025: A thorough mid-term assessment will be conducted to evaluate the progress of the Mission's implementation. This assessment will include a review of the Mission's objectives and targets, with a focus on potentially increasing their ambition. The Mission will proceed to its second implementation phase if the assessment confirms that key milestones have been achieved. Additionally, the review will determine whether any adjustments are necessary to ensure the Mission's objectives are met.
3. Final review in 2030: The review will encompass all Mission activities throughout its duration to assess whether the specific objectives have been achieved. It will provide recommendations on the continuation and potential scaling up of Mission activities to support the achievement of the Green Deal objectives by 2050. Additionally, the review will identify lessons learned to inform the future implementation of Horizon Europe Missions.

Example from EcoDaLLi WP7: Danube Innovation Strategic Action Plan

In EcoDaLLi's WP7, an action plan is delivered to support the Mission Secretariat in establishing a lighthouse implementation charter and achieving the Mission Ocean Goals. Specifically, Task 7.2: Monitoring Framework for Mission Ocean Objectives Assessment will establish a clear monitoring framework to evaluate progress towards the Mission Ocean objectives. EcoDaLLi will define clear KPIs for monitoring and activities for KPI analysis.

4.1. Summary

Monitoring and evaluation play a crucial role in the successful implementation and long-term effectiveness of NBS. They contribute to establishing **evidence for outcomes and processes** by systematically assessing the diverse impacts of NBS. While NBS are widely recognized for their multi-dimensional benefits, there is still limited empirical evidence regarding the range of outcomes they deliver, the synergies and trade-offs involved, and the mechanisms driving these results. Robust impact assessment frameworks provide the structure needed to collect and analyze this evidence, highlighting the positive outcomes while identifying areas where results reveal unintended impacts.

A well-constructed monitoring framework also supports **informed planning, investment, and policy decision-making** by providing clear evidence of NBS impacts across ecological, social, and economic dimensions. Decision-makers can use this reliable data to plan and prioritize investments, balancing immediate needs with long-term goals for resilience and sustainability. In the long term, monitoring fosters evidence-based planning, ensuring that both NBS and traditional grey infrastructure solutions are evaluated consistently.

Moreover, monitoring and evaluation enhance **strategic learning and adaptive management**. As living systems, NBS are influenced by local conditions, necessitating the adaptation of approaches based on observed outcomes. Continuous monitoring allows practitioners to understand the **strengths and weaknesses of various NBS approaches**, refine methods, reallocate resources, and shift objectives as needed. Feedback loops provided by monitoring frameworks are essential for enabling this adaptive management approach and ensuring ongoing improvements.

5. Key Challenges and Knowledge Gaps in NBS Application

Despite various international agreements aiming to promote sustainability and ecosystem resilience, significant challenges remain in the effective implementation of NBS. Barriers to NBS adoption include overly ambitious goals, financing limitations, and governance constraints. This chapter summarizes these challenges from the previous chapters.

Key Challenges in NBS Implementation

1. **Various definitions for NBS**: A universal definition for NBS is recommended, as various definitions bring both richness and complexity (international level).
2. **Ambitious International Agreements**: Although international agreements support sustainability and NBS, they often set ambitious targets that are challenging to meet in practice, due to discrepancies between policy aspirations and on-the-ground realities (international level).
3. **Financing Constraints**: Securing sufficient, stable funding for NBS projects remains a core issue. Many initiatives struggle to attract investment, especially when compared to traditional infrastructure, which is often seen as a safer, more predictable choice (international, national and local level).
4. **Governance Conditions**: Effective (co-)governance is critical to NBS success but can be limited by institutional complexity and regulatory fragmentation, where multi-jurisdictional governance complicates cohesive NBS implementation (international, national and local level).
5. **Increase NBS Examples**: Many current NBS projects are concentrated on urban ecosystem services, limiting the exploration of NBS potential in rural and regional contexts.
6. **Economic valuation of NBS**: While NBS present opportunities for new businesses, investment models, and green job creation, these potential benefits are often under-leveraged due to a lack of awareness and incentive structures. The need for an economic shift towards NBS.
7. **Cost-Effectiveness of NBS**: Although NBS can be cost-effective in the long run, short-term financial constraints and limited awareness of their benefits make them less appealing to investors.
8. **Need for more monitoring and evaluation data**: Scaling NBS requires better data on their effectiveness, which remains inconsistent, making it difficult to assess and compare outcomes across projects.

