Draft Standards for Planning, Design, Implementation, Monitoring, Evaluation of large-scale NbS

Deliverable D5.4

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Abstract (for dissemination, 100 words)	This report aims at gathering best practices from the RECONECT outputs (i.e., tools, deliverables, and reports) and overall experience, in order to foster the upscaling and wide implementation of large-scale NbS for hydro-meteorological risk reduction throughout Europe and beyond. The steps, challenges, and solutions of a NbS project encountered throughout RECONECT are reported here in a standardized way, following the life-cycle phases of planning, design, implementation and monitoring, evaluation, and learning (MEL). These standards are complemented by concrete examples from selected Demonstrators and Collaborators to provide more tangible guidance.
Keywords	Nature-based Solutions, Standards, Planning, Design, Implementation, Monitoring, Evaluation, Best Practices, Project Lifecycle

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Executive Summary

This report aims at gathering best practices from the RECONECT outputs (i.e., tools, deliverables, and reports) and overall experience, to foster the upscaling and wide implementation of large-scale NbS for hydro-meteorological risk reduction throughout Europe and beyond.

The steps, challenges, and solutions of a NbS project encountered throughout RECONECT are reported here in a standardized way, following the life-cycle phases of planning, design, implementation and monitoring, evaluation, and learning (MEL). These standards are complemented by concrete examples from selected Demonstrators and Collaborators to provide more tangible guidance.

Standards in the literature on NbS are mostly focused on pre-implementation phases (i.e., planning and design), but more information on the following phases (i.e., construction and post-implementation) is emerging. Despite the challenges in streamlining processes and gathering relevant knowledge on NbS establishment in different contexts, reports such as this can supply a first reference to build more truly all-encompassing frameworks.
In addition to processes carried out in practice within RECONECT, this report also highlights and integrates recommendations for other standards, taken from relevant literature and other NbS projects.

Therefore, this report supports the fulfilment of the standardisation requirements of RECONECT, by presenting practices developed and used based on the consensus of the different partners involved in RECONECT. Moreover, the produced standards actively contribute to both the exploitation of RECONECT results, and the upscaling of NbS through the provision of a list of steps/methods to follow/use to reach implementation.

The target audience for this document is diverse and includes a range of stakeholders involved in NbS implementation, policymaking, and research. This report is intended to have a wider impact beyond the RECONECT consortium, reaching practitioners from all areas, including consultants, councils, funds, and private practitioners, as well as governments at the city and local level, planners, businesses, and financial institutions.

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Abbreviations

WP – Work Package

MEL – Monitoring, evaluation and learnings.

EAWAG - Swiss Federal Institute of Aquatic Science and Technology

GA - General Assembly

GISIG - Geographical Information Systems International Group

HII - Hyfro-Informatic Institute

IHE Delft - UNESCO-IHE Institute for Water Education

IRPI - Research Institute for Geo-Hydrological Protection

IWA CONSALT - International Water Association CONSALT

NbS - Nature-Based Solutions

NCKU - National Cheng Kung University

RECONECT - Regenerating Ecosystems with Nature-based solutions for hydrometeorological risk reduction

UIBK - University of Innsbruck

UPM - Universiti Putra Malaysia

Glossary of Key Terms

A list of definition of terms used in the main body may be useful, especially if you're introduced to new terms or your definition deviates from a commonly used definition.

Principles: Essential drivers; ambitions; overall goals; the rationale behind everything. They guide the overall vision for developing large-scale NbS. They provide the thematic areas and a policy framework for the development of both guidelines and standards.

Best practices: Best practices in NbS refer to effective methods, based on evidence or experience, to achieve desired outcomes. These include strategies for interventions, design, implementation and monitoring. Best practices are seen to be reliable, recognized as standards, and subject to continuous improvement. Adopting best practices supports successful outcomes and sustainability of ecosystems and communities.

Guidelines: Set of directions to take, informed by the principles. Indicate the pathway to follow; break down the principle into a logical (and sometimes stepwise) approach. Not mandatory or enforced, instead they attempt to streamline the process of developing large-scale NbS.

Standards: Criteria, methods and/or practices to apply when following a guideline. They can be conceptual or specific depending on the purpose as well as the stage of the project lifecycle (e.g., planning, design, etc.). They provide an agreed way of doing something (agreed = developed through expert's consultations).

Project life-cycle: The project life-cycle is the standardized approach for the development and execution of large-scale NbS projects comprised of four distinct and interconnected phases: Planning, Design, Implementation, and MEL. Each phase plays an important role in ensuring the effectiveness, sustainability, and adaptability of NbS.

Term	**Acronym**	**Explanation**
Aspects (of NbS)	-	The 8 aspects are used to section the documents in the literature review. These aspects cover the three challenge areas described under "C".
Barriers	-	Conditions that can hamper the development of NbS.
Business case	-	Document that clearly communicates the benefits of a project, thus providing the arguments for initiating a project. A strong business case is essential in overcoming barriers.
Business Model	BM	A plan that explains how to create, deliver, and capture value to be profitable and successful. It outlines key strategies for revenue generation and sustainability.
Challenge areas	-	Challenge areas refer to the three dimensions of large-scale NbS; PEOPLE, WATER and NATURE.

Co-benefits	-	Additional benefits to the main benefit, which is often related to reducing the flood risk. These bring additional value for nature, people and/or economy.
Co-creation	-	A collaborative approach to engagement which allows stakeholders to collectively design and build more inclusive and sustainable mechanisms for change. RECONECT social innovation approach is underpinned by co-creation processes involving researchers and other stakeholders iteratively throughout the stages of co-assessment and planning; co-design; co-implementation, operations, and maintenance; and co-monitoring and evaluation.
Collaborators	-	Cases where large-scale NbS are to be developed and where proof-of-concepts and methodologies developed within RECONECT are tested.
Cost-benefit analysis	CBA	Evaluation method that compares the costs and benefits of a project in monetary terms, and often used as documentation for a business case.
Criteria	-	Potential impacts used to evaluate measures; in these deliverable criteria are being referred to as goals and sub-goals,
Cross-referencing	-	The process of comparing different cases/situations to abstract deeper learning such as general key lessons.
Demonstrator A	DA	Cases of large-scale NbS in Europe that provide proof-of-concept for the planning, design and implementation phase to the knowledge base of NbS developed through RECONECT.
Demonstrator B	DB	Cases of large-scale NbS in Europe that provide proof-of-concept for the monitoring, evaluation and learning (MEL) phase to the knowledge base of NbS developed through RECONECT.
Enablers	-	Conditions that can facilitate the development of NbS.
Feasibility	-	
Flood Risk	FR	
Future Damage	FD	
Goals	-	Goals and the referring "subgoals", are the defined purpose that taps into the chosen NbS. There has been defined 6 goals two

		withing each challenge area, and a total of 12 subgoals.
Hydro-meteorological risk	-	Natural phenomenon related to water and caused by atmospheric pressures and extreme weather conditions which result in floods, erosion, and/or droughts.
Indicator	-	Indicators are chosen categories used to assess and measure progress or change in the implemented large-scale NbS. The indicators are chosen based on the chosen goal and subgoal.
Key Performance Indicators	KPIs	Measurable metrics that assess performance, guide decision-making, and track progress towards business goals.
Large-scale NbS	-	NbS located either in rural areas or in combination with urban areas, as they adopt a larger regional system approach comprising of river basins and coastal landscapes. What makes an NbS large-scale is its system approach, holistically connecting multiple water features instead of being a standalone, separate solution.
Measures	-	A strategy or approach implemented to accomplish a specific objective or goal.
Multi-criteria Analysis	MCA	
Nature-Based Solution	NbS	Collective term for innovative solutions to solve different types of societal and environmental challenges, based on natural processes and ecosystems.
Participatory approach	-	Approach that involves a diverse group of stakeholders in tasks such as setting research objectives, gathering, and processing data, interpreting results, and implementing solutions with the goal to balance interests, benefits, and responsibilities between the relevant stakeholders, focus attention on user needs, and make the whole process – from planning to implementation and evaluation of its impact – transparent and inclusive.
Present Damages	PD	
Replication	-	Implementation of a similar NbS intervention based on previous project experience, in an area with similar challenges that the NbS can solve.
Replication Potential	-	The replication potential measures the feasibility of implementing NbS, incl. analysis of local barriers and enablers

Score	-	Values are used to quantify the performance of each measure in meeting each sub-goal.
Spatial allocation analysis	-	Spatial analysis (in ArcGIS) that determines suitable locations based on input maps (e.g., elevation, land-use) and criteria of suitability.
Suitability maps	-	The output of the spatial allocation analysis that provides a preliminary assessment of suitable locations for NbS.
Upscaling	-	Process related to the diffusion of information, knowledge, and experiences from NbS case-studies. It is a scale-related progression to reach greater impact.
Weights	-	Values are given by stakeholders to indicate the importance of each goal, sub-goal, and measure.

1 Introduction

1.1 Background

1.1.1 What are Nature-based Solutions?

Europe, like the rest of the world, is facing challenges regarding a changing climate and the effect of urbanization and loss of biodiversity. More extreme weather events are one of the changes expected throughout Europe. Traditionally, resilience to hydro-meteorological events, such as extreme rainfall leading to flooding, has been designed through grey infrastructure, i.e., concrete canals, dams, or mechanical pumping through pipelines. However, grey infrastructure is a long lasting, costly affair, that lacks the ability of adapting to the expected changes in hydro-meteorological events (OECD, 2020).
Upgrading grey infrastructure to manage the projected increased water volumes can result in the extraction of essential water from ecosystems. This extraction disrupts crucial natural processes, and could lead to long-term alterations and degradation of local ecosystems (Temmerman, et al., 2013).

NbS is a collective term for innovative green solutions which integrate biodiversity and ecosystem services to tackle hydrological, societal, and environmental challenges. These measures are designed by using natural elements to mimic or enhance natural processes to provide multiple benefits, that can either be utilized in restoration, protection, adaptation, and mitigation projects (Nature4nature).

NbS encompass a diverse range of interventions, spanning from implementations like SUDS (Sustainable Urban Drainage Systems) within urban settings to more extensive endeavours, such as large-scale adaptation or restoration projects. Despite their varying scales, these solutions share a fundamental principle: harnessing the inherent properties of nature. Whether it's through the integration of natural elements or the deliberate design of ecosystems, NbS aim to create holistic approaches that simultaneously address the needs of nature, water systems, and the well-being of communities.

1.1.2 RECONECT project

RECONECT (Regenerating ECOsystens with Nature-based solutions for hydro-meteorological risk rEduCTion) is a part of the European Commission's (EC) Horizon 2020 project. The project was started in September 2018 and is expected to finalize in August 2024. RECONECT aims to contribute to the European reference framework on NbS by demonstrating, referencing and upscaling large scale NbS and by stimulating a new culture for land use planning, linking the reduction of risks with local and regional development objectives in a sustainable way. RECONECT draws upon a network of Demonstrators and Collaborators across a range of local conditions, geographic characteristics, governance structures and social/cultural settings, to successfully upscale NbS throughout Europe and internationally. The RECONECT consortium includes researchers, industry partners and public authorities at a local and regional level.

This report presents a collection of standardized approaches for the implementation of NbS, gathered both from the RECONECT experiences and other projects.

1.2 Landscape of Current NbS Standards

The landscape of tools, guidelines, and standards to support the development of natural infrastructure projects are vast and increasing. Policymakers and practitioners can choose between a multitude of definitions, approaches, standards, and tools made for global, regional, national, and local application (OECD, 2020). Key works on natural infrastructure standards worth mentioning, include, but are not limited to:

- The IUCN Global Standard on NbS was launched in June 2020, with the aim to ensure the application of NbS is credible, and its uptake tracked and measured for adaptive management. It is construed in a way to ensure a systematic learning framework that take lessons to improve and evolve the application, creating a global user community that helps guide implementation on the ground, accelerate policy development and create conservation science on NbS (IUCN, 2020b). The standard provides an internationally recognised framework which allows for 1) effectively design NbS; 2) ensure and respond to stakeholders' rights, particularly upholding the rights of indigenous peoples and local communities; 3) increase the scale and impact of NbS; 4) prevent unanticipated negative outcomes and misuse of NbS and; 5) help funding agencies, policy makers and other stakeholders assess the effectiveness of NbS Implementation (IUCN, 2020).
- ISO 14007 and ISO 14008 are two standards by the International Organization for Standardization (ISO) that provide guidelines for quantifying and reporting the environmental benefits and costs of NbS initiatives. ISO 14007 focuses on life cycle assessments and determining environmental costs and benefits, while ISO 14008 looks at monetary valuation techniques for environmental impacts.
- Numerous frameworks exist that evaluate and quantify ecosystem services provided from NbS, assessing the benefits they deliver to people and nature, such as carbon sequestration, water purification and flood regulation. Examples of these frameworks are the Millennium Ecosystem Assessment (MEA, 2024) which was completed already in 2005 by several conservation and international organisations, and The Economics of Ecosystems and Biodiversity (TEEB, 2024) which looks at assessing the monetary value of ecosystem services for improved understanding of the benefits of conservation and NbS.
- The Satoyama Initiative, launched in 2010, promotes sustainable land-use practices and provides guidelines for integrating traditional ecological knowledge, emphasising the importance of engaging local communities and respecting cultural heritage when developing NbS projects (Takeuchi, 2010).

Moreover, National and Regional standards are being developed, tailored to their unique environmental and social context, most recently the Green Infrastructure Framework for England prepared by Nature England, focusing on creating nature-rich towns and cities to bring the benefits of nature to where people live (Natural England, 2024). At the regional level, the European Union supplied guidance for integrating ecosystems and green infrastructure into decision-making (European Commission, 2024).

Developing a standard to address implementation of NbS or other natural infrastructure is complex. Organizations such as the previously mentioned International Organization for Standardization (ISO) or the International Social and Environmental Accreditation and Labelling Alliance (ISEAL) exist to walk proponents through the steps for developing a standard and a framework, including key component such as correct stakeholder engagement. However, some of the challenges that arise when developing a standard go beyond the instructions provided and will have to be addressed on a case-by-case basis.

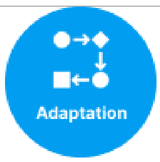
Some challenges identified in the literature address the changing regulatory environment, which affects the success of a standard. These underscore the necessity for a thorough understanding of the regulations in the geographic context where the standard is to be applied. Ensuring compliance with current regulations, while maintaining flexibility to adapt to future regulations, and advancements in NbS research, thereby enhancing the standard's applicability. The standards must account for the multidimensionality of NbS, considering their interconnected aspects and potential conflicts. They should accommodate various stakeholders with different priorities, values and interest, navigating trade-offs that may emerge between economic growth and environmental concerns. Additionally, they need to anticipate unintended consequences that could shift burdens from one sector to another, e.g. a nature-based flood prevention method alters river flow, it could unintentionally create water scarcity downstream. The development of a standard also relies on accurate and reliable data on environmental and social indicators to ensure the indicators used for monitoring, verifying, and tracking progress are quantifiable and measurable (Zuniga-Teran, et al., 2020).

The similarities found between existing standards, frameworks, and tools is that they mostly adhere to eight principles for the successful implementation and upscaling of NbS identified by IUCN and its Commission on Ecosystem Management (CEM) (IUCN, 2020b). Among other things, these principles highlight the need for rigorous monitoring, collection of data and reporting as key to assess the impact of NbS projects over time, and the need to adopt a flexible approach is recognized to accommodate the different context and scales of interventions. In this deliverable, and in the context of RECONECT, the 8 principles formulated by IUCN have been adapted into the 12 guiding principles, which are presented in the chapter below.

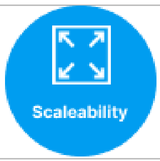
1.3 Guiding Principles

The guiding principles serve as the foundation for developing standards and guidelines for large-scale NbS. These principles act as guiding beacons, ensuring that NbS standards and guidelines are both consistent and effective in addressing large-scale NbS. In RECONECT, these principles serve as focal points because the goal is to expedite the standardization of large-scale NbS. This endeavor hinges on ensuring that these standards possess the essential traits of scalability and replicability. The 12 principles are presented in Table 1 below.

Table 1: The 12 guiding principles

	The principle of adaptation emphasizes the importance of designing large-scale NbS to be flexible and responsive to changing environmental conditions and evolving challenges. It means that NbS projects should be able to adjust and accommodate new circumstances, ensuring their continued effectiveness over time.

Evidence-based	Being evidence-based implies that standards and guidelines of large-scale NbS are grounded in scientific research and proven practices. It is crucial to rely on empirical data and studies to ensure that the recommended approaches are effective, reliable, and have a track record of success.
Good governance	The principle refers to the need for clear and effective decision-making structures to oversee the implementation of NbS. It highlights the importance of involving relevant stakeholders, establishing accountability, and defining roles and responsibilities to ensure effective project management and coordination.
Financial viability	This principle focuses on the financial aspects of NbS projects, including funding mechanisms, cost estimation, and budget management. It addresses the need for sustainable financing to support the implementation and long-term maintenance of NbS initiatives.
Flexibility	Flexibility is about designing NbS standards and guidelines with room for adjustments and adaptations to specific local conditions and varying contexts. It recognizes that different projects may require tailored approaches while still adhering to the chosen KPIs.
Inter-disciplinarity	Inter-disciplinarity stresses the importance of collaboration and integration of knowledge from diverse fields and expertise. It means involving professionals from different disciplines to holistically address all three challenge areas; people, water and nature.
Local anchoring	Local anchoring highlights the significance of involving and engaging local communities, stakeholders, and indigenous knowledge in the planning, design, and implementation of NbS projects. It ensures that solutions are relevant and respectful of local cultures and needs.
Multi-functionality	Multi-functionality indicates the need for NbS projects to provide multiple benefits beyond their primary objectives. It encourages standards and guidelines of NbS to address all three challenge areas (NATURE, PEOPLE, and WATER) simultaneously.
Replicability	Replicability focuses on designing NbS initiatives in a way that allows successful approaches to be replicated in other regions or projects. It involves documenting and sharing best practices and lessons learned to facilitate the adoption of effective solutions elsewhere.
Resilience	Resilience refers to designing NbS projects to withstand and recover from disturbances or shocks. It means building solutions that can adapt to changing conditions and remain effective even in the face of future uncertainties.
Safety	Safety underscores the need to prioritize the well-being of communities and ecosystems in the implementation of NbS projects. It involves risk assessment and mitigation strategies to ensure that the solutions do not harm the environment or communities they aim to benefit.

	Designing NbS projects in a way that allows them to be implemented at different scales, from local to regional or even national levels. It means considering the potential for widespread adoption and impact beyond individual projects.

1.4 Literature Review

To understand the extent, and the limits, of the current NbS standards, the first step for this deliverable was to review the available literature on the subject. The review encompassed a wide range of reference types, such as those listed in section 1.2, including general and technical standards, guides targeted at specific project phases, documents focusing on distinct NbS aspects, policy briefs, scientific publications, frameworks, and scoping studies. A total of 37 external (i.e., not part of RECONECT) documents were evaluated, many of which incorporated case studies. A substantial portion of these references were endorsed or published by institutions such as the World Bank, the European Commission, European Union, and Climate-KIC. CIRIA also played a significant role, contributing with diverse publications that spanned from handbooks to phase-specific guidance. While the focus was primarily on medium- to large-scale NbS, relevant small- to medium-sized solutions were also considered (see Annex A for the complete bibliography consulted for the literature review).

During the review, it was possible to identify eight thematic areas: (i) ecosystems, biodiversity & environmental quality, (ii) society & human well-being, (iii) risk management & hazard, (iv) costs & financing, (v) policy & regulation, (vi) stakeholder involvement, (vii) organizational setup, coordination & synergies, (viii) data collection and analysis. These reviewed documents often spanned multiple thematic areas.