6. Policy Recommendations on NBS Application

Based on the findings outlined in this deliverable report, the following recommendations are proposed to address the identified gaps and challenges - a combination of technical and non-technical strategies. The following approaches are recommended:

"Need for a unified, internationally recognized definition for NBS."

1. **Universal definition for NBS:**

A universal definition for NBS is recommended, as various definitions bring both richness and complexity.

"Need for more evidence data and lack of standardized approaches for assessing NBS impacts."

2. **Addressing Technical and Non-Technical Barriers:**

Use a mix of regulatory, economic, and fiscal incentives to encourage NBS adoption, alongside capacity-building efforts, awareness campaigns, and knowledge dissemination.

Implement NBS-specific performance indicators to measure impact, systematically allowing for greater accountability and transparency.

"Lack of NBS examples and best practices."

3. **Establishing Common Data and Knowledge Sharing Platforms:**

Develop centralized databases for sharing information on NBS impacts, case studies, and performance metrics. Accessible data can help build a stronger evidence base and guide project planning and funding decisions. A diverse range of examples and case studies across various contexts is essential to illustrate how local conditions influence outcomes. Challenges, indicators, data, and other specific elements of NBS should be defined for diverse projects/interventions.

4. **Set of international standards to address sectoral differences and variations across climates and geographies:**

A consistent set of international standards is necessary to guide NBS planning, implementation, monitoring, and sustainability assessment. Given the diversity of NBS initiatives—ranging from small urban projects to large cross-border landscape efforts—standards must be adaptable to different contexts and scales. Specific technical standards at the international level are required to address sectoral differences and variations across climates and geographies.

5. **Tailoring NBS to Local Contexts:**

Identify context-specific NBS solutions that provide multipurpose benefits and are suitable for the particular environmental and socio-economic conditions of the area. This ensures NBS are both effective and aligned with local needs.

"Missing knowledge on NBS and lack of stakeholder involvement."

6. **Promoting Education and Capacity Building:**

Enhance educational programs and capacity-building initiatives focused on NBS. Multi-stakeholder involvement, from planning through implementation, can foster a shared understanding of NBS benefits, build a sense of ownership, and drive coordinated action.

Initiate multi-stakeholder dialogues at the outset of NBS projects to address institutional and socio-cultural barriers and ensure inclusive participation.

7. **Mobilizing Stakeholders and Community Engagement:**

Engage politicians, local communities, and other stakeholders from the start of NBS projects to build support and address potential resistance early on. This approach helps bridge institutional gaps and aligns community values with NBS goals.

8. **Encouraging Cross-Sectoral Collaboration at the European Level:**

Foster cross-sectoral collaboration to address broader sustainability challenges, adapt to climate change, and support European Green Deal objectives. A collaborative approach can enhance NBS integration across sectors, particularly in urban planning and development.

"Funding constraints for NBS projects compared to grey infrastructure."

9. **Expanding Funding Opportunities through European Collaboration:**

Increase funding opportunities for NBS by leveraging European partnerships. Collaborative funding mechanisms can support the upscaling of NBS and make it easier for municipalities and regions to implement NBS at larger scales.

10. **Private Sector Involvement:**

Engage the private sector through legislative, market, and social incentives to enhance NBS implementation. Encouraging private sector participation can drive NBS innovation, create green jobs, and attract young professionals from diverse fields to the NBS sector.

Successfully overcoming the barriers to NBS implementation requires coordinated efforts across technical, financial, and governance domains. By developing performance indicators, enhancing stakeholder collaboration, promoting multi-sectoral involvement, and securing sustainable funding, NBS can become a cornerstone of resilience and sustainability strategies across Europe. This approach not only supports the environment but also fosters economic growth, job creation, and a healthier society, paving the way for a more sustainable future.

6.1. Summary

1. **Universal definition for NBS**
2. **Addressing Technical and Non-Technical Barriers**
3. **Establishing Common Data and Knowledge Sharing Platforms**
4. **Set of international standards to address sectoral differences and variations across climates and geographies**
5. **Promoting Education and Capacity Building**
6. **Mobilizing Stakeholders and Community Engagement**
7. **Tailoring NBS to Local Contexts**
8. **Encouraging Cross-Sectoral Collaboration at the European Level**
9. **Expanding Funding Opportunities through European Collaboration**
10. **Private Sector Involvement**

7. Conclusion and Outlook

The EcoDaLLi project underscores the transformative potential of NBS to address pressing environmental and societal challenges in the Danube River Basin. By focusing on ecosystem-based governance, innovative solutions, and multi-stakeholder collaboration, the project has identified key barriers and opportunities for advancing NBS. However, these recommendations are derived specifically from the work conducted by EcoDaLLi and should be viewed as an initial framework rather than universally applicable solutions.