In addition to the thematic areas, the gathered literature was also classified based on the project life-cycle phases that they assessed. Specifically, the project life-cycle phases as they were defined in the context of this deliverable i.e., planning, design, implementation, and monitoring, evaluation, and learning (MEL) were used (for more details on these phases, see section 1.6.2). This other kind of classification was done to account for possible gaps in specific steps of NbS realization. Although a few documents covered all phases comprehensively, most were tailored to specific phases, such as detailed planning or strategy development, see Table 2.

Table 2: Matrix classifying NbS standards according to project life-cycle phases (columns) and thematic areas (rows) assessed. The full references are listed in Annex A.

	Planning	Design	Implementation	MEL
Ecosystems, biodiversity & environmental quality	[1] [3] [4] [6] [12] [15] [17] [19] [18] [21][30]	[6] [3] [12] [4] [25][37]	[13] [15]	[1] [6]
Society & human well-being	[1] [16] [17] [3] [21][30]	[1]		[34] [35]

Risk management & hazard	[3] [9] [17] [1][8] [6] [2] [12][25] [37]	[3] [13] [2] [18] [31] [32]	[12] [13]	[1] [13]
Costs & Financing	[1] [6] [13] [17] [3] [8] [15] [4] [22] [23][28]	[12] [18] [26][27]	[27]	
Policy & regulation	[1] [8] [15] [16] [4] [6] [11] [22][17]			
Stakeholder involvement	[1] [4] [6] [9] [12] [15] [16] [17] [14] [19] [28] [37]	[5] [6] [9] [4] [19] [20][24][26] [37]	[6] [9]	[9]
Organisational setup, coordination & synergies	[1] [16] [17] [6] [8] [22] [25] [37]	[13] [4] [18] [24][26]	[13]	[37]
Data collection & analysis	[3] [12] [13] [14] [34] [35]		[13]	[10] [13] [4] [20] [23] [34] [35]

Moreover, several published RECONECT deliverables were screened in a separate review from the rest of the literature (Table 3). This was done to systematically assess whether and/or to what extent the project's output reflected the patterns and themes identified in the current literature.

Table 3: Classification of finalized RECONECT Deliverables based on life-cycle phases (columns) and thematic areas (rows) assessed.

	Planning	Design	Implementation	MEL
Ecosystems, biodiversity & environmental quality	D1.1, D1.2, D1.4	D2.3	D1.5, D1.4	D1.2, D1.5, D2.6, D3.1, D3.2, D1.4
Society & human well-being	D1.1, D1.7			D1.2, D2.6, D3.1, D3.2,
Risk management & hazard	D1.1, D1.2, D4.2, D1.7, D2.7	D2.2, D2.3, D2.7	D1.5	D1.5, D4.3

Costs & Financing	D1.2, D1.4	D2.4, D5.7	D5.7, D1.4	D2.4, D4.4, D5.7, D4.3, D1.4
Policy & regulation	D1.3, D1.6, D4.4, D5.5	D2.2		D2.5, D5.5, D4.3
Stakeholder involvement	D1.2, D2.1, D4.1	D2.2,	D2.4, D6.10	D1.2, D2.2, D2.4, D2.5, D4.3
Organisational setup, coordination & synergies	D2.5, D3.3	D3.3	D3.3	D2.2, D3.3
Data collection & analysis		D2.3	D1.5	D1.5, D3.2, D3.5, D1.4

1.4.1 Gap analysis

As shown in Table 2, the literature review revealed a strong emphasis on the planning phase, especially on aspects like ecosystems, environmental quality, cost, financing, policy, regulation, and stakeholder involvement. However, the design phase had considerable coverage in aspects such as (i) ecosystems, biodiversity & environmental quality, (iii) risk management & hazards, (iv) costs & financing, (vi) stakeholder involvement, and (vii) organizational setup, coordination & synergies. Gaps were also identified in the areas of (v) policy & regulation, and (viii) data collection and analysis within the design and implementation phases. While there was an overall lack of literature addressing all aspects of large-scale NbS in the implementation and MEL phases, the RECONECT deliverables provided significant focus on planning, design, monitoring, and MEL (Table 3).

The screening of RECONECT deliverables highlighted generally good coverage across all phases and aspects, particularly in the planning and MEL phases. Areas such as (ii) society & human well-being and to some extent (viii) data collection and analysis also demonstrated a limited documentation for the implementation and design phases. The overlap of certain aspects between different phases contributes to this pattern. For instance, while data collection and analysis frameworks are available, they are primarily categorized under the MEL phase rather than planning. This distinction underscores the importance of distinguishing interfaces and assessing the relevance of each aspect to specific phases.

In conclusion, the areas of (v) policy & regulation, and (viii) data collection and analysis require more extensive coverage across all four NbS project life-cycle phases, both in the literature and RECONECT. These gaps hinder the assessment and understanding of NbS impacts, and show the need for a standardized approach for designing NbS. Such standardization would foster evidence-based design standards, facilitating better outcomes and minimizing negative impacts on ecosystems.

These findings from our review align well with gaps that are made apparent in the wider literature, summarized in the following points:

1) **Lack of standardized and universally accepted frameworks.** In the rapidly evolving field of NbS, it has become clear that additional efforts are needed to harmonize and align the standards to avoid confusion and facilitate broader adoption and be able to correctly report and measure impact (IUCN, 2020a).
2) Gaps in **adequately considering unique cultural, social, and ecological** contexts across communities and regions, despite some standards emphasizing community engagement and local knowledge (Wells et al., 2019).
3) **Financing and investment** are the missing pieces in most conservation and sustainability projects, and NbS is no different. Where many standards focus on project evaluation and assessment, challenges related to financing NbS and attracting investments at scale, including getting private sector buy-in, have yet to be sufficiently addressed (Goswami et al., 2023).
4) Complications and lack of addressing the **economic value of NbS**, and with that the non-market use as well as the non-use benefits, which also makes it difficult to calculate return of investment, and "sell" the concept to investors (Veerkamp, et al., 2021).
5) Need for **more resources and platforms for capacity building, knowledge sharing,** and training to help stakeholders understand and apply the standards effectively and to address the previous point on financial uptake, as financial capacity building can address the lack of revenue streams for the operation, implementation and maintenance of NbS. This lack of capacity can also be felt in the effectiveness of NbS from technical and financial perspectives to the completion of bankable and scalable best practice knowledge products (Piacentini & Rossetto, 2020).
6) Continuous **monitoring and evaluation** are key to ensuring long-term stability, and while it has been addressed in several standards, it is still not adequately addressed throughout (Network Nature, 2024).
7) Gaps in the existence of frameworks that **aim at large-scale NbS** and that incorporate landscape dynamics in their design (Wu, et al., 2021).

These gaps need to be addressed to enhance the coherence, effectiveness, and scalability of natural infrastructure standards, and ensure wider adoption and success in tackling environmental challenges. Stakeholders should strive to collaborate and update these frameworks to reflect the latest scientific knowledge and best practices while the field continues to evolve. RECONECT's innovative approaches and a wide network of case studies, combined with its attention to financing and investing criteria, monetization of NbS benefits, data collection, and analysis, can contribute to expanding the development of NbS standards moving forward.

1.5 RECONECT context

1.5.1 Backdrop

The placement of *Deliverable 5.4 - Standards for Planning, Design, Implementation, Monitoring, Evaluation of large-scale NbS*, within WP5 is schematized in Figure 1-1. Moreover, deliverable D5.4 serves as a link to various other deliverables across WPs, actively drawing on the inputs provided by these interlinked components. Some of the key sources it draws upon include:

- D1.4 - Guidance on integrating innovative technologies
- D2.2 - Baseline assessment for Demonstrators (demand & supply)
- D2.8 - Guidelines for large-scale NbS
- D2.3 - Scope of works for Demonstrators
- D4.3 - Upscaling strategy

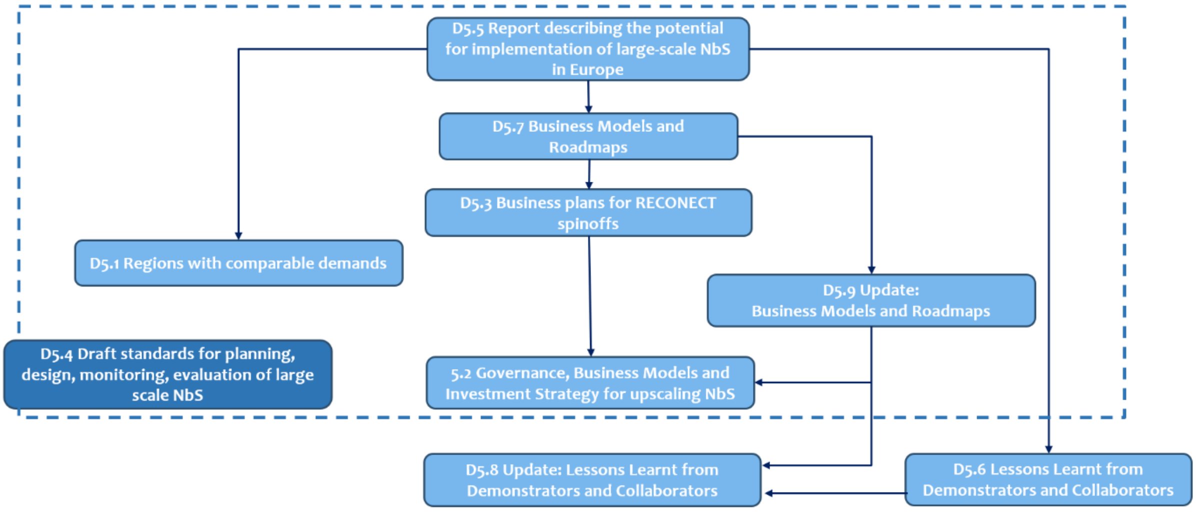


Figure 1-1 - Context of D5.4 within WP5. The dotted line encompasses the WP5 Deliverables whose outcomes are summarized by D5.4.

Furthermore, D5.4 plays a role in providing inputs to other deliverables as well. These include:

- D1.8 - Final report on NbS tools/models
- D4.7 - Strategies for mainstreaming NbS
- D4.8 - Pre-feasibility studies for Collaborators
- D6.11 - Exploitation plan for outreach

1.5.2 Targeted Expected Impacts

This report contributes in reaching various RECONECT Expected Impacts (EIs), as shown in Table 4.

Table 4: Targeted EI and actions taken in this report to reach them

EI	Description	How it was targeted
#2	*"The mainstreaming of NbS in land use planning, landscaping and territorial policies due to the provisioning of appropriate tools and best practice."*	This deliverable will provide insights on how to integrate territorial policies into the process of selecting and develop NbS measures. Furthermore, this deliverable will provide insight on how the adoption of NbS influences land use planning and landscaping. Based on the learnings from the cases valuable tools and best practices will be identified to encourage wider uptake.
#3	*"Development of an integrated EU-wide evidence base and a*	The development of an integrated EU-wide evidence base and a European reference framework on NbS is pivotal. To achieve this,

	European reference framework on NbS."	this deliverable will leverage best practices extracted from internal RECONECT documentation as well as external sources. This deliverable will outline the steps involved in compiling an evidence base, underscoring the critical significance and potential impact of establishing a cohesive European reference framework for NbS within the project lifecycle.
#5	*"Improve disaster risk management, due to enhanced capacity for providing quantitative assessments of NbS for disaster risk reduction and climate change adaption."*	The standards will exemplify the design of resilient NbS measures, considering present and anticipated climate conditions. These examples will showcase the integration of best practices through feedback loops, emphasizing the enhancement of quantitative assessments for disaster risk reduction and climate change adaptation. By focusing on these aspects, the standards aim to fortify disaster risk management.
#6	*"Reduced human and financial cost due to better and more flexible disaster risk management with NbS."*	This deliverable will emphasize the optimization of disaster risk management with NbS, aiming to reduce both human and financial costs. This will be achieved by presenting best practices for designing robust NbS measures that flexibly adapt to diverse scenarios. This approach seeks to leverage qualitative and quantitative data, thereby improving the performance and inclusion of existing and future NbS measures.
#7	*"Contribution to the priorities of the EIP Water."*	The priorities of EIP Water focus on several aspects of water management and environmental sustainability. Large-scale NbS will in this deliverable be portrayed as adaptation strategies for hydrometeorological events, and therefore include all the features and important considerations when imitating the hydraulic cycle. Therefore, the standards presented in this deliverable will be in alignment with the priorities of EIP Water.

1.5.3 Target Audience

The target audience for this document is diverse and includes a range of stakeholders involved in NbS implementation, policymaking, and research. The primary audience includes the European Commission, RECONECT partners, demonstrators, and collaborators, as well as local, regional, and national policymakers and agencies.

In addition to these stakeholders, the document is also relevant to NbS practitioners and academic experts. Governments at the city and local level, planners, businesses, and financial institutions looking at NbS within the EU on a large scale. Furthermore, it's important to note that the audience for this document extends beyond the RECONECT consortium. The document is intended to have a wider impact, reaching practitioners from all areas, including consultants, councils, funds, and private practitioners.

By reaching a wider audience, the document can facilitate a better understanding of the benefits of large-scale NbS and the necessary steps for designing and implementing effective NbS solutions. This will contribute to achieving broader goals such as mitigating climate change, reducing the risk of natural disasters, and improving the quality of life for local communities.

1.6 Scope

1.6.1 Vision

The proposed standards for large-scale NbS are designed within a general and conceptual approach, operating at a "best practice" level. By doing so, the findings and recommendations of this deliverable can serve as a foundational reference for recognized standardization institutions in their current and future work, rather than concentrating on specific features of NbS which would limit the nature of standardization. Hence, the proposed standardized approaches and/or best practices aim to ensure effective and well-coordinated NbS initiatives.

These standards intend to assist in the processes necessary for a successful implementation of large-scale NbS in sites within Europe, given the outcomes and learnings of the RECONECT project. Together with recognized European organizations working with the development of standards, the RECONECT project aims at laying the foundations for what will eventually become the EU large-scale NbS standards for hydro-meteorological risk reduction taking into account the geographical and climatic variations in a pragmatic way.

1.6.2 Project life-cycle

The standards introduced in this report will be grouped into four phases; planning, design, implementation and monitoring, evaluation, and learning (MEL), represented in the project lifecycle depicted in Figure 1-2.

1. **Planning**
   The initial phase of planning forms the bedrock of any NbS, encompassing a range of activities crucial for informed decision-making and setting strategic objectives. This involves conducting a thorough analysis of environmental and social factors, alongside understanding stakeholder needs. The planning phase is where KPIs are first identified. These, along with a comprehensive baseline assessment, are utilized to develop both the preliminary business case and prefeasibility study.
   Within RECONECT, the standardization of the planning phase largely draws upon inputs from Collaborators and Demonstrators A, which planned and (in the Demonstrators' case) implemented the NbS during RECONECT's lifetime.

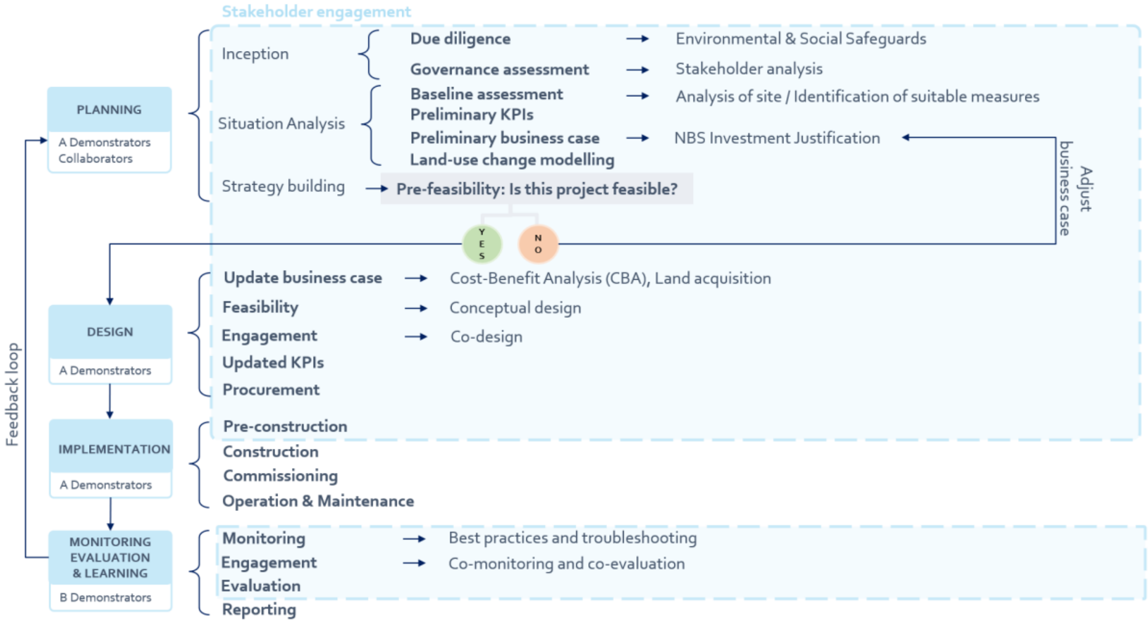


Figure 1-2: The phases and processes within the project life-cycle

2. **Design**
   The design phase translates the conceptual planning of the NbS into a specific design plan, refining its components and strategies. This means, that the preliminary business case and a prefeasibility study are evaluated and updated following the selected NbS measures and choice of final KPIs. The final KPIs will be updated based on the co-design with the stakeholder engagement, which will be conducted throughout the design phase.
   As demonstrators A advanced with the implementation of their NbS, the inputs shaping best practices for standardizing the design phase primarily stem from them.

3. **Implementation**
   The Implementation phase is dedicated to translating the design and implementation roadmap into actionable steps, thereby bringing the NbS project to reality. This involves understanding the tendering and procurement processes specific to EU context. The implementation phase requires outlining strategies for supervising and inspecting the construction site, as well as establishing plans for ongoing operation and maintenance. This includes managing, monitoring, and maintaining NbS to ensure their continued functionality and impact. Once again, as they implemented their NbS projects, demonstrators A will be referred to to provide examples for developing monitoring and maintenance plans and supervising construction sites.

4. **MEL (Monitoring, Evaluation, and Learning)**
   The MEL phase is an ongoing process integral to enhancing project outcomes and guiding future decisions. It consists of various key components. Firstly, there's the preparation of a monitoring program to systematically track project progress and outcomes, based on developed Key Performance Indicators (KPIs). Additionally, there's the establishment of engagement in co-monitoring and co-evaluation, ensuring active stakeholder involvement in assessing project performance and providing valuable feedback. Furthermore, the MEL phase introduces standardized approaches for reporting, aimed at capturing lessons learned and transferring them to other projects for improved outcomes.

Insights gained during the MEL phase are pivotal for refining the initial stages of future NbS projects. This process is particularly vital for validating the concept of large-scale NbS and optimizing processes at each stage of project implementation. The knowledge and insights driving the MEL phase primarily come from demonstrators B, who have focused within the project on monitoring of activities.

To better summarize the many steps and outputs involved in the Planning and Design phases, they are schematized further in the Annex B. Summary of best practices for the Planning and Design phases.

2 Planning

In the planning phase, the core elements of a large-scale NbS initiative take shape, including vision development, stakeholder engagement, conceptualization, and business case, all of which support the development of the overall pre-feasibility assessment of the NbS.
The planning phase consists of three sub-phases: the *Inception*, hereafter the *Situation Analysis*, and lastly the *Strategy Building*. The inception sub-phase aim to get an understanding of the governance setting the opportunities and barriers in which the NbS project will be operating, and delve into existing permits, regulations, and guidelines. It is within this step that stakeholders are identified, and the groundwork is done to open the discussions regarding the features and financials of NbS.

The second sub-phase, known as the *situation analysis*, delves deeper into the physical details. Here, the specific features of the project site are identified. This step includes defining preliminary KPIs, and identifying suitable NbS measures. Preliminary KPIs are both the foundation of the baseline assessment and serve as an identification of the success criteria of NbS. The same KPIs lay the foundation of the preliminary business case, which is utilized in engaging stakeholders and securing funding.

The final sub-phase revolves around *strategy building*. Leveraging the chosen KPIs and an understanding of the business model, this step assesses the pre-feasibility of implementing the large-scale NbS. If the assessment deems the project unfeasible, a re-evaluation and update of the current preliminary business case is required, followed by a renewed pre-feasibility evaluation. If the assessment confirms the feasibility of the NbS project, the focus shifts to developing a project plan.

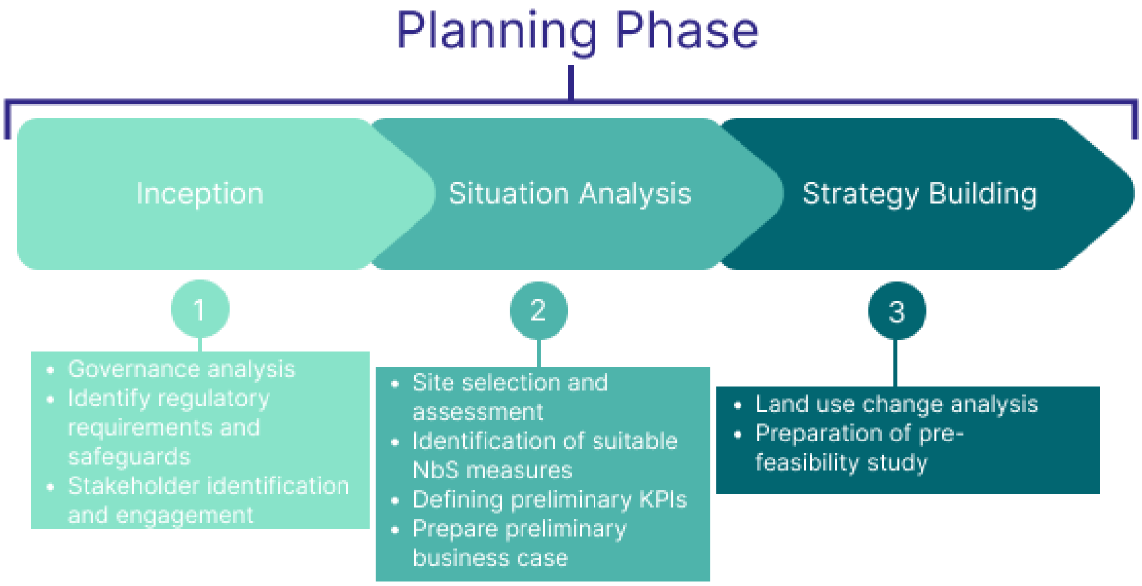


Figure 2-1 - These three sub-phases of the planning phase collectively form a framework for the successful realisation of large-scale NbS projects.

2.1 Regulations and Safeguards – due diligence

One of the critical aspects of due diligence in large-scale NbS projects is compliance with existing policies, regulations, and safeguards. These are designed to protect people and

the environment from adverse impacts, and to promote positive development outcomes. Projects need to address the risks identified in these regulations in order to receive support for their implementation.
For a successful outcome, NbS have to be integrated into policy guidelines, which often include overlapping policies on spatial planning, economic incentives, biodiversity protection measure, and environmental assessment.

Within RECONECT, the case studies analysed the policies influencing their projects on four different levels: international, national, regional, and local level. Internationally, relevant frameworks include, among others, the Paris Agreement on Climate Change, the UN Sustainability Framework, the Global Framework for Climate Services, the United Nations Framework Convention on Climate Change, and ultimately the Sustainable Development Goals. There are also some relevant EU Directives, such as the Water Directive, the Floods Directive, or the Habitat Directive.

However, most knowledge on policies amongst the cases has been registered at the national level (e.g., water management strategies, disaster protection plans, infrastructure development programs, etc.), and partly also on regional level. Very little information is provided at local level, which is mostly comprised of municipal plans.

Ideally, by adhering to the existing policies, the NbS projects will be able to strike a balance between all their potential benefits, i.e., ecological conservation, community well-being, and resilience to hydro-meteorological events. For example, in the Demonstrator A case Seden Strand, an overlap was found between the need to protect the coast from sea level rise (stated in a risk management plan at local scale) and the need to improve the status of the fjord habitats (a Natura 2000 site). This synergy has concretized into the implementation of a NbS project using salt marshes for the protection of the coast and the simultaneous creation of a better habitat for breeding and migrating birds.

However, in other cases, compliance might be difficult to achieve. For example, in the Tordera River Collaborator case, sectorial regulation included in the Management Plan of the River Basin District of Catalonia, establishes that flood protection measures should aim to provide full protection for the 100 years return period flood. Thus, the initial risk reduction target for the project was to fully protect the most vulnerable areas and activities for the 100-year flood. However, in most urban areas, floodplains have been historically constrained and occupied by different uses and activities. This context made the original risk reduction target impossible to achieve, and it had to be lowered.

2.2 Engagement: stakeholder analysis, co-assessment and co-planning

Successful implementation of NbS can depend heavily on coordination with the NbS owner and the stakeholders involved, and during the planning phase of the NbS, it is important to identify and engage key stakeholders, which may include local authority departments, regulatory bodies, local community groups, and their representatives, and residents around the area including private or organizations and businesses.

In this section, we are focusing on stakeholder engagement approaches during the planning phase. It’s fundamental to ensure good communication with stakeholders and local communities from an early stage in the planning to understand their needs and desired benefits, to gather input and support for the project, and to communicate trade-offs and benefits of the NbS project. Stakeholder engagement should continue throughout the whole planning process. Moreover, it’s good practice to document the outcomes of stakeholder engagements clearly for frequent reference in further stages of the project.

Within the RECONECT project, the initial engagement of stakeholders was determined with stakeholder analysis and mapping in the different case studies. Once the stakeholders were identified, they were engaged in co-assessment and planning activities, to provide an assessment of places and people exposed to hydro-meteorological hazards, their vulnerabilities, preferences, and perceptions, as well as the barriers and enablers for NbS implementation. Based on these assessments, the applicable types of NbS and their feasibility are determined. The two processes are described in the subsections below.

2.2.1 Stakeholder analysis

The stakeholder analysis process developed within RECONECT was produced to answer the call for 'multilevel or multiscale governance' approaches to risk reduction (Archer, et al., 2014), and to mainstream an inclusive approach in the NbS implementation process. It comprises three steps:

1. Stakeholder identification - identify stakeholders that should be included in the co-creation process of NbS (e.g., in relation to their exposure to the risk, or considering questions related to social cohesion and equity);
2. Stakeholder mapping - map stakeholders according to representation (i.e., based on their groups and roles), and according to influence, i.e., to what extent they affect and/or are affected by the hazard and/or the NbS;
3. Stakeholder involvement - determine the level of participation required and/or desired by each stakeholder.

Within RECONECT, the results of these three steps were summarized in the matrix represented in Figure 2-2.

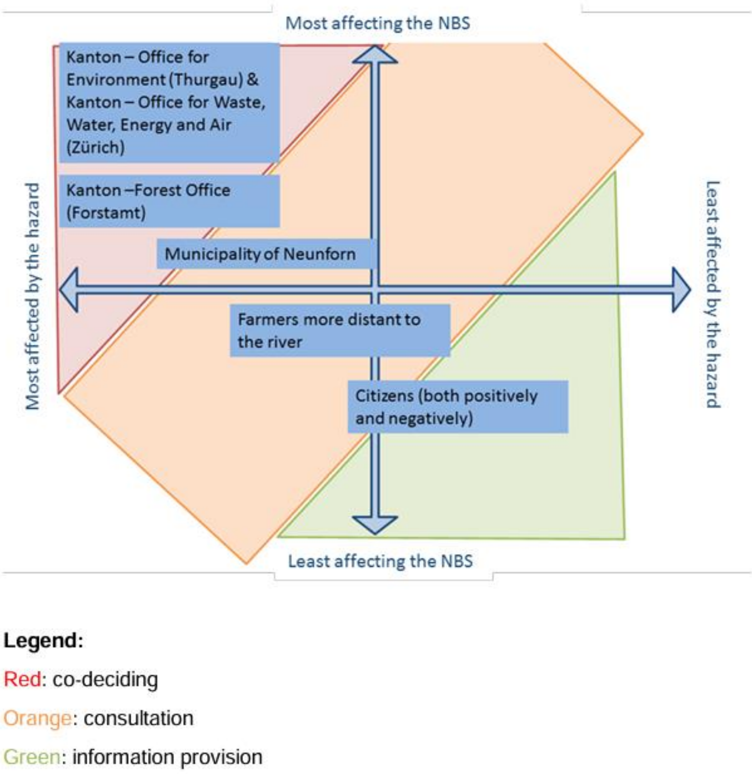


Figure 2-2: Stakeholder matrix with recommendations for engagement for the demonstrator B case Thur River, Switzerland (from Deliverable 2.1 – Preparing co-creation: stakeholder analysis)

Such an analysis can support reaching a balanced representation of different stakeholder groups to ensure the representation of different experiences, interests, and views. Stakeholders may be self-identified or selected by others. They may represent themselves directly, be represented by a group or organization, or represent their community or particular interest groups (Forrester, Swartling, & Londsdale, 2008). A good stakeholder mapping process will facilitate a lot of different processes: helping identify windows of (financial, or political) opportunity; creating ownership and thereby commitment of actors involved; increasing acceptance and relevance of the research produced; increasing transparency of the process, as well as increase the representativeness of results. Furthermore, obtaining a balance of representation of stakeholders can ensure an inclusive process, which in turn could favour a more bottom-up approach to governance, rather than a strictly top-down one.

2.2.2 Co-assessment and planning

Effective stakeholder engagement throughout the NbS implementation cycle can be supported by co-creation methodologies, which are very well suited for exploring NbS (van Ham & Klimmek, 2017); (Kabisch, Korn, Stadler, & Bonn, 2017). During stakeholder analysis, the required/desired level of involvement is stated (step 3 in 2.2.1), thus the purpose of co-creation is to actually generate active involvement of stakeholders throughout the different stages of a process (Vargo & Lusch, 2004), to include local knowledge and expertise (Barquet & Cumiskey, 2018), increase support for NbS, and optimize the potential of obtaining co-benefits (Raymond, et al., 2017).

The previously described stakeholder analysis helps identify the stakeholders to engage in the first step of the iterative co-creation process of implementing NbS, namely the co-assessment and planning phase. During this phase, the main goal is to answer the following questions: *what is at risk? What are the suitable types of NbS to implement? What are the chosen solution's benefits and costs?*

To answer these questions, several assessments are performed, such as assessments of hazards, vulnerabilities, and risk, as well as assessments of costs and benefits, and barriers and enablers (Section 2.3). Moreover, stakeholders' experiences, expectations, needs, and capacities to implement NbS and other risk mitigation options are brought to the table, as well as utilized decision-making processes and practices. Inviting stakeholders to the discussion and these assessments is a fundamental part of this process. This can be achieved through participatory methodologies such as workshops with experts and/or key stakeholders, retrospective reflections, and future planning. More details and examples on the application of this process are shared in Section 2.4.

2.3 Baseline Assessment

To initiate a baseline assessment, it is necessary to identify and understand the location of the potential NbS, its physical attributes and contextual environment. While RECONECT primarily focuses on large-scale NbS projects aimed at mitigating hydrometeorological risks, it also addresses other underlying challenges and conditions in the project area (Fish, 2011).

The spatial, temporal, and frequency aspects of the hydro-meteorological risks must be taken into consideration when implementing NbS. The three-dimensional approach utilized within the RECONECT project assesses these dimensions and provides a comprehensive analysis of risk factors. This approach is used for determining whether risks stem from the severity of hazards, the vulnerability of the area, or a combination of both (Figure 2-3).

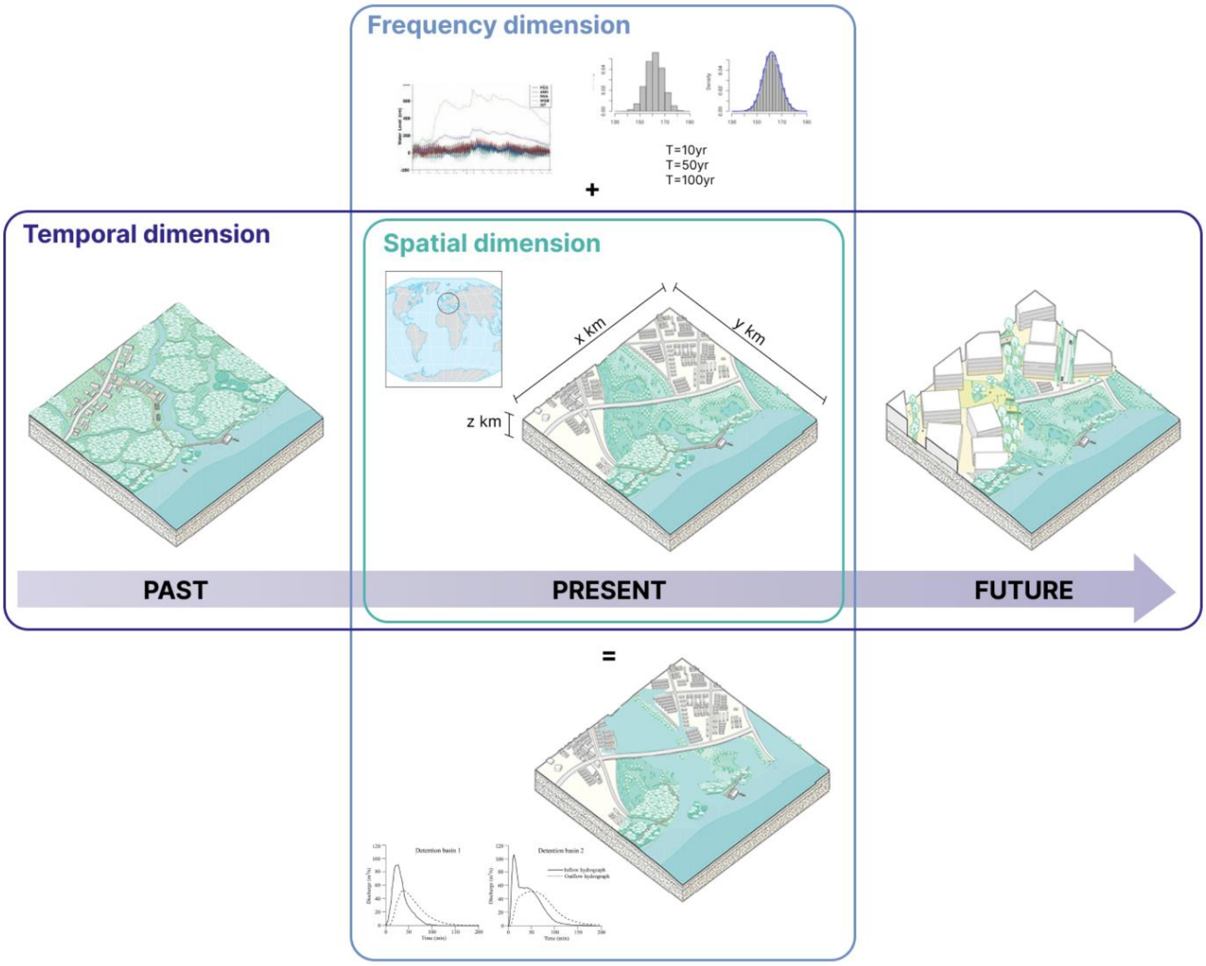


Figure 2-3: Illustration of the three-dimensional approach (illustrations from Felixx, 2024).

For hydrometeorological risk reduction through NbS the baseline assessment quantifies and identifies hazard magnitudes, vulnerabilities, and relevant factors within the focal area, providing insights for evaluating NbS effectiveness through pre- and post-intervention comparisons. The following sub-sections detail these two steps, which directly support the identification of suitable NbS measures. This latter process, combined with an example from RECONECT is described in Section 2.4.

2.3.1 Identify challenges/hazards

Step 1 - Historical data

Historical data is a valuable resource in the understanding of the challenges of hydrometeorological hazards in the project area and offers insights into past events and vulnerabilities. Analyzing historical patterns supports the selection of NbS measures that effectively address current climate, societal, and environmental situations (Fish, 2011). Additionally, this step underscores the importance of local stakeholder engagement in co-planning, ensuring a contextually anchored approach (IUCN, 2020).

Typically, historical data can be gathered from various providers, including weather stations, coast guards, and insurance companies, depending on the project site's location. The importance lies in ensuring that this historical data accurately reflects the current baseline of today's climate. This entails considering not only the historical occurrences of significant hydrometeorological events but also their recurrence intervals. Equally significant is the extraction of average data for (i) temperatures, (ii) precipitation patterns, (iii) sea-level rise, and (iv) dis-/recharge of groundwater.

Step 2 - Future climate predictions
The future climate conditions are equally important, even if they are not an immediate concern. This forward-looking approach is necessary for implementing adaptive measures that exhibit resilience in the change of climate and environmental conditions (WWF, 2017). This underscores the significance of the temporal dimension, particularly in assessing how NbS performance aligns with long-term objectives. It guides decisions on whether to implement large-scale or smaller NbS measures.

Step 3 – Selecting hazards
Comparing the present and predicted climate provides valuable insights into both current and potential hazards and challenges. This comparative analysis serves as a necessary exercise for identifying the specific hazards that require effective management. When addressing hydro-meteorological risks, the main categories are displayed below:

- Fluvial flooding
- Pluvial flooding
- Coastal flooding
- Ground water flooding
- Flash flooding
- Storm surge
- Drought
- Landslide

By categorizing and understanding these hydro-meteorological risks within the context of current and predicted climate conditions, it becomes possible to implement effective measures that mitigate their impacts and enhance community resilience.

2.3.2 Establish physical site conditions

The assessment of the project site provides insights into the physical characteristics of the site, enabling the design of effective and tailored NbS measures.

1. <u>Existing site topography:</u>
   Understanding the site's topography is fundamental. This involves mapping the natural contours and elevations of the land, as it significantly influences water flow patterns and potential flood risk areas. This also includes measuring the area of the watershed and the project area, and the slope of the terrain.
2. <u>Flow paths, ponding areas, and discharge points:</u>
   Identifying existing flow paths, ponding areas, and discharge points is essential for comprehending how water moves across the site. This knowledge informs the design of NbS measures that can effectively manage water flows and predict the total amount of water that needs to be managed. This also includes measuring the time of the concentration based on the distance of the stream.
3. <u>Soil types and infiltration potential:</u>
   Assessing soil types and their infiltration potential is critical. Different soils have varying capacities to absorb and retain water. This information is vital for choosing NbS measures, which optimize soil's water-retention capabilities. This also includes assessing the risk of both drought and landslide.
4. <u>Potential for surface water discharge</u>:
   Understanding the potential for surface water discharge is crucial for managing excess water. It informs decisions regarding the routing of water away from vulnerable areas or toward designed water storage or treatment features.

5. <u>Existing infrastructure:</u>
   Examining existing infrastructure above and below ground is essential. This includes identifying built structures, utilities, and transportation networks that may impact NbS planning, but also consider to co-exist easing both systems. This also includes having insight in new adaptation strategies and existing plans. Also this section is vital information, that can be used to deploy an agent-based solution.
6. <u>Land cover and land use:</u>
   Assessing the current land cover and land use provides insights into how the site is utilized and how it interacts with water. Understanding whether the land is predominantly urban, agricultural, forested, or undeveloped helps tailor NbS measures to the specific ecological and human contexts. This information guides the integration of NbS into existing land use practices and identifies opportunities for coexistence and synergies between natural and human systems.