Policy recommendations for NBS implementation are inherently challenging to generalize across the entire Danube Basin due to the region's diverse local conditions. Local context is important to consider when formulating policy recommendations. Policy recommendations must consider environmental, and socio-economic factors, governance structure, stakeholder dynamics, infrastructure and regional challenges, as well as resource availability. Local contexts strongly influence the feasibility, design, and effectiveness of NBS. Therefore, this report aims to provide an overarching perspective on considerations for decision-makers, future NBS implementers, and donors, rather than prescriptive, one-size-fits-all solutions.

By integrating local context into policy recommendations, decision-makers can ensure that the proposed solutions are not only theoretically sound but also applicable and sustainable in the real-world settings where they are implemented. This approach enhances the likelihood of success and the long-term benefits of the policies.

In the next stages of the EcoDaLLi project, these initial recommendations will be tested and validated in four distinct regions: the Upper, Middle, and Lower Danube, as well as the Danube Delta. This validation process will assess the recommendations in diverse regional contexts with their respective stakeholders, refine their applicability, and further specify actionable guidelines. By putting the findings in local realities, EcoDaLLi will strengthen the relevance and impact of its proposed strategies.

Looking forward, the success of NBS implementation depends on continued cross-sectoral collaboration, the development of robust monitoring frameworks, and the scaling of innovative governance and funding mechanisms. As these efforts progress, NBS have the potential to become transformative tools for sustainable water management, biodiversity conservation, and socio-economic resilience, both within the Danube and Black Sea River Basins and as a lighthouse for other regions.

8. References

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? *Landscape and Urban Planning*, *182*, 12–21. https://doi.org/10.1016/j.landurbplan.2018.10.003

Avritzer, L. (2020). Informal Governance and Participatory Institutions. In D. Berg-Schlosser, B. Badie, & L. Morlino, *The SAGE Handbook of Political Science* (pp. 1023–1033). SAGE Publications Ltd. https://doi.org/10.4135/9781529714333.n64

Brill, G., Shiao, T., Kammeyer, C., Diringer, S., Vigerstol, K., Ofosu-Amaah, N., Matosich, M., Müller-Zantop, C., Larson, W., & Dekker, T. (2021). *Benefit Accounting of Nature-Based Solutions for Watersheds: Guide.* United Nations CEO Water Mandate and Pacific Institute. www.ceowatermandate.org/nbs/guide

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

Caswell, C., & Jang, N. (2024). *Mainstreaming Gender Equality and Social Inclusion in Nature-Based Solutions for Climate Change Adaptation.* International Institute for Sustainable Development.

Cohen-Shacham, E., Walters, G., Janzen, C., & Maginnis, S. (Eds.). (2016). *Nature-based solutions to address global societal challenges*. IUCN International Union for Conservation of Nature. https://doi.org/10.2305/IUCN.CH.2016.13.en

Connop, S., Vandergert, P., Eisenberg, B., Collier, M. J., Nash, C., Clough, J., & Newport, D. (2016). Renaturing cities using a regionally-focused biodiversity-led multifunctional benefits approach to urban green infrastructure. *Environmental Science & Policy*, *62*, 99–111. https://doi.org/10.1016/j.envsci.2016.01.013

Davies, C., Chen, W. Y., Sanesi, G., & Lafortezza, R. (2021). The European Union roadmap for implementing nature-based solutions: A review. *Environmental Science & Policy*, *121*, 49–67. https://doi.org/10.1016/j.envsci.2021.03.018

De Siqueira, L. P., Tedesco, A. M., Meli, P., Diederichsen, A., & Brancalion, P. H. S. (2021). Gender inclusion in ecological restoration. *Restoration Ecology*, *29*(7), e13497. https://doi.org/10.1111/rec.13497

Demozzi, T., Oberč, B. P., Prieto López, A., Larbodière, L., & Borges, M. A. (2024). *Sustainable agriculture and Nature-based Solutions* (A. Arroyo Schnell, Ed.). IUCN, International Union for Conservation of Nature. https://doi.org/10.2305/EZVW9195

European Commission, D. G. for R. and Innovation. (2015). *Towards an EU research and innovation policy agenda for nature-based solutions & re-naturing cities: Final report of the Horizon 2020 expert group on 'Nature based solutions and re naturing cities' : (full version).* Publications Office. https://data.europa.eu/doi/10.2777/765301