2.4 Identification of suitable measures

The process of selecting a suitable measure for mitigating hydrometeorological risks within a focus area is a multifaceted decision-making endeavour. It needs a careful balance between various objectives, criteria, and the often-conflicting interests of diverse stakeholders and ambitions. Assessing the baseline conditions forms the foundation for identifying potential measures that effectively address the challenges at hand while aligning with project objectives.

The iterative feedback to achieve a balance between the measure to choose, the relevant hydro-meteorological hazard(s) and the goals to be achieved with the NbS project is represented in Figure 2-4. In the context of RECONECT, the goals (representing specific challenge areas, e.g., “Water quantity”) to be achieved are further divided into sub-goals (e.g., “Flood, coastal, landslide risk reduction”), whose success can be determined through the use of specific indicators (e.g., “Flood hazard”), quantified by defined variables (e.g., “Flood peak reduction”).

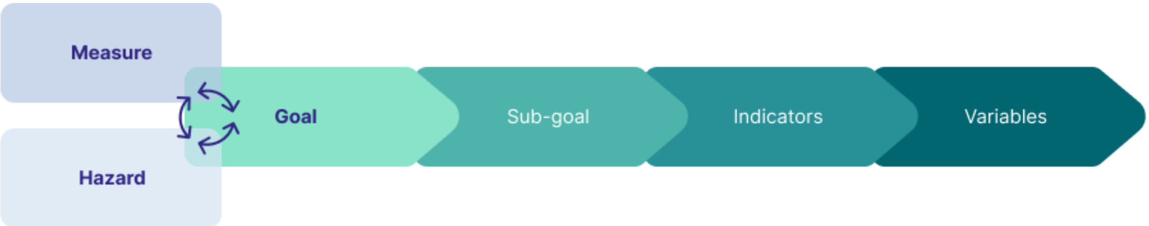


Figure 2-4: The three steps in shortlisting NbS measures (hazard, measure, and goal) and the following hierarchy of goals sub-divisions. Modified from Ruangpan and Vojinovic (2021).

The main barriers are yet the physical conditions of the surrounding environment and the space given. When identifying suitable measures for the project site, it all comes down to evaluation of the challenge. Based on the given hazard that the measure should manage, a shortlisted overview of suitable measures can be developed.

The first screening process of measures is depicted in Figure 2-5. In RECONECT, the Measure Selector Tool was developed to streamline this selection process. To do that, the Tool provides a screening of an extensive list of NbS measures for hydro-meteorological risk reduction, to assist in narrowing down which NbS may be suitable for a given location. The user can apply six filters such as hazard type, area features at location of feature, affected area type etc. Based on that, a shortened list of potential NbS is given to the user. The Measure Selection Tool has proven especially useful for those projects who do not have extensive NbS in-house knowledge and/or expertise already.

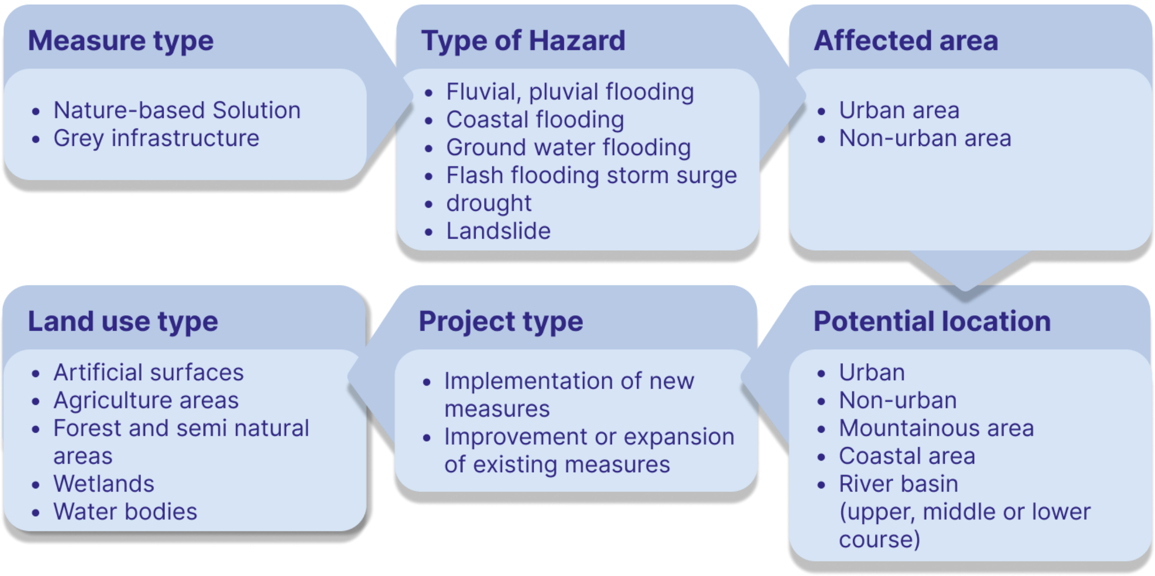


Figure 2-5: Step by step approach in shortlisting suitable NbS measures

The screening is followed by an evaluation, which is grounded in several key factors, including the scale of the project and the feasibility in implementing the identified measures for all the identified hazards. The suitability of the shortlisted measures is assessed in relation to the project's scope and the specific hazards at play. Additionally, the practicality and viability of applying these measures across the entirety of the project site is evaluated.

2.4.1 Multicriteria Analysis (MCA)

Subsequently, the final shortlisting is presented to stakeholders via a Multicriteria Analysis (MCA). This allows for active engagement and input from stakeholders who can provide valuable insights, particularly regarding the cultural context and the needs of the local citizens. Their perspectives and preferences support the final selection of measures, and this ensures that the solutions implemented are not only technically sound but also align with the values and requirements of the community. In this process, stakeholders select and rank the measures, this ensures that only the most suitable measures are selected, preventing any unsuitable choices for the area of interest or local community. The framework of the MCA, adapted from Ruangpan, et al., (2021) is reported in Figure 2-6.

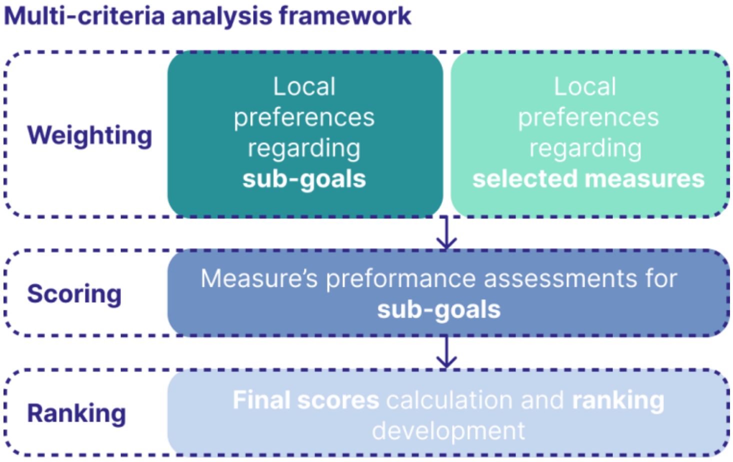


Figure 2-6: MCA approach. Modified from Ruangpan et al. (2021).

2.4.2 Baseline assessment and measure selection process in a RECONECT Collaborator

The Tamnava River Basin Collaborator project in northwestern Serbia aims at finding the optimal and sustainable strategy to mitigate flood risk in the Tamnava basin, and at advocating and promoting implementation of NbS as a holistic approach to addressing intensifying hydrometeorological risks in a sustainable manner. Here the process of baseline assessment and measure selection done in this case are reported as described by the Collaborator in *Deliverable 4.2 – Baseline assessment and potential for NbS in Collaborators*.

The baseline assessments in this site included pre-intervention hazard magnitudes, vulnerabilities and all relevant factors affecting the hydrometeorological risk(s), including physical features (climate, topography, geology, land cover and use, etc.) and socio-economic characteristics (development plans, regulatory context). In the case of Tamnava, flooding hazard is the most prominent, but the area is also prone to a larger array of hazards, including droughts, landslides and heatwaves. As for the elements susceptible to hazard impacts in the area, there are 49,268 inhabitants vulnerable to flooding, as well as transport, water, and energy infrastructure. The dominant economic activity is agriculture, and there are no natural protected areas in the Tamnava river basin. As part of the baseline assessment, the project has also reported existing measures to contrast the hydrometeorological hazards in the area, both structural (e.g., dikes, drainage ditches, bank stabilization), and non-structural measures (e.g., monitoring with sensors).

Once the baseline assessments were in place, the selection of potential NbS measures was done through the two steps described previously:

1) Preliminary selection of measures (screening) from the RECONECT catalogue of measures using the Measure Selection Tool. The first screening was made from the catalogue of measures by applying six filters, i.e., criteria on the types of measures to be applied, hazards, affected area, location for measures, project, and land use. The Tamnava case obtained 25 measures, that were then reduced to 17 by using their expert knowledge to remove the measures that were not relevant or not suitable for their site.

2) Ranking the 17 potential measures through an MCA which incorporated stakeholders' preferences of different goals obtained through a survey. The NbS goal that obtained the highest scores was the reduction of the main risk (i.e., flooding), followed by improvement water quality and increased human well-being. Biodiversity, habitat structure and socio-economic benefits had a lower ranking (Figure 2-7).

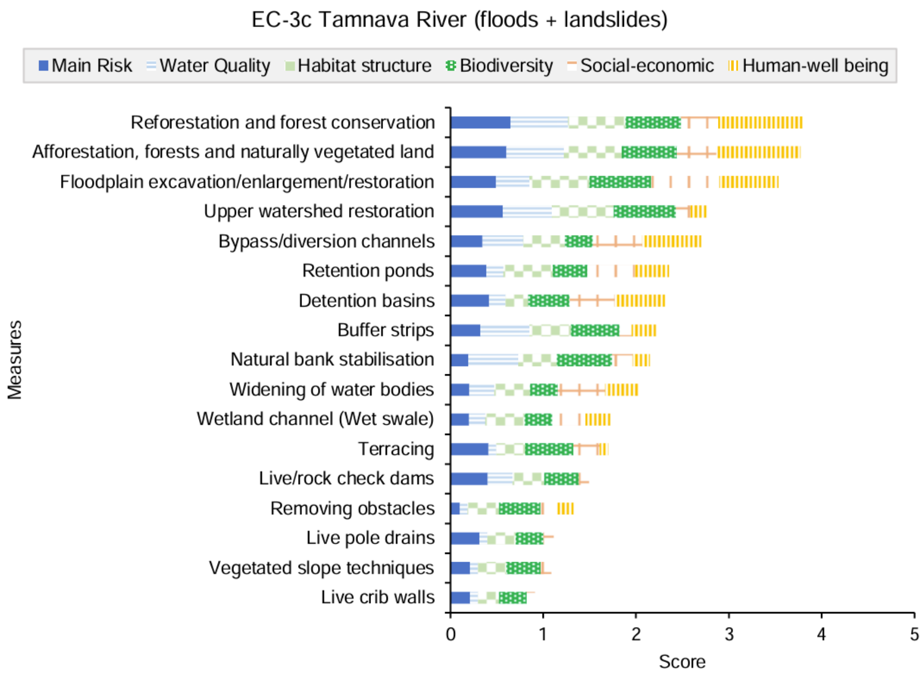


Figure 2-7: Ranking based on the results of the MCA of the preliminary selected NbS measures for the Tamnava River Basin Collaborator (from Deliverable 4.2 - Baseline assessment and potential for NbS in Collaborators).

2.5 Preliminary KPIs

During the planning phase of NbS, it is necessary to identify some preliminary key performance indicators (KPIs), to aid in identifying goals, assessing the different types of NbS that can be implemented, and ensuring that the performance of the chosen solution can be understood and monitored. NbS performance is defined as the degree to which NbS addresses an identified challenge and/or fulfill a specified objective in a specific place, time and socio-economic context (Raymond, et al., 2017). NbS performance measures:

1. Change towards certain targets;
2. The change in relation to the baseline or reference;
3. A combination of numbers 1 and 2 (Dumitru & Wendling, 2021)

The preliminary KPIs identified during the planning phase serve to give a first direction of the scope of works and will have to be reassessed at a later stage once the project enters the design phase.

In order to determine appropriate KPIs for NbS projects, it is important to frame the context in which the planning of NbS takes place. First, plans of implementing NbS should highlight these strategies' multifunctionality (i.e., their ability of providing many environmental, socio-economic, and cultural benefit), as well as addressing the 12 principles (Table 1). In addition to increasing resilience to climate change, they support biodiversity conservation, human health and well-being, climate change mitigation, recreation and tourism, and job creation (EEA, 2021; Raymond, et al., 2017).

Second, the planning of a NbS needs to take a landscape approach, i.e., taking into consideration the whole area where the solution is created, for example a watershed. That is because NbS benefits are not limited to the site where the solution is implemented but spill over to many places inside and outside the area of implementation, beyond administrative limits (European Commission, 2015).

Planning with people and selecting the right time scale for the project are fundamental to reaching both of the previous two points. Regarding engaging stakeholders, as mentioned in section 2.3.1, it is key to involve stakeholders that are going to be affected and/or affect the NbS in the planning of the measure. As for the time scale, it refers to the awareness that most NbS will need time to become functional. For example, it might take several years for wetlands to start retaining nutrients or create the optimal conditions for enhancing wildlife.

KPIs have to be determined within these frames of multifunctionality and planning taking into consideration stakeholders, the landscape and the timeframe of the project. In particular, to cater to the need for multifunctionality, it is important that the assessment of all potential benefits of NbS (i.e., economic, environmental and social) are taken into consideration from the very beginning of the planning of the project. Failing to set KPIs for the recognition and the valuation of the multiple impacts stemming from NbS can be particularly harmful in a planning context, where being able to obtain a holistic overview of a strategy's benefits is fundamental for designing and implementing a NbS fulfilling the desired impacts. Common standard for key indicators is important for comparing NbS effectiveness across regions, which allows to make results transferable and more easily communicable across different contexts (Dumitru & Wendling, 2021).

2.5.1 Preliminary KPIs selection in RECONECT

Within the RECONECT project, the abovementioned requirements to select appropriate KPIs are summarized in the NBS Indicator Selection Tool, which was developed by IHE (described in more detail in *Deliverable 2.3 – Scope of Works for Demonstrators A and B*). Altogether 91 Indicators have been suggested, grouped into three categories WATER (31), NATURE (23) and PEOPLE (37). In addition to the indicators themselves, suggested variables for the assessment of indicators, examples of assessment methods and references to scientific literature and best practices are included in the Tool.

The RECONECT approach of using an Indicator Selection Tool across case studies supports knowledge sharing, facilitates cooperation and creation of new methods and methodologies for NbS monitoring. Moreover, the Tool's structure including the different NbS impact areas eases a well-rounded assessment of the project's benefits.

The first application of this Tool by the RECONECT Demonstrators was aimed at identifying the indicators relevant to their NBS case. The results of this application are summed up in Table 5. The Demonstrators A identified 53 different relevant indicators, uniformly distributed by the 3 categories (WATER, 18; NATURE 18; PEOPLE, 17). The most chosen indicators are being Vulnerability/Flood risk reduction (WATER), Change in vegetation along watercourses (NATURE), Increasing recreational opportunities of NBS area (PEOPLE). As for the Demonstrators B, their list includes 55 indicators (out of the total 91 proposed by the Indicator Selection Tool), the most chosen being Flood Hazard

(WATER), Changes in riparian habitat (NATURE), Reduced/avoided damage cost from hydro-meteorological risk reduction (PEOPLE). This selection is going to be re-assessed and eventually adapted during the following life-cycle phases.

Table 5: Summary of identified relevant indicators in the pre-selection of KPIs phase by Demonstrators A and B (from Deliverable 2.3 – Scope of Works for Demonstrators A and B).

	DEMONSTRATORS:		INDICATORS			TOTAL:
			WATER	NATURE	PEOPLE	
TYPE A	Elbe Estuary, Germany	DA-1	10	4	9	**23**
TYPE A	Seden Strand, Odense, Denmark	DA-2	7	10	9	**26**
TYPE A	Tordera River Basin, Catalonia	DA-3	8	9	3	**20**
TYPE A	Portofino Natural Park, Italy	DA-4	3	5	5	**13**
TYPE B	IJssel River Basin, The Netherlands	DB-1	3	13	3	**19**
TYPE B	Inn River Basin, Austria	DB-2	6	2	1	**9**
TYPE B	Greater Aarhus, Denmark	DB-3	9	21	15	**45**
TYPE B	Thur River Basin, Switzerland	DB-4	7	14	8	**29**
TYPE B	Var River Basin, France	DB-5	2	3	3	**8**
TYPE B	Les Boucholeurs, France	DB-6	3	4	2	**9**
		TOTAL:	**58**	**85**	**58**	**201**

2.6 Preliminary business case

2.6.1 The specifics of a NbS business case

A business case provides the justification for starting a project, as it records its benefits, costs, and impacts.

Implementation of large-scale NbS across rural and natural landscapes requires the development of a business case taking into consideration the complexity of the living and ecosystem components at the base of the project's social and environmental benefits. A "business-as-usual" (BAU) business case for infrastructure financing delivers a reasoned case for initiating a project, outlining the details on costs, associated risks, as well as pros and cons, alternative options, actions to take, identification of potential barriers, and the predicted timescales over which the project will be completed. However, it will likely fall short of capturing all the benefits delivered by NbS, especially the non-market ones catering to the well-being of people and the environment.

This shortcoming may lead to an underestimation of NbS's value as investments, which in turn can produce barriers from the initial stage of the project, when looking for financing, planning of investment costs, or the establishment of a public-private partnership. Therefore, new methods of business case development are required to complement the strictly financial aspects, e.g., including the application of quantitative cost-benefit analysis (CBA) and analyses that include non-market cultural, social, and ecological benefits.

Summing up, NbS business cases should reflect a triple bottom line of economic, social, and environmental sustainability in a manner that equitably serves the community. However, because each NbS often comprises a site-specific mixture of products and services, the creation of a business case may require the collection of case-based specific data and a case-to-case approach. Nevertheless, the common trait of NbS business cases is that the main advantages and disadvantages of the NbS must be considered (Carlson & White, 2017; The Nature Conservancy, 2013). Examples of advantages are: capital and operating expense savings, lower environmental footprint, better operational performance, and benefits to nature (e.g., improved habitats) and to people (e.g., increased recreational opportunities). On the other hand, examples of disadvantages to be taken into consideration are: large project land footprint, longer pilot periods, operational risks, and biotic stresses.

2.6.2 Building holistic NbS business models in RECONECT

To support the development of strong business cases for NbS, a NbS Business Model Framework was developed within RECONECT (*Deliverable 5.7 – Business models and roadmaps*). The use of business models is not yet so widespread in NbS contexts, but they are increasingly studied to ensure a more structured and strategic approach to demonstrate why the project is needed and what the benefits of the project will be when it is finished. A well-prepared business case might also lead to accessing more diverse sources of funding (i.e., private investments), which is increasingly regarded as a critical point for the upscaling of NbS (Finance Earth, 2021).

Business model canvases and roadmaps are developed to structure, concretize and ease the communication of the NbS business case. Business model canvases can be used as a planning tool, while the roadmaps can provide more structure to the various components, as they outline the key activities needed to obtain a set of objectives.

In the RECONECT approach, inspired by McQuaid (2019), a business model canvas is comprised of three sections, each focused on:

- **Value proposition –** reporting the outline of the value delivered by the NbS to the different beneficiaries. This is central to the business model, as it justifies the creation of the NbS. Examples of value proposition could be: reduced pollutants levels in the water; flood protection of built-up areas; increasing biodiversity and local attractiveness.
- **Value creation and delivery** – listing the stakeholders, activities and resources needed to deliver the value proposition.
- **Value capture –** focusing on the ongoing costs of delivering and maintaining NbS, captured benefits and cost reduction opportunities.

On the other hand, roadmaps act as a link between the business model, the key activities for the implementation of the NbS and the responsible and involved stakeholders. Moreover, the approach taken in this project links key partners and key beneficiaries to the roadmap, all of which can take on various roles throughout the project, i.e., being responsible or involved in key activities. As such, the roadmap is a strategic extension or support of the business model by providing another layer of analysis that emphasises life-cycle outcomes. In RECONECT, the roadmap follows the following typical phases of the project life-cycle; planning, design, implementation, operation and maintenance (O&M), and monitoring and evaluation (M&E).

The core components of the business model canvas and roadmap are summarized in Figure 2-8.

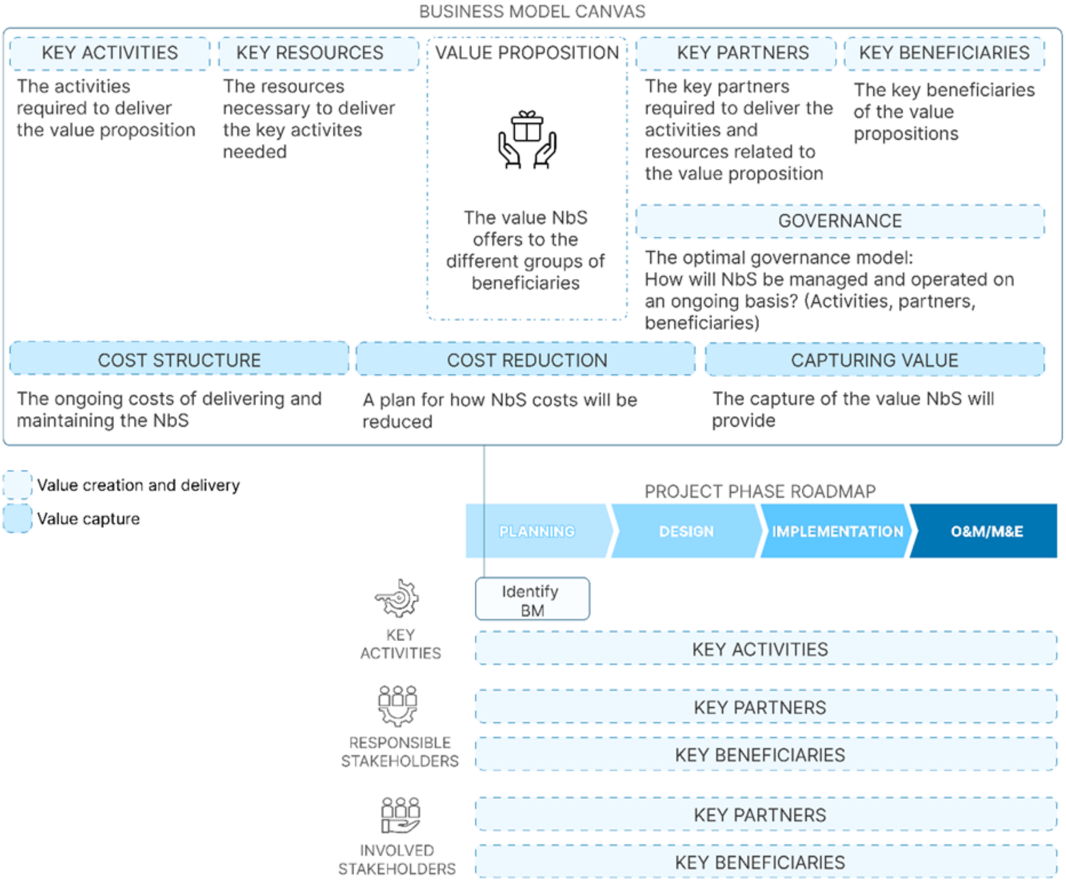


Figure 2-8: Core components of the business model canvas and roadmap. The link between business model (BM) and roadmap is also highlighted. (From Deliverable 5.7 - Business models and Roadmaps)

These approaches were tested during the RECONECT project, Figure 2-9 shows the compiled BM and roadmap of the Demonstrator B Thur River.

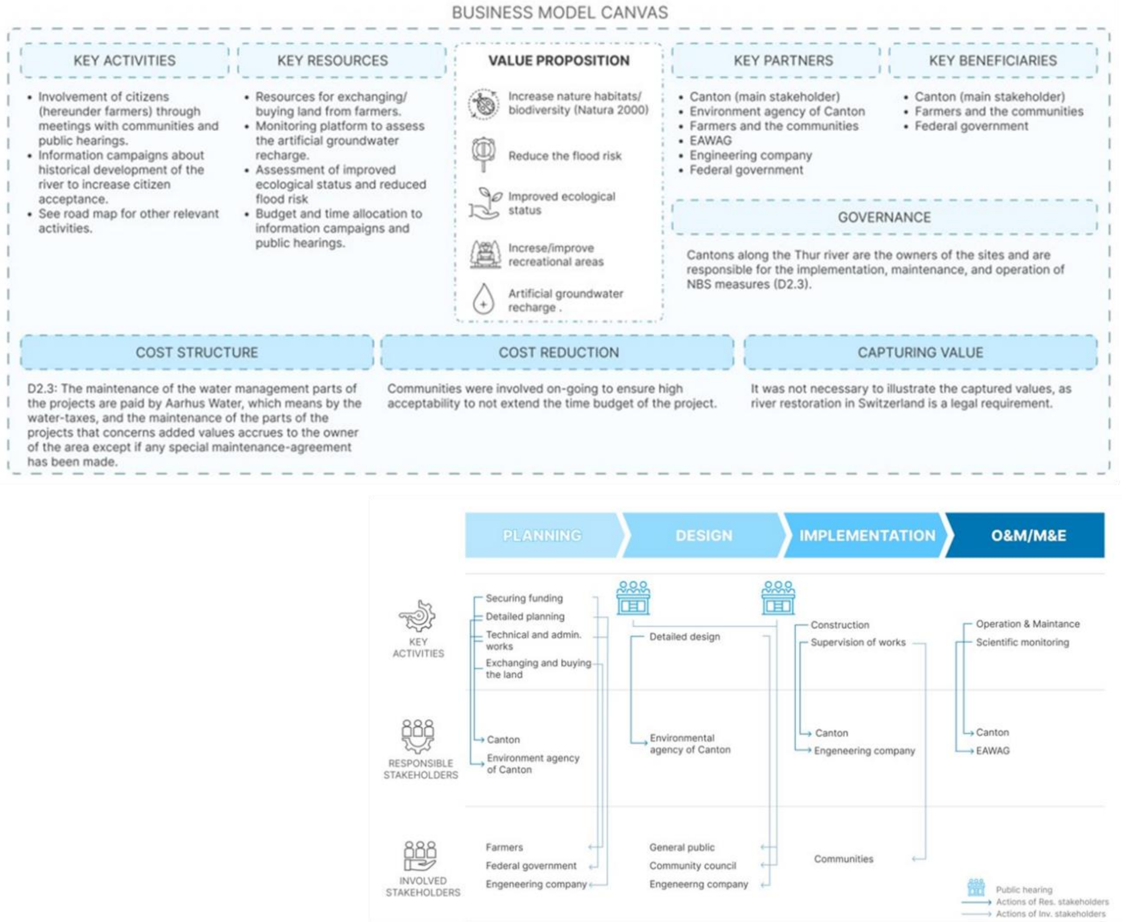


Figure 2-9: Filled in BM and roadmap for the Demonstrator B Thur River (From Deliverable 5.7 - Business models and Roadmaps)

2.7 Land-use change

To shape future land use planning and policy, land use models are fundamental (Verburg, et al., 2014). Land Use Change Modelling (LUCM) is able to incorporate environmental, social, and economic driving factors to predict the location, mechanisms, and extent of historical and future changes (Yao, et al., 2017). By doing this, LUCM allows us to bridge the gap between natural and human systems across temporal and spatial scales (Islam et al., 2018; Promper et al., 2014).

Various LUCM options exist, but all work with driving factors, constraints, and land use classes. Usually, the extent of analysis taking place and the data available are the determining criteria for which model to choose (Tizora et al., 2018). Some of the most used current LUC models, together with their main characteristics, are listed in Table 6 below.

Table 6: Most common LUC models and their characteristics (edited from Penny et al., 2022)

Model/ Framework	Spatial resolution	Scale	Availability

CLUE/Dyna CLUE (various versions)	Depends on input	Globally applicable more suitable for smaller scale studies	Dyna-Clue freely available (limited extent)
DINAMICO EGO	Depends on input	National, subnational	Freely available
SLEUTH	Depends on input	Globally applicable	Available
FLUS	Depends on Input / 1 x 1 km applicable	Globally/continental Applicable – works well on a regional/country basis	Freely available
PLUS	Depends on Input / 1 x 1 km applicable	Globally Applicable – Suitable for large (country scale) and very small catchments (250km^2)	Freely available

2.7.1 NbS suitability mapping: approaches and challenges with Land Use Change Modelling

All land use models are calibrated using past land use maps, and to obtain the most solid results land use classes need to be kept consistent. Therefore, introducing a potential NbS, which is interpreted as a new land use type by the model, can be an issue for the modelling process. Nevertheless, some methodologies have been developed for suitability mapping for NbS:

1. **PLUS models**: PLUS models can be used to estimate where NbS locations could be placed. The model creates outputs providing growth and development probability for different land used, based on driving factors such as groundwater levels, rainfall, soil drainage, etc. For example, Penny et al. (2023), used the Land Expansion Analysis Strategy (LEAS) function of the PLUS model to measure the influence of independent variables (e.g., driving factors such as groundwater level and soil capability) on the variation of dependent variables (e.g. growth in a specific LU type such as viticulture or vegetables). This way the model was able to provide guidance to policy makers and land utilizers (such as farmers) on where optimal potential produce growth areas could be placed. Such an approach could be adjusted to include optimal areas for the development of NbS especially for solutions including trees, wetlands, mangroves, or flood plains (i.e., NbS which easily overlap with specific land use categories).
   GIS used in combination with Multicriteria Decision Analysis (MDCA-GIS) can be used to assess the reduction in risk/hazard due to the implementation of a NbS (Penny, et al., 2023a). In a concrete example, Mubeen et al. (2021) used this approach in the RECONECT Collaborator case Tamnava River basin in Serbia. Flood maps were used to determine the volume of floodwater that would need to be stored to reduce flood risk in the basin and downstream areas. The suitability

maps, based on 5 criteria; land use type/zone, soil type/class, slope, distance from stream and distance from road were then used to estimate the storage capacity of potential new NBS and their prime locations.

2. **Geospatial analysis:** Geospatial analysis in ArcGIS Pro was sued by Baldwin et al., (2022) to identify areas for NbS that would reduce flooding and provide improved water and habitat quality. Suitability maps were based on land ownership, biophysical characteristics, current land use and water management opportunities. Suitable (open) land (i.e., land not including high-value crops or existing infrastructure) identified was further classified in: areas suitable sites for forest and tree planting (e.g., at least five acres in size, low productivity soil); sites suitable for wetland restoration or creation (e.g., hydric soils, slopes below 2%); sites suitable for water farming (e.g., located out of floodplain); and stream restoration sites (e.g., sinuosity, buffer vegetation).

2.7.2 Land Use Change Modelling and Land Ownership

The dynamics of land use change are significantly driven by public policies (Tavares et al., 2014), especially those influencing maintenance, expenditure of public funds and property rights. Property owners and land developers often hold significant political power within local and regional jurisdiction where planning decisions occur. Thus, these stakeholders can be a strong barrier to NbS implementation if they are hostile towards it (e.g., if property owners do not trust they will get a return on investing in NbS to allocate land to ecosystem functions).

To minimize the resistance of landowners, the literature suggests that NbS implementation would benefit from a flexible performance-based planning approach – thus incorporating multiple land uses and users. Frantzeskaki et al. (2019) and Govind and Alam (2023) discern this further suggesting that planners need to have a transparent collaborative/coordinated approach to NbS that allows learnings across multiple actors (local governments, NGO, Citizen groups) in order to build understanding and trust.

Moreover, the inclusion of stakeholders has the additional benefit of improving the quality of the input data for LUC models, i.e., by adding details on the available data and on perceived hydrological hazards. In a study by Penny et al. (2022), the contributions of local stakeholders and academics formed the basis of seven plausible future LU scenarios via a FLUS model and an optimization tool. The stakeholder engagement resulted in important inputs and the design of LU scenarios that were consequently modelled more relevant to local farmers – as they were based upon stakeholders' opinions, interests and needs. Findings from this research were used to propose suitable LUC scenarios and possible policy recommendations to decision-makers to help with effective water resources management. Similar approaches could be developed in other contexts to facilitate overcoming potential skepticism.

2.8 Pre-feasibility

Pre-feasibility studies are utilized to guide stakeholders through informed decision-making processes. These studies offer an initial analysis, covering essential aspects such as vulnerability mapping, financial prerequisites, anticipated challenges, and the evaluation of a selection of NbS measures. By providing a holistic overview of the project's potential, pre-feasibility studies enable stakeholders to assess feasibility and make informed choices regarding project approval or investment selection (INN, 2023).

Pre-feasibility studies offer a starting point for addressing and mitigating barriers to NbS adoption. By identifying key issues and opportunities early on, stakeholders can develop strategies to overcome challenges and maximize the effectiveness of NbS measures in addressing environmental and societal needs, hence the design (and planning) of NbS depends on the insight stakeholders have in NbS (Langemeyer, et al., 2020; Venter, et al., 2021; IUCN, 2020).

2.8.1 *Preparations of pre-feasibility study*

The pre-feasibility study operates as an iterative process, heavily reliant on feedback and input from both the preliminary KPIs and the CBA. These foundational elements are rooted in the MCA conducted during the baseline assessment, setting the groundwork for the overall scope and evaluation of the suggested NbS measure. This whole process is ideally to be conducted in close relationship with the relevant stakeholders.

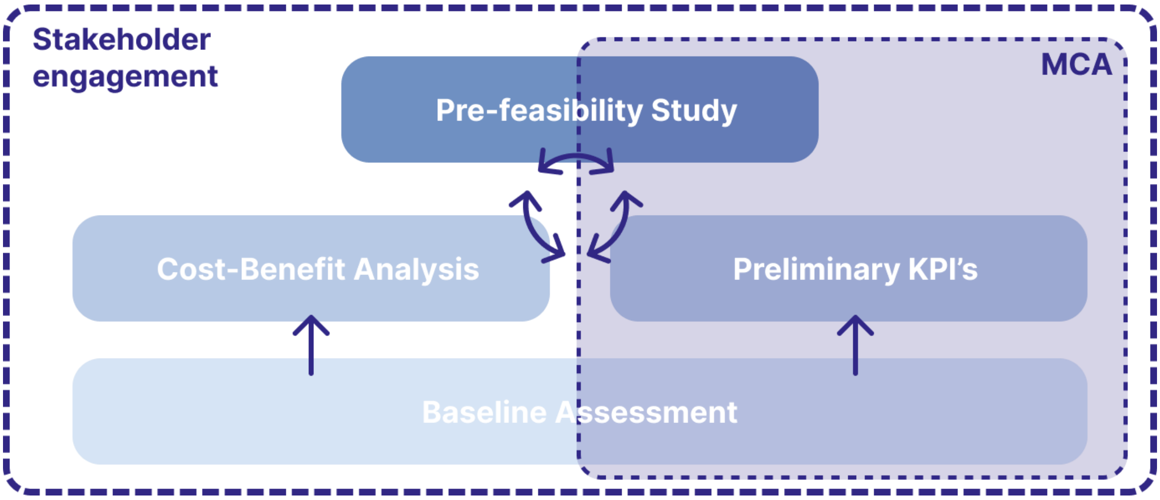


Figure 2-10: Synergy between CBA, preliminary KPIs, and Pre-feasibility Study

Figure 2-10 illustrates the relationship between the CBA, preliminary KPIs, and pre-feasibility assessment. In a co-planning and co-assessment framework, developing a suitable set of KPIs based on the baseline assessment contributes to driving the co-benefits included in the CBA. Furthermore, the CBA and preliminary KPIs are both influenced by and impact the pre-feasibility study. Should the project prove unfeasible, adjustments to KPIs or the CBA are necessary. Effective communication among stakeholders is vital in refining feasibility, as the design relies on stakeholder knowledge (IUCN, 2020).

Earlier RECONECT reports (*Deliverable 4.5 - Report on local acceptance, institutional, and political feasibility among Collaborators)*, provided insight into challenges obstructing the adoption of NbS. This was achieved through the collection and evaluation of Collaborator cases. The identified challenges included existing structures and funding schemes that predominantly favour traditional infrastructure over NbS due to constraints such as legal provisions, administrative hurdles, and inadequate budget allocation. Furthermore, limited awareness amongst the public, uncertainties, and a reactive approach to disaster management pose significant obstacles. Coordination gaps across sectors further delay NbS integration, highlighting the need for cross-sectoral collaboration and capacity-building efforts.

2.8.2 Institutional feasibility

The concept of institutional feasibility revolves around the presence of supportive or hindering institutions crucial for the effective implementation of policies and accompanying strategies. Institutions encompass both formal regulations like laws and informal constraints such as customs and traditions, shaping human interaction in political, economic, and social context (North, 1991).

Management of the NbS project should incorporate societal factors to ensure the feasibility and sustainability of NbS, potentially through socio-ecological modelling and transdisciplinary processes involving experts, practitioners, and stakeholders. This approach facilitates citizen participation, integration of local knowledge, environmental justice, and economic growth while addressing uncertainties and (Fish, 2011), which is identified as one of the greatest barriers when it comes to realizing large-scale NbS (Raymond, et al., 2017).

2.8.3 Pre-feasibility outcomes in RECONECT

Following the processes presented in Section 2.4.2, the Tamnava River Basin Collaborator proceeded with the pre-feasibility assessment of the identified measures. Based on the results reported in *Deliverable 4.8 - Prefeasibility study for implementation of NBS in Collaborators*, the following NbS measures were considered for further analyses:

- Retention ponds,
- Afforestation and reforestation,
- Floodplain restoration,
- Buffer strips,
- Removing obstacles in the watercourses.

Wet swales were another measure generally suitable for this context, but they were discarded by the stakeholders on account of demanding and costly maintenance, in addition to land ownership issues. This latter outcome highlights the importance of involving stakeholders from the very beginning of the process. The pre-feasibility study was rounded off with an assessment of the barriers to the NbS implementation in the Tamnava basin, based on workshops with stakeholders, and the definition of a sustainable roadmap to the implementation of the proposed risk reduction strategy including specific recommendations for decision makers.

3 Design

3.1 Update business case

The return on investment, the efficiency and effectiveness of the NbS intervention, and equity in the distribution of benefits and costs are key determinants of success for an NbS. Therefore, it is necessary that sufficient consideration is given to the economic viability of the project also after the planning phase, both at the design stage and through implementation (IUCN, 2020).

During the business case update phase there is a more detailed exploration of cost structures, revenue projections, and investment viability, all aspects needed to ensure long-term financial sustainability within NbS initiatives (Camacho, et al., 2023).