European Commission, D. G. for R. and Innovation. (2020). *Public procurement of nature-based solutions: Addressing barriers to the procurement of urban NBS : case studies and recommendations.* Publications Office. https://data.europa.eu/doi/10.2777/561021

European Commission, D. G. for R. and Innovation. (2021). *Evaluating the impact of nature-based solutions :a summary for policy makers.* Publications Office. https://data.europa.eu/doi/10.2777/2219

European Commission, D. G. for R. and Innovation. (2022). *The vital role of nature-based solutions in a nature positive economy.* Publications Office. https://data.europa.eu/doi/10.2777/307761

European Commission, D. G. for R. and Innovation. (2023a). *Baseline study for the implementation of lighthouses of the Mission 'Restore our ocean and waters by 2030': Atlantic, Arctic, Danube and Mediterranean lighthouses.* Publications Office. https://data.europa.eu/doi/10.2777/34856

European Commission, D. G. for R. and Innovation. (Ed.). (2023b). *Guidelines for co-creation and co-governance of nature-based solutions: Insights form EU funded projects.* Publications Office. https://data.europa.eu/doi/10.2777/157060

Fenten, T. (2024). *Governance conditions for a successful restoration of riverine ecosystems. Lessons learned from the Rhine river basin.* [Master's thesis Sustainable Development]. Copernicus Institute of Sustainable Development, Utrecht University.

Giordano, R., Pluchinotta, I., Pagano, A., Scrieciu, A., & Nanu, F. (2020). Enhancing nature-based solutions acceptance through stakeholders' engagement in co-benefits identification and trade-offs analysis. *Science of The Total Environment*, *713*, 136552. https://doi.org/10.1016/j.scitotenv.2020.136552

ICPDR (Ed.). (2024). *The Danube River Basin. Facts and Figures.* https://www.icpdr.org/sites/default/files/nodes/documents/icpdr_facts_figures.pdf

IUCN. (2020). *BRIDGE: Building River Dialogue and Governance. Greater Cooperation through Water Diplomacy and Transboundary Water Management.* https://iucn.org/sites/default/files/content/documents/bridge_project_brochure_0.pdf

Kabisch, N., Korn, H., Stadler, J., & Bonn, A. (Eds.). (2017). *Nature-Based Solutions to Climate Change Adaptation in Urban Areas: Linkages between Science, Policy and Practice*. Springer International Publishing. https://doi.org/10.1007/978-3-319-56091-5

Lindelien, M. C., Schmitz, T., Dalton, J., Iza, A., & Jara, D. (2024). *Supporting effective transboundary water governance: Lessons from BRIDGE 2011-2024.* IUCN.

Martin, J. G. C., Scolobig, A., Linnerooth-Bayer, J., Liu, W., & Balsiger, J. (2021). Catalyzing Innovation: Governance Enablers of Nature-Based Solutions. *Sustainability*, *13*(4), 1971. https://doi.org/10.3390/su13041971

Martinov, M., Veskovic, M., Djatkov, D., Viskovic, M., Nesterovic, A., Kolakovic, S., Schlichenmaier, N., & Scrieciu, A. (2024). *EcoDaLLi Deliverable 2.1. Methodology for Mission Relevant NBS Assessment.* [Deliverable]. EcoDaLLi.

Mendes, R., Fidélis, T., Roebeling, P., & Teles, F. (2020). The Institutionalization of Nature-Based Solutions—A Discourse Analysis of Emergent Literature. *Resources*, *9*(1), 6. https://doi.org/10.3390/resources9010006

Miralles-Wilhelm, F. (2023). Nature-based solutions in agricultural landscapes for reducing tradeoffs between food production, climate change, and conservation objectives. *Frontiers in Water*, *5*, 1247322. https://doi.org/10.3389/frwa.2023.1247322

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

OECD. (2011). *Water Governance in OECD Countries: A Multi-level Approach*. OECD. https://doi.org/10.1787/9789264119284-en

Pauleit, S., Zölch, T., Hansen, R., Randrup, T. B., & Konijnendijk Van Den Bosch, C. (2017). Nature-Based Solutions and Climate Change – Four Shades of Green. In N. Kabisch, H. Korn, J. Stadler, & A. Bonn (Eds.), *Nature-Based Solutions to Climate Change Adaptation in Urban Areas* (pp. 29–49). Springer International Publishing. https://doi.org/10.1007/978-3-319-56091-5_3