3.1.1 Steps for Business Case Update

While the preliminary business case lays a foundation centred on value proposition, capture, value creation, and value delivery (Section 2.6.2), its update aims at making the NbS project bankable (i.e., ensuring that it's a strong, fundable proposal) (Ellis & Pillay, 2017). This is a gradual process which is carried out throughout the design phase, feeding off the outcomes and re-assessments obtained from the other actions in this phase. The Five Case approach is recommended for the creation of a strong business case (Altamirano, 2021):

- Building the strategic case – confirming the alignment to existing policies, frameworks, etc. Linked to the assessments in Section 3.3.
- Building the economic case – ensuring that the project provides the best value to society and wider environment. This can be achieved through the re-evaluation of risk assessments, environmental impact studies, and economic analyses such as CBA. More details in Section 3.3.
- Building the commercial case – demonstrating that the preferred way forward will result in viable procurement and contracts (Section 3.6).
- Building the financial case – assessing and demonstrating the affordability and fundability of the project. This can be done through re-assessments and data validation of the business models already developed (see Section 2.6.2).
- Building the management case – ensuring that the project can be successfully delivered. This depends on the project's capacity to deliver, monitor and evaluate its goals (Section 3.5).

These points will be assessed throughout the Design chapter, in the sections specified in each bullet-point.

3.2 Land acquisition

A critical constraint for the implementation of NbS measures is the availability of the areas of intervention. For example, in the Demonstrator B Greater Aarhus, specifically in the sub-site of Lystrup, the development on public-owned ground was a main criterion for the design of the various climate adaptation measures. While in the Demonstrator A Portofino Park, the design of measures along the slopes was influenced by the necessity to avoid critical areas with many single owners, as it was almost impossible to gather them under a single agreement.

However, it is often challenging to avoid including private-owned ground in NbS projects, which leads to the need of undergoing a land acquisition process. Within (and outside) of RECONECT, this process is regarded as one of the greatest barriers to realizing NbS. This is because it is a costly affair that demands political will, community support, and funding.

Land donation for such purposes is a rare case, particularly for large-scale NbS that require significant quantities of land. Therefore, it's essential to design the NbS in a way that adheres to the community and gains support from local citizens to secure funding. Any failure to do so can lead to funders leaving the project and withdrawing their money.

There are various funding methods available for land acquisition projects, such as direct appropriations, taxes, fees, tax incentives, bonds, grant funding, and partnerships with private or non-profit organizations. Municipalities can collaborate with utility companies or NGOs that have an interest in the NbS. Additionally, land trusts can offer resources and support for traditional land acquisition projects, simplifying the process for communities to carry out these programs (Planning for Hazards, 2016). Some methods for obtaining land are listed below, together with examples from RECONECT.

- **Purchase land:** The traditional approach to acquiring land involves outright purchase, wherein stakeholders buy the land required for NbS implementation. However, this method demands significant financial resources for acquisition and ongoing maintenance. While purchasing land may initially present fewer conflicts with landowners, it is crucial to involve local communities in the decision-making process to address their concerns and ensure the sustainable management of NbS over time.
  This is the method mostly used within the RECONECT project, e.g., in the Demonstrator B Thur River and in the Demonstrator A Seden Strand, where private landowners were offered a compensation for their land.
- **Land swap:** In cases where the NbS project owners (e.g., municipality or government) already own suitable land, a land swap can be an advantageous option. Land swapping involves exchanging stakeholder-owned land with private landowners, allowing both parties to benefit mutually. This approach avoids the need for monetary transactions and can facilitate NbS implementation without disrupting existing landowners' rights or activities. This approach has not been the main method for any RECONECT case study.
- **Renting land:** Renting land from willing landowners provides another avenue for NbS implementation, particularly when landowners are unable to utilize their land for profitable purposes. Governmental institutions can enter into rental agreements with landowners to implement NbS measures and monitor their effectiveness. However, this approach requires careful legal considerations to determine responsibilities for maintenance and financing, ensuring clarity on the roles of both parties involved.
  For example, despite using one-off compensation to the landowners to get the rights to establish the new dike and improve the habitats, Odense Municipality (Demonstrator A Seden Strand) has committed to monitoring the site “only” for the initial five years post-implementation to ensure a successful transition and optimal ecological development. After this period, monitoring responsibilities will transfer to the landowner, ensuring ongoing maintenance and sustainability of the NbS project. This case shows that a certain “hybridization” between these land acquisition approaches is also possible.

3.3 Feasibility assessment

Large-scale NbS feasibility studies are comprehensive assessments, building upon the results of the prefeasibility studies. They demand substantial resources and more precision. Large-scale NbS feasibility studies should strive to provide economic estimates within a 10 to 20 percent margin of accuracy, whereas prefeasibility studies may allow for a slightly wider range, between 20 and 30 percent (INN, 2023).

The primary objective of these studies is to establish the technical, legal, environmental and financial feasibility of implementing a NbS project. These in-depth assessments serve as the foundation for determining the project's capital requirements, operating expenses, and its overall benefits, as well as its technical and economic viability within the context of large-scale NbS measures.

Key points (RES4CITY, 2023) that link to the creation of the strategic and economic cases (see Section 3.11) and need to be considered in feasibility assessments are:

- Technical and legal feasibility: evaluating if the chosen NbS can be practically implemented within the site's constraints and existing regulations and safeguards.
- Economic viability: assessing the financial implications, including upfront costs, operational expenses, and potential long-term benefits or savings.
- Environmental impact: analysing the ecological footprint and potential effects of the project (e.g., on biodiversity, water and air quality, soil conditions, etc.).
- Social acceptance: considering community perceptions, involvement, and the potential socio-cultural impact of the NbS. This last point will be discussed more in detail in Section 3.4.

Further dimensions that can be assessed are also circularity (i.e., considering the implementation of circular economy principles to minimize waste) and gender issues. Below we explore more in detail the dimensions analysed in RECONECT feasibility assessments and supplement them with the example of the Demonstrator A Park of Portofino (as detailed in *Deliverable 2.4 - Technical specifications and procurement processes for Demonstrators A and B*).

Technical and legal feasibility

Assessing the technical feasibility of NbS measures extends beyond mere engineering considerations. It delves into the intricacies of ecological processes, hydrological dynamics, and adaptive management frameworks. This phase examines the technical nuances of each selected NbS, ensuring their alignment with the project's objectives, the site's ecological makeup and landscape value (Camacho, et al., 2023). Moreover, the feasibility assessment also needs to make sure that the proposed NbS complies with the international, national and local regulations that were identified as relevant in the planning phase (Section 2.1).

In the case of Portofino Park, the following aspects were considered:

- The projected efficiency of the risk mitigation strategy, which was assessed to be high;
- The feasibility of the chosen measures in regard to natural features and logistic complexity of the catchment. Specifically, the degree of compatibility of the NbS project with the specific context of a mountainous area by the sea, where the implementations had to be small and spread out on the territory, was assessed;
- The integration of the proposed NbS with relevant regional policies for land management/planning and with River Basin management plans;
- The availability of the areas for intervention (i.e., “who owns the land?”, as presented in Section 3.2);

- The possibility of improving the visibility and governance model of the Portofino Regional Park, also in the perspective of becoming a National Park (ongoing procedure).

Economic viability

Beyond technical expertise, feasibility assessments delve into socio-economic dynamics. They navigate the intricate interplay between NbS interventions and societal aspirations, weighing the benefits accrued by local communities against the potential disruptions or challenges posed by implementation. It's about understanding the socio-economic fabric and ensuring that NbS measures become enablers of inclusive growth.

In the Portofino case, the economic viability of the project was analysed through the consideration of:

- A Cost-Benefit Analysis of the measures. Considering the high value of the elements exposed to hazard (in particular the road at the Paraggi catchment mouth that links Portofino with Santa Margherita Ligure), the presence of residential buildings of high economic value, the tourism facilities in Paraggi, and the cultural heritages and tourism facilities in San Fruttuoso, it was estimated that the total cost of the NbS measures lead to a small cost/benefit ratio;
- The possibility of reducing risk injuries among park visitors during heavy rainfalls. Safer hiking routes might contribute to a higher tourist activity, corresponding to a higher economic return in the area;
- The chance of improving the collaboration between the Park Authority and the main local actors, as well as between landowners for projects that can benefit the local community at large.

Environmental impact

A cornerstone of the feasibility assessment lies in its dedication to ecological sustainability. Feasibility assessments also scrutinize the potential impacts of NbS measures on local ecosystems, striving to safeguard biodiversity, promote habitat preservation, and nurture the resilience of natural systems. This phase examines the interdependence between NbS measures and ecological health, aiming for synergistic coexistence.

Nevertheless, to completely understand the environmental impacts of NbS it's also necessary to consider their dis-services, defined as functions perceived as detrimental to human well-being despite being (potentially) positive for ecosystems. For example, dense vegetation, such as bushes, may be perceived as unsafe (Peschardt & Stigsdotter, 2013), leading to reduced usage due to concerns about safety and adverse health impacts (Hegetschweiler, et al., 2017). Addressing conflicting interests and drawbacks can contribute to ensuring the effectiveness, equity, and social acceptance of NbS initiatives. However, the notion of disservices has been notably underrepresented in the literature on NbS (Lyytimäki & Sipilä, 2009).This oversight, as highlighted by Dumitru et al. (2020), underscores a significant gap in understanding and addressing potential drawbacks associated with NbS design and implementation.

In the Portofino Demonstrator, the environmental impact of the implemented measures has been assessed through the analysis of:

- The materials and techniques to be used in the area of high cultural landscape value of San Fruttuoso, where the sole use of dry-stone walls was allowed for the re-building/stabilization of terraces (Figure 3-1);
- The possibility of stimulating the natural regeneration of woods by removing allochthonous and low adaptive species (e.g., Pinus pinea L.) to favour the climax species in the area (e.g., Quercus ilex L.).

- The chance of the reduced erosion and slopes instability benefitting the regeneration of both natural and man-made ecosystems.

Disservices as defined above were not particularly relevant in the Portofino case, therefore they did not play a role in the feasibility analysis of the case. Though the project had to navigate trade-offs between the three NbS challenge areas (Water, People and Nature). For example, the area shown in Figure 3-1 is fenced off to avoid wildlife (i.e., wild boars and goats) damaging the newly established terraces and therefore lowering the risk reduction potential of the NbS measures. This is however not seen as an obstacle to the movement of the local fauna, as the fenced area is rather contained in size.

Figure 3-1: Restored dry-stone walls in San Fruttuoso di Camogli. Photo source: GISIG's presentation at the 11th RECONECT GA.

3.4 Engagement: co-design

During the design phase, it is not only important to engage with stakeholders to identify their needs and desired benefits, but also to explore the possibility of designing the NbS to meet their demands. This potential for co-creation and holistic development of NbS can be a powerful tool for building social capital and enhancing the sustainability and resilience of communities.

For this step, defined as co-design, the main questions to be answered are: *which design configurations meet stakeholders' needs and uses? How can NbS be designed for multiple benefits?* Different NbS design configurations are analyzed, and the local stakeholders previously identified during the planning phase are involved in further discussions about their preferences and needs.

Ideally, the co-assessment and planning step for the engagement of stakeholders (Section 2.2.2) has produced a good overview of which degree of co-creation is needed and/or desired within the project, which will in turn influence the kind of tools needed to effectively foster co-design with stakeholders. In Table 7 are listed some co-design approaches that can be used, and some respective examples from the RECONECT cases.

Table 7: Examples of co-design approaches

Main goal	Method	Examples from RECONECT
To ensure stakeholder engagement.	Communication to stakeholders, expert interviews and building maps for the formation of relevant partnerships.	***Demonstrator B, Ijssel River*** Stakeholder communication involved many citizen information evenings (at least 1 per community), meetings with landowners (3-6 meetings per landowner), and meetings and discussion with the many other stakeholders (authorities, nature or cultural interest groups and protection agencies). The project put a large focus on communication of plans and designs prior to permit applications, to try to prevent citizens/stakeholders objecting to the plans. (From *Deliverable 2.4 - Technical specifications and procurement processes for Demonstrators A and B*)
To invite stakeholders to test and validate ideas about NbS and the NbS project.	Assumption mapping (e.g., fostering discussions to identify and prioritize the project's key assumptions or hypotheses about desirability, viability, and feasibility in terms of importance and evidence), and field trips to the NbS area with the stakeholders.	No RECONECT case study appears to have implemented this specific approach in their co-design strategy.
To adjust criteria to ensure local relevance of the NbS project to environmental, health, economic, socio-political, technical issues.	Focus groups and workshops.	***Demonstrator B Greater Aarhus – Lystrup Climate Adaptation*** The citizens of Lystrup were invited to several workshops led by the University of Aarhus together with a private company 'Habitats', where they generated ideas about future recreational use of the area Hovmarksparken. The citizens' involvement here was a part of a new concept called 'Wild on Purpose' which aims at bringing more biodiversity into cities on private initiatives. Thus, the

		stakeholder involvement went further than just ‘informing’, since the citizens ware actually a part of selecting recreational features in the area. (From *Deliverable 2.4 - Technical specifications and procurement processes for Demonstrators A and B*)

3.5 Monitoring, evaluation and final KPIs

During the design phase, measures for monitoring and evaluating the performance of the NbS should be put in place. This process includes the updating of the KPIs identified in the planning phase, which should be reassessed in light of the developed design. According to the EU Handbook on evaluating the impact of NbS (Dumitru & Wendling, 2021), impact evaluation plans and their final KPIs must follow some overarching principles, presented here:

1. Be scientifically sound – the indicators chosen to measure a change in outcome attributable to an NbS intervention should be: credible, salient (i.e., clearly conveying useful and relevant information), legit, and feasible.

2. Be practical and straight-forward – the monitoring and evaluation of each NbS is unique, but some basic general requirements include a cooperative dialogue among practitioners, local authorities, stakeholders, and researchers; clear definition of scope and site of investigation; choice of a control area/group (when applicable); and the choice of a feasible frequency of data collection.

3. Use reference conditions and baseline assessment – baseline data are important for measuring reference conditions that are used later in the assessment process for the before-and-after comparison.

4. Align with policy principles and reporting obligations – to assure relevance for policymakers, it is important to seek alignment with key policy objectives. For example, the desired impacts of NbS implementation can feed into local/regional/national strategic objectives and policies.

5. Be based on a transdisciplinary approach – collaborative actions should be driven by local authorities and practitioners, who are aware of real conditions as well as administrative and technical barriers. However, they should also involve additional expertise, for example from the civic sector, industry, and scientists.

In the context of RECONECT, the Indicator Selection Tool (Section 2.5.1) has been created to gather existent NbS indicators and support the case studies in the selection of relevant ones for them. The indicators included in the Tool have been gathered from best practices and the literature, thus they are expected to comply with the abovementioned EU Handbook principles. The coming sections present the guiding questions (Dumitru & Wendling, 2021) used for the appropriate monitoring and evaluation plan including final KPIs in RECONECT.

- **Which are the appropriate final indicators to select?**

As mentioned in Section 2.5, to appropriately monitor the NbS implementation, impacts across all the different NbS challenge areas (i.e., social, economic, and environmental) have to be identified. Then, the selected indicators for their monitoring and evaluation should form a coherent framework, taking into consideration synergies and trade-offs between the different impacts. In some cases, it might be difficult to assess all of the desired indicators, e.g., because of financial or time constraints. In that instance, indicators can be ranked and differentiated into critical/core KPIs and desirable/additional ones to measure when/if more resources are available. Nevertheless, it should be always made sure that a certain balance among impact areas is maintained, and that the more complex indicators are not systematically down-prioritized.

When choosing final KPIs, the Demonstrators A and B re-assessed the number of sub-goals selected and restricted their focus on five sub-goals and six sub-goals (see Table 8). The various Demonstrators were free to choose whether they were going to assess all the listed sub-goals or just a part. However, they were expected to consider at least one sub-goal per challenge area. The full list of assessed sub-goals per Demonstrator can be found in D2.6.

Table 8: Focus goals and sub-goals of Demonstrators A and B (from Deliverable 2.6 – Co-monitoring and co-evaluation plans for Demonstrators A and B

Challenge area	Goal	Sub-goal
WATER	Water quantity	Flood, coastal, landslide risk reduction
NATURE	Habitat structure	Increase habitat area (quantity)
	Land cover area	Shifts in land use and land cover
	Biodiversity	Maintain and enhance biodiversity
PEOPLE	Socio-economics	Increase recreational opportunities
		Stimulate/increase economic benefits

- **Which are the appropriate methods to assess the KPIs?**

Once the indicators are set, an appropriate method to assess each of them has to be selected. Overall, the criteria that are indicated to help with the selection of proper methods are:

- Data quality – appropriate methods should include a selection of standardized, scientifically tested measurement instruments.
- Temporal and spatial adequacy – frequency, temporal and spatial planning of measurements should consider the timeframe and scale in which NbS impacts are expected to happen.
- Economic/resource budgets – to be calculated attentively, e.g., taking into consideration overtime benefits as well.

There might be more than one possible method for the assessment of each indicator, in that case the most suitable will have to be chosen. As mentioned in Section 2.5.1, the

RECONECT Indicator Selection Tool includes examples of methods that are used in the literature for the assessment of the reported indicators.

It's key to balance correctly the influence that methods to measure KPIs and KPIs themselves have on each other, as poor monitoring results in insufficient proof of the impacts of NbS, which in turn leads to difficulty in upscaling the NbS approach. Within RECONECT, it has been brought forward that it is often the case that the available methods influence the choice of KPIs. For example, if it's not possible to use people counters to measure the "Increase in recreational opportunities" sub-goal (e.g., budget exceedance, lack of knowledge on how to operate them), instead of using alternative methods (e.g., surveys or interviews), the sub-goal is excluded from the project's plan. Caution is advised in this kind of approach, as a relevant KPI should not be discarded because the most relevant monitoring method is not immediately available. While it's inevitable that such constraints will emerge and impact the indicators' measurements, it's also important to be aware of these limits and try to counterbalance them.

- **What data needs to be identified and collected to assess the selected indicators?**

Before collecting new data, it's necessary to identify the baseline/reference data that is already available. Baseline values include i) the value of the indicator before the implementation of the NbS; ii) a pre-defined value, e.g., by regulation; iii) the value of the indicator pre- and post-NbS implementation in a control area. In relation to the latter, if it is impossible to find a suitable control area, an alternative approach is to make predictions about what the situation would be like in the project area in absence of the NbS implementation.

If baseline data is not available, it is advised to plan for baseline collection before the start of the implementation of the NbS. Otherwise, there is the risk of limiting the possibility of attributing (positive) impacts to the implementation of the NbS. Moreover, baseline data is needed to make sure that the gathered data is comparable and can be connected to existing datasets. This can also be an encouragement to make monitoring a regular practice maintained over time.

New data can be gathered directly, or collected through public, private or third sector agencies at national and international levels. Moreover, data might be collected several different times before, during and after NbS implementation. This way a higher precision of the assessment can be obtained. To assess the impacts/changes brought by the NbS, and their related uncertainties, the value of the monitored indicators after NbS implementation are compared to the ones in the reference/baseline situation. Finally, the result of this comparison allows to determine NbS performance in meeting the target objectives.

In RECONECT, doing the establishment of monitoring and evaluation plans it was required from all Demonstrators to identify and register the reference events and base lines for all the indicators selected. Figure 3-2 shows examples of the base line identified by the Demonstrator A Elbe Estuary in regards to their chosen Water indicators (from *Deliverable 2.6 – Co-monitoring and co-evaluation plans for Demonstrators A and B)*.

Sub-goal	Impacts	Indicators	Reference Event/ Base line
Flood risk reduction	I: Lowering of the water level	slowing and storing run-off / flood peak reduction	The Water level will determine if the planning (assessed with a Hydrodynamic model) and implementation (measured data) of the hybrid solution is successful. For the base line or reference situation, any recorded flood event before the NBS implementation can be used to compare the situation (intended impact)
	I: Reduction of the inundation time / Flood hazard reduction	Flood hazard	The Water level will determine if the planning (assessed with a Hydrodynamic model) and implementation (measured data) of the hybrid solution is successful. For the base line or reference situation, any recorded flood event before the NBS implementation can be used to compare the situation (intended impact)
	I: Economical savings from operating the pumping stations	Delay time to peak	The storm pumping station Ochsenwerder works when the water level reaches 1,10 m above the sea Level. For the base line or reference situation, any recorded flood event before the NBS implementation can be used to compare the situation (intended impact) In particular the pumping costs per year.
	I: Reduction of the total amount of water	flood peak reduction **pumping stations	For the base line or reference situation, any recorded flood event before the NBS implementation can be used to compare with the situation (intended impact_ which is the reduction of the total amount of water coming into the lower stretch of the Dove-Elbe.

Figure 3-2: Defined reference events/base line data for the indicators for the Water challenge area of the Demonstrator A Elbe Estuary (modified from D2.6)

- **How to develop the local monitoring and data collection plan?**

As a last step, an effective local monitoring and data collection plan is to be put in place. Different sources (CLES, 2010; Compas, 2010; United Nations, 2010) state that a structured sequence of actions is needed to coordinate all of the stakeholders. In the EU Handbook for the evaluation of the impact of NbS (Dumitru & Wendling, 2021), these steps are summarized in two lists of questions: one to structure the monitoring activities and one to structure the data collection and storage plan. These two lists are reported in Table 9 below, together with examples of how they have been answered from the Demonstrator A Seden Strand.

Table 9: Summary of the responses given by the Demonstrator A Seden Strand to the questions for the development of a monitoring plan in relation to the Nature indicator "Increase in biodiversity of flora and fauna".

Questions to structure the monitoring activities	Answers from RECONECT case study Seden Strand
What will be monitored (i.e., expected outcomes and chosen indicators)?	The change of species richness and composition.
Where will the monitoring take place?	The spatial sampling will be Seden Stand, ca. 27 ha.
Who will oversee the monitoring?	Odense Municipality and Amphi International
When will the monitoring take place (e.g., times and frequency of data collection)?	The start of data collection is expected by June – July 2020 in the case of vascular plants, and April 2019 in the case of birds (also possibly earlier data sets from DOF (Danish Ornithological Society) database). The monitoring frequency includes a baseline in 2020 (before the NBS implementation) and in the case of vascular plants, the next field season after NBS implementation, and again after 5 and 10 years from the implementation. In the case of birds, every month during period April- September.
Questions to structure the data collection and storage plan	Answers from RECONECT case study Seden Strand
Which type of data will be collected and what is the target population or type of sample?	The data required in this case is species count data and environmental variables, such as terrain elevation (Danish Hight Model), flooding extent and frequency, soil type, salinity, land use etc. Regarding species count data, the method includes a field survey (direct observation), terrestrial vascular plants (number and cover of species per plot), and birds (number of breeding, foraging and overwintering species per plot).
Who will analyse the data / perform the analyses?	The responsible for data collection on species count data during the project time will be Amphi International. For the environmental variables Eurosense is responsible for the Lidar survey, while the measurements of flooding and salinity are the Odense Municipality's responsibility.

Who will store the data (e.g., in a data platform or database)?	Odense Municipality
How will the data be presented to inform policies, citizens, and decision-making processes?	The data will be shared with stakeholders (both political and not) through presentations.

3.6 Procurement

3.6.1 Contract Procurement Processes

Procuring large-scale NbS in the EU involves adherence to specific procurement procedures that align with EU regulations, ensuring fairness, transparency, and access to a wide range of suppliers. Understanding the types of public tendering procedures, thresholds, rights, and evaluation criteria is crucial for entities engaging in procurement for NbS projects within the EU. The possible public tendering procedures for NbS projects within the EU as presented in EU (2024) are:

- **Open Procedure**: This widely used method allows anyone to submit a full tender, promoting openness and inclusivity.
- **Restricted Procedure**: Participation is open, but only pre-selected entities can submit tenders, ensuring that only qualified candidates progress to the tendering stage.
- **Competitive Negotiated Procedure:** Allows negotiation with pre-selected candidates based on the complexity or specificity of the purchase, particularly in sectors like water, energy, transport, and postal services.
- **Competitive Dialogue:** Enables contracting authorities to propose solutions for defined needs, fostering dialogue with potential bidders.
- **Innovation Partnership:** Applied when procuring goods or services not yet available in the market, allowing multiple companies to participate.
- **Design Contest:** Invites innovative ideas and designs for a specific project.

Contracts exceeding specified thresholds adhere to general EU procurement rules, while lower-value tenders follow national rules but must respect EU principles. Within RECONECT, none of the Demonstrators A had such a high expense that it had to apply for a public EU tender for the implementation works. Therefore, contract procurement primarily involved adherence to national legislation and established guidelines for public procurements. Projects typically use public tender procedures to solicit bids, fostering competition among potential contractors and encouraging innovation. To provide a sense of the extent of different approaches possible, the processes for the contract procurement for the three Demonstrators A, as described in *Deliverable 2.4 - Technical specifications and procurement processes for Demonstrators A and B*, are reported here.

Elbe Estuary, Hamburg
Due to specific conditions in the Demonstrator, no contract procurement had to take place. Following the national/local rules, the contract has been given to the Agency of the State of Hamburg (LSBG), which has a special authorisation to execute implementation projects of the State of Hamburg. This has been communicated and confirmed by the German National Contact Point.

Seden Strand, Odense

The Municipality of Odense complies with the national legislation in relation to tenders and the collection of tenders that are regulated in the Public Procurement Act. Thresholds in Odense Municipality are as follows:

• Over DKK 500,000 (€ 67.000) in 4 years = national offer;
• Over DKK 1,500,000 (€ 201.000) in 4 years = EU offer.

Acquisitions / services that are below the threshold values can be entered into by bidding or direct negotiation. Odense Municipality will still collect min. 2 offers in each case, where possible to secure the most advantageous price and / or best solution for the project. The offers are made based on a description (written or oral) prepared by the Municipality of Odense.

Park of Portofino

The procurement contract for the design was led by the Portofino Park Authority that is both responsible for the area and the institutional beneficiary of the interventions. Since the Park is a public entity, it must follow national legislation about public procurements as well as respect the general EU criteria of transparency and equal treatment.

Considering that the estimated amount for the NbS design was lower than the threshold of 30.000 €, the national legislation allowed to directly assign the contract for the NbS design to a group of professionals exclusively based on their previous experience in the area and demonstrated skills. Thus, the Park Authority decided to give the design for the two areas of San Fruttuoso and Paraggi to two distinct professional groups that already successfully realized similar designs in the Park’s territory with other EU funded projects.

3.6.2 Criteria for Evaluation of Contracts

In RECONECT projects, contract evaluation typically involves assessing tenders based on a combination of quantitative and qualitative criteria. While tenders are usually evaluated primarily based on the lowest bid that complies with tender documents, higher-value contracts may consider both qualitative and economic factors to select tenders offering the best quality/cost ratio. Variation exists, with some cases including individual criteria for selection, such as price versus cooperation. Contracts managed by organizations may uphold standards and guidelines developed to ensure a comparable and high-quality procedure for planning and contracting. Once again, the example of the three Demonstrators A is presented.

Elbe Estuary, Hamburg

As mentioned in the above section, no contract procurement took place and the contract followed national/local rules. There is no information available on measures to ensure the quality performance of the contract works.

Seden Strand, Odense

The prequalified adequate contractors and the tenderer had to compile the Tender Schedules. Odense Municipality evaluated the tenders and the contractor offering the lowest bid and complying with the conditions in tender documents was chosen for the signing of the contract.

Park of Portofino

The economic offer and the quality of the proposed design was evaluated according to the Park Authority’s criteria, following a best value for money ratio.

3.6.3 Measures to Ensure the Quality Performance of Contract Works

In RECONECT projects, ensuring quality performance of contract works involves adherence to detailed designs and technical specifications. Contractors are required to execute works precisely as outlined, often using advanced technologies like 3D-digital drawings. Additionally, project consultants provide supervision during execution and commissioning, with the thorough examination conducted by relevant authorities and chosen contractors upon completion ensuring compliance with defined criteria. Adherence to detailed technical guidelines and legal standards ensures quality, with measures like conducting final audits to verify proper execution and construction accounting. Quality management systems may also include assessments of invoice control, environmental impacts, work environment requests, and the availability of necessary skills. Here are the descriptions of the quality assessment in the Demonstrators A, as reported by the Demonstrators themselves.

Elbe Estuary, Hamburg
There is no information available on measures to ensure the quality performance of the contract works.

Seden Strand, Odense
The works had to be carried out by the contractor in accordance with the drawings from the detailed design and the requirements in the Technical Specifications provided. Drawings of dikes and new streams had been done as 3D-digital drawings, which could then be used by the contractor to navigate GPS-controlled machines. This way, the earthworks were carried out exactly as designed. At the end of each assignment the complete work was also examined by the partnership of RECONECT partners collaborating in the Seden Strand case, namely Odense Municipality, Ramboll and Amphi, together with the chosen contractor.

Park of Portofino
The performance of the contract works has been conducted under the strict control of the technical office of the Park Authority, and according to the defined criteria.

4 Implementation

As mentioned in the Introduction of this report, literature covering the implementation phase of the NbS project life-cycle is lacking. The following section was compiled using available reports considering implementation, namely: ACT, 2018; CLC, 2022; PUB, 2018; NAIAD, 2020; WGB, 2017; ADB, n.d. It has to be noted that the available literature is for the most part focusing on urban/small-scale NbS, which might influence the type of best practices reported here. An attempt to include implementation experiences from large-scale initiatives is done by integrating examples from RECONECT.

4.1 Objectives and goals of Implementation phase

The implementation phase commences upon contract award and concludes upon project completion. Prior to commencing the implementation phase, all necessary permits must be obtained, except phased construction.

Implementation consists of two separate sub-phases: Construction and Operation & Maintenance (O&M). The primary goal for construction is to create a physical asset according to specified designs and plans, whereas O&M aims to ensure the efficient functioning and upkeep of existing infrastructure. The focus is on maintenance, repairs, and optimization rather than new construction. Hence Construction has a set start and end date, whereas O&M is an ongoing cyclic process throughout the life of the facility.

The regulatory aspect of construction leans towards building codes and regulations, whereas O&M focuses more on regulations for health, environmental standards and other operational requirements. All local engagement must be considered during the construction phase to inform the citizens about changes in traffic and other similar activities that may concern or disturb the current living situation.

All the steps of this phase are presented in the following sections. Moreover, the main actors involved in NbS implementation are defined in Table 10, together with examples from the RECONECT Demo A Seden Strand (from *Deliverable 2.3 – Scope of Works for Demonstrators A and B)*.

Table 10: Overview and definitions of the central actors in the phase of NbS implementation

Title	Description	Example from the Demonstrator A Seden Strand
Owner	The entity that holds the asset.	Odense Municipality.
Operator	The entity tasked with day-to-day management of the NbS implementation. In some scenarios, the owners might undertake the operational duties themselves.	Odense Municipality, responsible for permissions, developing of demonstration project, construction and maintenance (also including financing).
Designer	The entity tasked with the design of the implementation/construction plan. Also in this case, in	A partnership between Odense Municipality and the RECONECT Partners Amphi International and Ramboll. The

	some scenarios, the owner entity might overlap with the designer.	latter two have been responsible for developing: • Preliminary project with description of first design and baseline for the first landowner negotiations • Support at landowner negotiations • Development of nature plugins in the dike • Design of habitat improvements on the coastal foreland • Description of detailed project • Creation of necessary documents for the procurement of the construction works including support with the procurement process • Support at supervision of the construction works.
Contractor/Constructor	The entity responsible for the actual building of the infrastructure.	HedeDanmark A/S

4.2 Pre-construction

4.2.1 Quality Plan and Site Investigation

Upon Contract award, the Contractor is mandated to promptly furnish a preliminary Project Quality Plan (PQP). This plan shall encompass the following:

- Summary of Contract Requirements: Comprehensive elucidation of all proposed quality activities.
- Quality Assurance and Control Procedures: Explicit listing of procedures earmarked for execution by the Contractor throughout project implementation.
- Codes of Practice, Standards, and Specifications: Inclusion of all pertinent regulations and benchmarks intended for adherence.
- Proposals for Audits: Provision of strategies concerning internal, external, and subcontractor quality assurance audits.
- Statement of Quality Records: Specification of the quality records to be maintained, their preparation timelines, and subsequent storage modalities.
- Inspection and Testing Plans: Detailed plans delineating the inspection levels and responsible parties for individual activity.
- Standard Implementation Forms: Establishment of standardized forms for PQP execution.
- Testing and measuring instruments calibration results: All testing and measuring instruments shall be tested or calibrated at regular stated periods by approved authorities with traceability to a National Standard.

The Project Quality Plan must be regularly reviewed and enhanced, at least annually, to incorporate any changes to the Contractor's procedures, subject to Designer's/Owner's approval.

Before the onset of any physical construction activities, the Contractor must conduct a comprehensive site investigation as per the stipulated scope in the tender contract. Any site-related concerns or discrepancies must be expeditiously addressed and resolved in collaboration with the Designer/Owner.

Prior to on-site inspection, the Designer/Owner is obligated to furnish all relevant data within their possession concerning surface, sub-surface, hydrological, and ecological conditions at the Site (see Section 2.3). Additionally, any pertinent data acquired by the Employer post-Tender Completion shall be promptly disclosed to the Contractor.

The Constructor shall follow the tender drawing provided by the Designer/Owner to develop a construction drawing to be approved by the Designer/Owner. The site inspection checklist shall be developed based on the approved construction drawings.

At the core of site investigation are targeted examinations based on nature of the project, it should at least include soil testing, the detection of underground services and identification of existing structure or natural features.

Soil testing, comprising visual inspection and laboratory analysis, is imperative to unveil soil properties and ascertain the availability and quality of local construction materials. The Contractor is obliged to align the scope of site investigation with the design criteria of the proposed NbS features, in close coordination with the Designer.

Precise determination of the location of all underground utilities and potential obstructions is important to facilitate smooth implementation of planting and landscaping works.

All existing structures, installations, and natural features pertinent to the Works shall be surveyed to establish their precise position, size and form. Any disparities observed must be promptly communicated and rectified.

The delineation of the construction boundary serves to confine all construction activities, personnel, equipment, and materials to the designated area. In instances where the construction boundary lacks existing access roads, the Contractor is tasked with providing suitable access, subject to regulatory approval.

A comprehensive site investigation report must be submitted to the Designer or Owner for acceptance, encapsulating all findings and pertinent details unearthed during the site investigation phase.

4.2.2 Resource management and testing

The Contractor is obliged to provide samples of materials to the Designer for approval before their utilization in the works. These samples encompass manufacturer's standard samples and contract-specified samples all incurred at the Contractor's expense, while any additional samples as directed by the Designer as a Variation.

Material samples shall undergo testing at an accredited laboratory, with all test results promptly submitted to the Designer/Owner for approval. Testing criteria shall, at minimum, encompass:

- Particle size distribution
- Soil composition
- Hydraulic conductivity

- Physicochemical suite
- Nutrients suite
- Heavy metal suite

Testing of soil samples shall further entail:

- pH factor analysis
- Mechanical analysis
- Percentage of organic content determination
- Recommendations on requisite additives for achieving satisfactory pH levels and nutrient supply, tailored to each soil layer.

The Contractor is mandated to maintain meticulous records of on-site personnel and equipment, providing detailed accounts of both the quantity and classification of Contractor's Personnel and Equipment. These records must be submitted monthly in a format endorsed by the Designer until the completion of all works and subsequent ratification. Additionally, the Contractor must meticulously plan storage spaces to mitigate environmental impact and uphold material quality, strictly adhering to prescribed standards. Any detected deficiencies or deviations from the contract in material or workmanship empower the Designer/Owner to reject said materials, with clear reasons provided to the Contractor.

The Contractor shall build mock-up as indicated in the Specification from the Designer to construction sequence, material selection and landscape integration. The quality of workmanship, methodologies, and materials utilized in the final features must mirror those endorsed in the approved mock-ups, ensuring consistency and adherence to standards.

Upon rejection, the Contractor is obligated to promptly rectify any identified defects, retest the material, and ensure its compliance with the Contract. This ensures that the construction process maintains high standards and meets all specified requirements without compromise.

4.2.3 Construction Plan

The Contractor is mandated to undertake all reasonable measures to safeguard the environment within and around the construction perimeter, mitigating pollution, noise, and other detrimental impacts arising from construction activities (Figure 4-1).

Emissions, surface discharges and effluent from Contractor operations must adhere strictly to specified values outlined in the Specification or as stipulated by relevant laws.

A comprehensive Construction Management Plan (CMP) is to be submitted by the Contractor, incorporating essential elements such as:

- Work breakdown structure
- Project schedules
- Communication plan
- Risk management plan
- Phase and budget delineation
- Quality control measures
- Safety management plan
- Job site monitoring protocols

The CMP, accompanied by a detailed Construction Environmental Management Plan (CEMP), shall be presented to the Designer/Owner for approval prior to construction commencement (Figure 4-1).

In cases where tree removal, transplantation, or protection is needed during the Construction Period, the Contractor shall execute these tasks in strict accordance with local specifications or guidelines. A comprehensive tree plan, indicating the trees earmarked for removal, retention, or transplantation, as well as salvageable logs, shall be submitted to the Designer/Owner for acceptance before commencement of said activities.

The Contractor is required to submit an installation plan to the Designer/Owner no less than 14 days before scheduled installation. This plan must offer a detailed description of methods, activities, materials, and scheduling strategies aimed at achieving the installation of plants and structures as per project requirements.

The Constructor shall develop a comprehensive safety plan based on the tender documents and the approved construction drawings. The safety plan shall define the safety protocols, emergency procedures and guidelines for the proper use of safety equipment. The Constructor shall include schedules for regular safety briefings and training sessions.

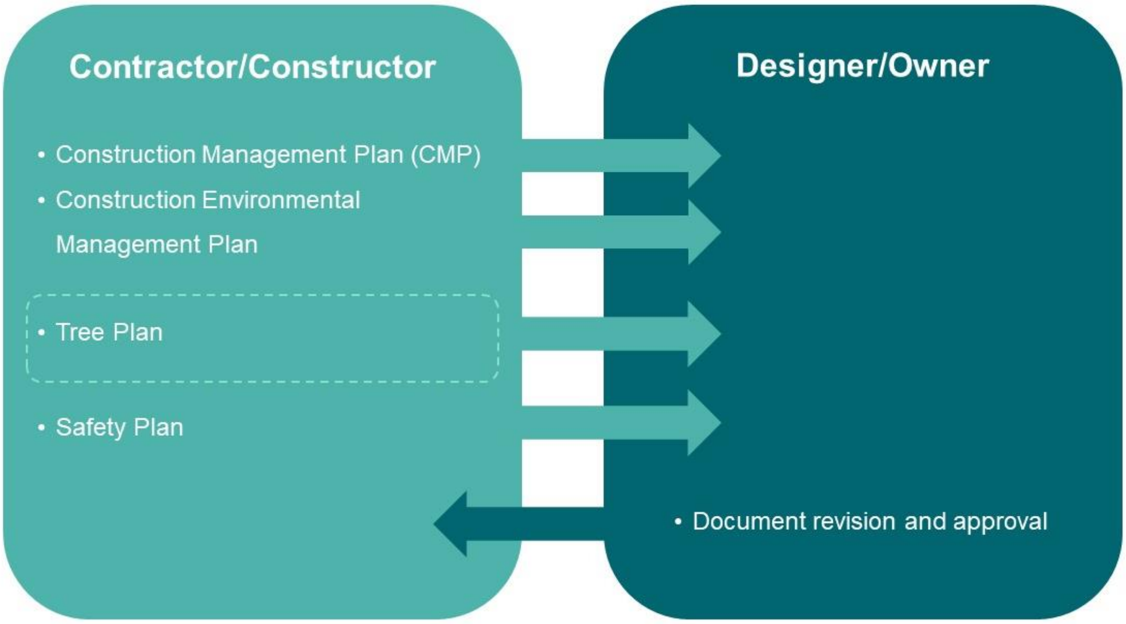


Figure 4-1: Summary of the documents to be submitted by the Contractor to the Owner/Designer during the Construction Plan phase

4.3 Construction

The Contractor shall ensure proper set-out of the work, subject to approval by the Designer/Owner before commencement. It is essential for Contractor to adhere to the CMP, CEMP and installation plan, with any deviations promptly communicated to and approved by the Designer/Owner prior to implementation.