Pusch, M., Waldenberger, L., Waheed, A., Haimann, M., Penning, E., & Habersack, H. (2024). *DANUBE4all Manual on Nature-based Solutions (NbS). DANUBE4all Deliverable 4.1.* [Deliverable]. https://0a028191-b6c1-4098-a07c-3420dad17191.usrfiles.com/ugd/0a0281_5a21494e663e4f7c8f93c2c9bdbde121.pdf

Raymond, C. M., Frantzeskaki, N., Kabisch, N., Berry, P., Breil, M., Nita, M. R., Geneletti, D., & Calfapietra, C. (2017). A framework for assessing and implementing the co-benefits of nature-based solutions in urban areas. *Environmental Science & Policy*, *77*, 15–24. https://doi.org/10.1016/j.envsci.2017.07.008

Sahay, S. (2025). Nature-based solutions as urban adaptation to climate risk: Framework for economic evaluation as decision support tool. *Sustainable Cities and Society*, *118*, 106037. https://doi.org/10.1016/j.scs.2024.106037

Salcedo-La Viña, C., Trivedi, A., & Grace, K. (2023). Enabling Women as Key Actors in Nature-based Solutions. *World Resources Institute*. https://doi.org/10.46830/wriwp.21.00164

Schlichenmaier, N. (2024). *Deliverable D1.2 EcoDaLLi Wiki—Scoping paper on concept, definitions and tehmatical scope of EcoDaLLi* [Deliverable].

Seddon, N., Chausson, A., Berry, P., Girardin, C. A. J., Smith, A., & Turner, B. (2020). Understanding the value and limits of nature-based solutions to climate change and other global challenges. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *375*(1794), 20190120. https://doi.org/10.1098/rstb.2019.0120

Simelton, E., Carew-Reid, J., Coulier, M., Damen, B., Howell, J., Pottinger-Glass, C., Tran, H. V., & Van Der Meiren, M. (2021). NBS Framework for Agricultural Landscapes. *Frontiers in Environmental Science*, *9*, 678367. https://doi.org/10.3389/fenvs.2021.678367

Sowińska-Świerkosz, B., & García, J. (2022). What are Nature-based solutions (NBS)? Setting core ideas for concept clarification. *Nature-Based Solutions*, *2*, 100009. https://doi.org/10.1016/j.nbsj.2022.100009

Stoffers, T., Altermatt, F., Baldan, D., Bilous, O., Borgwardt, F., Buijse, A. D., Bondar-Kunze, E., Cid, N., Erős, T., Ferreira, M. T., Funk, A., Haidvogl, G., Hohensinner, S., Kowal, J., Nagelkerke, L. A. J., Neuburg, J., Peller, T., Schmutz, S., Singer, G. A., … Hein, T. (2024). Reviving Europe's rivers: Seven challenges in the implementation of the Nature Restoration Law to restore free-flowing rivers. *WIREs Water*, *11*(3), e1717. https://doi.org/10.1002/wat2.1717

UNEA. (2022). *UN Environment Assembly 5 (UNEA 5.2) Resolutions* (UNEP/EA.5/Res.5). United Nations Environment Programme. v

Van Der Jagt, A. P. N., Buijs, A., Dobbs, C., Van Lierop, M., Pauleit, S., Randrup, T. B., Skiba, A., & Wild, T. (2023). With the process comes the progress: A systematic review to support governance assessment of urban nature-based solutions. *Urban Forestry & Urban Greening*, *87*, 128067. https://doi.org/10.1016/j.ufug.2023.128067

Van Wesenbeeck, B. K., Kok, S., Avila, C., Gwee, R., & Penning, E. (2021). *Economic rational of NBS in freshwater ecosystems*. WWF Netherlands. https://wwfint.awsassets.panda.org/downloads/economic_rationale_of_nbs_in_freshwater_ecosystems_1.pdf

World Bank. (2017). *Implementing nature-based flood protection. Principles and implementation guidance.* The International Bank for Reconstruction and Development. https://documents1.worldbank.org/curated/en/739421509427698706/pdf/Implementing-nature-based-flood-protection-principles-and-implementation-guidance.pdf

Zingraff-Hamed, A., Hüesker, F., Albert, C., Brillinger, M., Huang, J., Lupp, G., Scheuer, S., Schlätel, M., & Schröter, B. (2021). Governance models for nature-based solutions: Seventeen cases from Germany. *Ambio*, *50*(8), 1610–1627. https://doi.org/10.1007/s13280-020-01412-x