Before starting any on-site installation, erosion control measures must be established. Erosion refers to the process of soil or rock particles being displaced from a particular location by elements such as wind and water. Erosion can have an impact on private and public property and wildlife, as excessive chemicals, construction material along with other pollutants might end up being carried into waterways. The Contractor is responsible for implementing suitable measures to block stormwater inflows and any runoff from accessing the NbS features during construction and testing. Additionally, the Contractor must ensure that all materials remain undamaged throughout the loading, transportation, and unloading processes at the site. Any damages to the work incurred during NbS feature installation by others must be rectified promptly by the Contractor.

Special attention must be paid to minimizing compaction of filter media by delineating access routes and constraining the allowable work area. This is important as filter media compaction has a negative impact on water infiltration, removal of pollutants by biochemical processes, and the provision of other ecosystem services in agricultural and forest ecosystems, but also in human-made structures e.g., stormwater control measures (Das et al., 2023). The Contractor bears the responsibility for verifying all field measurements and promptly submitting drawings to prevent work delays. Submission of As-Built and As-Planted Drawings to the Designer/Owner within three months of project completion is mandatory to ensure comprehensive documentation of the completed works.

All materials supplied and installed shall be in accordance with this Specification. The Contractor shall warrant the NbS features system against defects, faulty materials and workmanship for agreed period of time.

As an example of the construction works done in RECONECT, the works carried out in the Demonstrator A Seden Strand (from *Deliverable 2.4 – Technical specifications and procurement processes for Demonstrators A and B*) are shown in Figure 4-2, Figure 4-3 and listed here:

- Clearing of trees and bushes to improve the habitats for waders.
- Removal of 825 m of old summer dikes.
- Construction of 1,500 m of new dikes with 3 ramps to allow for farm machine crossing.
- Establishing of nature plug-ins in the new dikes.
- Excavation of 930 m of a new watercourse and terrain modelling to improve water movement and storage, and allowing the development of new habitats within the project area.
- Construction of a new sluice lock in the dike.
- 16 m Ø 600 mm pipe with backflow blocker in the dike for the local stream.
- Establishing of nature trails to improve the dissemination to the public of the NbS and climate changes effect on the area.
- Establishing of grazing facilities to improve and secure the existence of habitats within the project area.

Figure 4-2: Visualization of the works done in the Seden Strand project (from Odense Municipality), including the placement of the relocated dike, the new meanders of the restored stream, the locations of new ponds and nature plug-ins.

Figure 4-3: Pictures of the specific NbS works. Clockwise from the top left: removal of trees; creation of the new dikes; nature plug ins (the rocky pits in the dike, providing habitats for amphibians); creation of the new watercourse.

4.4 Commissioning

Upon completion of each work phase, the Contractor must request the Designer, where applicable, to witness the commissioning of the related installation. Prior to the physical handover inspection and Test on Completion, a concise briefing on system setup, layout, operation and control is required from the Contractor.

The Contractor should provide the Designer with a notice (minimum of days depends on location) before the Test on Completion is carried out. Tests shall encompass, but are not limited to, ponding tests, leakage tests, hydraulic conductivity tests, and water quality tests where applicable.

In the event of any defects or failures during the Test on Completion, the Contractor is responsible for promptly rectifying all identified issues within the specified timeframe. Subsequent testing and reporting will be necessary for any remedial work undertaken. Once the works have successfully passed all tests, the Contractor is obligated to submit a certified report of the results, along with as-built drawings and operating manuals to the Designer.

The Contractor shall prepare a comprehensive checklist for acceptance by the Designer to facilitate any handover inspection. All inspection checklists shall be signed off by the Designer during the handover. Thorough training for system shall also be provided to the Operator during installation handover. Performance Certification and Taking-over

Certification will be issued by the Designer to the Contractor upon completion and testing of all work, including rectification of any defects. Taking-over Certification can be sought for each section if works are divided as such.

Upon receipt of the Performance Certificate and Taking-over Certification, the Contractor must promptly remove any remaining equipment, surplus materials, wreckage, rubbish and temporary works from the site. Works shall be formally taken over by the Owner/Operator following successful completion of tests and submission of inspection checklists.

4.5 Operation and Maintenance (O&M)

The Designer is responsible for providing the Operator with maintenance checklists for different NbS features during the handover process. These checklists will outline the necessary tasks to ensure the proper functioning of the NbS features. The Operator shall record the outcomes from inspections and operation activities, keeping detail records in an appropriate operation and maintenance file for future reference. Ideally, maintenance responsibilities should be shared between the landowner and the local drainage authority to ensure the effective upkeep of NbS features.

A comprehensive maintenance strategy incorporating both proactive and reactive approaches is essential to uphold the performance of the NbS features.

Proactive maintenance encompasses regular inspections and operational actions aimed at preventing issues before they arise. Here are some examples of the actions included in proactive maintenance (specifically those related to NbS for the counteraction of hydro-meteorological risks):

- Inspect the operation of the NbS features
- Maintain a consistent flow for constructed wetlands
- Check for evidence of preferential flow paths
- Conduct regular clean-up and remove any litter/materials covered up on the feature surface or manholes grating
- Check for sediment accumulation on feature surface, inlet, outlet and overflow manholes and clean up the deposits if any
- Check for biofilms
- Monitor water ponding after rainfall events and remove any potential mosquito habitats
- Check for erosion/scouring
- No damage by animals and insects

Reactive maintenance involves addressing issues as they arise to prevent further deterioration or malfunction:

- Raking or replacing materials for those clogged filter media
- Replacing filter media/soil and replant for those eroded surfaces or depression
- Flush the subsoil drainage system if subsoil drainage is blocked
- Clean up any blockage in the inlet and outlet

As an example, the following inspection frequencies (Table 11) are recommended for different NbS features:

Table 11: Suggested inspection frequencies for various NbS features (from (ACT, 2018).

NbS Features *	Porous pavements and infiltration system	Gross pollutant traps	Swales and buffers	Bioretention swales and basins	Wetlands	Ponds	Sediment basins
Inspection Frequency	3 months	Varies	4 months	3 months	3 months	3 months	3 months

*The listed features refer to small-scale NbS. This is mostly due to the limited literature on the implementation of large-scale NbS. Nevertheless, these features are often integrated in larger scale projects.

For the Demonstrator A Seden Strand, the operation and maintenance activities were organized as follows (as specified in *Deliverable 2.4 – Technical specifications and procurement processes for Demonstrators A and B)*:

- The main operation and maintenance activities on the new dikes will be performed by landowners who are directly benefitting from the NbS (i.e., are protected from flooding). This is except for the first three years after construction where the new dikes will be maintained by Odense Municipality. This is mainly proactive maintenance.
- As for the conservation and securing of the new habitats (also mainly proactive maintenance), the Municipality is the responsible authority, in close collaboration with the landowners. However, the coastal meadows are expected to develop according to the dynamic influence from the normal tide and storm tide. Therefore, in an ideal development scenario, no further man-made works shall be done, except cleaning up the streams in the meadows, if the grazing should not be enough to maintain the actual flow from the hinterland (the only case of possible reactive maintenance). The raise of sea level in Odense Fjord will make the meadows wetter. Deposit of sediments and seaweed will slowly increase the level of the lower meadows. The meadows near Seden Strandby are dry with the actual sea level, so coastal meadows are expected to remain in the project area, also with higher sea level.

5 Monitoring, Evaluation and Learning

The literature review has identified a significant gap in existing literature concerning the Monitoring, Evaluation, and Learning (MEL) phase. Many deliverables and activities within RECONECT are geared towards covering monitoring, evaluation, and learning to support the development of NbS, as well as normalizing and upscaling large-scale NbS (cf. Guiding principles). The subsequent sections delineate standards for monitoring, evaluation, and learning, drawing input mostly from Demonstrators B within RECONECT and supplemented by the available literature to establish best practices for this phase.

Effective monitoring and evaluation plans are crucial for the success of NbS (Ershad et al., 2019). Therefore, there's a need for monitoring programs and evaluation frameworks that clearly outline the impacts of NbS, including co-benefits and dis-services. These monitoring frameworks should be robust and flexible, as the effectiveness of NbS may vary between immediate effects influenced by design and implementation and long-term effects dependent on additional factors (Dumitru et al., 2020).

The utilization of monitoring programs and robust reporting systems not only strengthens the proof of concept but also plays a significant role in creating incentives for stakeholders to adopt NbS more widely, as these increasingly seek evidence to gauge the effectiveness of NbS interventions (Dumitru et al., 2020). The main steps and considerations for the creation of a monitoring and evaluation program have been explored in Section 3.5, therefore we focus here on the key challenges and how to overcome them during the implementation of the plan, taking inspiration from the RECONECT experience.

5.1 Troubleshooting: common issues in Monitoring and Evaluation

In this section are gathered common constraints to a successful monitoring and evaluation campaign of NbS benefits, as well as possible solutions to them.

Challenge 1: Uncertainty about values and benefits an NbS can bring, as well as constraints related to financial and temporal aspects of monitoring. This often leads to underprioritization of the assessment of environmental and social benefits (or co-benefits).

This could be due of various reasons, including dispersed and siloed data, missing knowledge on specific monitoring and evaluation processes, and the complexity of quantifying intangible and long-term benefits. However, it's important to remember that downplaying the impacts of NbS co-benefits can overall decrease the perceived benefits of the NbS implementation, and consequently negatively influence the chances for uptake of these approaches.

RECONECT approach: Focusing on the structured assessment of a smaller set of quantitative indicators across challenge areas

As reported in Section 3.5, the RECONECT Demonstrators A and B produced a list of focus sub-goals to be prioritized in their monitoring plans for the assessment of NbS benefits across the Water, Nature and People challenge areas (see Table 12 and *Deliverable 2.6 - Co-monitoring and co-evaluation plans for Demonstrators A and B*).

Based on the results of a workshop conducted by Ramboll with some of the RECONECT partners during the 10th GA in Odense in September 2023, the "intensity" of monitoring (i.e., the combined effect of manpower, knowledge, equipment, and time needed for the monitoring) of the focus sub-goals and respective indicators is reported here (Table 12, Table 13Table 13, Table 14). The scale is arbitrary (+ is the least intense, +++ is the most intense), but it's reported to give an idea of the participants' perceptions and in most cases experience of the monitoring process. This knowledge might be useful for future projects, for example to compare the project's resources to the chosen indicators' monitoring needs.

Table 12: Prioritized indicators for the Nature challenge area

Goals	Sub-Goals	Recommended indicators	Monitoring "intensity"*
Habitat structure	Increase habitat area (quantity)	Changes in habitat area	+
	Habitat provision and distribution (quality)	Change in location of habitat boundaries	++
	To reflect ecological status and physical structure of habitats	Improve structure of the riparian area	n/a
Land cover area	Shift in land use and land cover	Change in land cover	+
		Change in land use	+
Biodiversity	To maintain and enhance biodiversity	Species richness and composition	+++
		Number and type of protected species	+++
		Density of native species	n/a

Table 13: Prioritized indicators for the People challenge area

Goals	Sub-Goals	Recommended indicators	Monitoring "intensity"*
Socioeconomics	Increase recreational opportunities	Increase recreational opportunities of NBS area	++
		Enhancing attractiveness of places for living and working, and to visit	++
	Stimulate/increase economic benefits	Reduced/avoided damage costs	+++
		Change in land or property values	n/a

Table 14: Prioritized indicators for the Water challenge area

Goals	Sub-Goals	Recommended indicators	Monitoring "intensity"*
Water quantity	Flood, coastal, and landslide risk reduction	Flood hazard reduction (coastal and riverine)	++
		Landslide hazard reduction	++
		Reduction in economic vulnerability	+

*Defined as the qualitative assessment of the combined effect of manpower, knowledge, equipment, and time needed for the monitoring.

Challenge 2: Unclear scale and timeframe of monitoring.

A good planning of monitoring activities (addressed in Section 3.5) can partly solve this issue, but the long-term impacts of NbS (often linked to environmental benefits, such as habitat restoration) can still be difficult to frame (Raymond, et al., 2017).

RECONECT approach: Adjusting based on feedback from monitoring

A meaningful monitoring campaign allows to ensure that the NbS project is on track to achieve its desired outcomes. This is especially relevant for environmental benefits, as ecosystems are inherently unpredictable (Fish, 2011), being influenced by various factors as "open air systems". Consequently, establishing simple rules for their evolution is challenging. Therefore, monitoring programs necessitate periodic evaluation to enhance ecosystem tracking and facilitate data comparison and exchange among fieldworks, both annually and over the long term (Kumar, et al., 2021).

If the NbS intervention appears to be working, possible adjustments to the plan include re-assessments of the exit strategy to make sure that the NbS is sustainable after the project ends. For example, a plan can be developed to establish further monitoring and maintenance activities, together with their budget needs and who will be responsible for them.

If, on the other hand, the intervention is not keeping up with the expected results, it will be necessary to identify what needs to be changed and if such changes will deliver the required results. If that's not deemed likely, a whole new strategy may need to be considered (Donatti, et al., 2021).

A meaningful example in RECONECT of the importance of monitoring and adjusting according to its (unexpected) outcomes can be drawn from the experience of the Demonstrator B in Greater Aarhus. Through the periodic monitoring of water quality, it was discovered that the retention period in Lake Egå (*Figure 5-1*) was longer than expected, leading to higher temperatures and lower oxygen content in the water. These conditions can be harmful for the aquatic fauna of the lake, specifically for those fishes undergoing smoltification (i.e., a series of physiological changes where young salmonid fish adapt from living in fresh water to living in seawater). In order to counteract this situation, updates to the solutions in place to manage the water discharge are in the works.

Figure 5-1: Lake Egå surrounded by grazed meadows. The purpose of establishing this wetland was to reduce the nitrogen supply to Aarhus Bay (in the background), to improve the natural conditions in and around the area, and to reduce the flood risk from the river Egå (from Deliverable 2.3 - Scope of Works for Demonstrators A and B).

Challenge 3: Political interferences and/or lack of political will, often leading to gaps in financing for the monitoring and evaluation processes

RECONECT approach: Planning for clear communication and division of responsibilities

Early and clear communication with political and decision-making actors is paramount. Strategic KPIs (especially if directly contributing/linked to existing or upcoming regulations) increase the support for NbS implementation. The levels of uncertainty associated with evaluation outcomes can however constitute a significant barrier for obtaining political support. In RECONECT, all the case studies strived for a clear division of responsibilities for the monitoring tasks (including public stakeholders) in order to avoid this specific barrier (see Section 3.5).

Challenge 4: Missing knowledge on how to assess NbS

RECONECT approach: Fostering knowledge sharing through twinning activities

In some indicators' cases, monitoring and evaluating require very specific knowledge that the design team may not possess. In this case reaching out, using clear communication, and establishing a concrete network of knowledge sharing are key actions to take. Often there is also the need to communicate outside of scientific spheres. This broad transdisciplinarity may be very useful, but at the same time could uncover conflicts between different disciplines. In this instance it can help to have aligned expectations beforehand, with a special focus on the different stakeholders' "sphere of influence". RECONECT's Twinning activities (e.g., Twinning Roadtrips in connection to GA meetings, bi-lateral meetings and in-person visits to the various Demonstrators) were used to foster and maximize knowledge sharing among partners.

Challenge 5: Involvement of stakeholders and stakeholder fatigue

RECONECT approach: Developing structured methods for stakeholder engagement

Co-monitoring and involvement of stakeholders is fundamental for the proper assessment of NbS benefits, especially for the social and environmental ones, as many monitoring methodologies for the quantification of these impacts rest upon active feedback from the population/users/ stakeholders (e.g., willingness-to-pay surveys to establish the monetary value of ecosystem services or increased recreational opportunities). More details about these methods are listed in Section 5.2.

Aside from collecting data for assessments, this inclusion can be useful for the convincing of stakeholders that might not be confident about the effectiveness of NbS. Because of that, particularly important is the communication of the social and environmental benefits to different levels of decision-makers and citizens. However, it's important to keep in mind that many monitoring activities can rely heavily on the stakeholders. For example, recurring monitoring of the population (e.g., through surveys or workshops) or continuous input required from the project owners, which might lead to stakeholder fatigue. A clear, co-designed monitoring plan with shared responsibilities can help manage and avoid such situations. Creating trust and including stakeholders' inputs are imperative steps to ensure a solid collaboration.

5.2 Engagement: co-monitoring and co-evaluation

Co-monitoring and co-evaluation processes are carried out by aiming to answer together with stakeholders to the questions: *How effective are co-implemented NbS in achieving desired benefits and co-benefits? What works, what does not work and why?*

As seen in Chapter 3, it is fundamental to have established a clear monitoring plan, to determine aims and objectives, relevant indicators, target values, program duration, and roles and responsibilities of the stakeholders. All these components are needed to assess the NbS and have a baseline to which progress can be valued iteratively.

With these components settled, during the MEL phases the involvement of stakeholders can mainly contribute to i) data collection (explored more into detail in the following sub-section), and ii) comparing the implemented NbS to other types of measures, to get a general sense of the benefits (and disbenefits) of the selected NbS perceived by the stakeholders.

Involvement of stakeholders in data collection for MEL

Stakeholder engagement can be used to support data collection on hazards, exposures, vulnerabilities, impact evaluation of the implemented NbS. It can mainly contribute to two types of evaluations:

1) (Economic) quantification of NbS benefits - the active participation of stakeholders in NbS assessment is particularly relevant for the quantification of intangible NbS benefits, such as for example benefits for psychological well-being or the economic valuation of the implemented NbS. Specifically for the latter, methodologies for the monetary quantification of NbS benefits (e.g., revealed or stated preference methods) heavily rely on the integration of local knowledge of the context in which the project is implemented. Stakeholders can be co-creators of the assessment method (i.e., most often a survey), but also its targets. In RECONECT, many of the Demonstrators collaborated with the partner DTU (Technical University of Denmark) for the co-creation of a willingness-to-pay survey to monitor and assess

the non-market benefits (mostly People and Nature benefits) of their NbS. The survey was then shared with the general population in the NbS area.

2) Validate and adapt expert estimates and models of risk - stakeholders' inputs can be used both to validate and adapt expert estimates and models of hydro-meteorological risk, and to gather valuable insights on NbS impact assessment.

Nevertheless, the abovementioned co-creation of assessment methods for the quantification of NbS benefits is not the only available engagement opportunity in the MEL phase. Examples of other co-creation tools that can be used to maximize stakeholder engagement for the two purposes above are citizen science tools, such as geo-questionnaire surveys (i.e., a tool that allows to simultaneously collect qualitative, quantitative and spatial data through the use of an interactive map usually accessible online). However, these latter approaches have not been used in RECONECT.

5.3 Evaluate NBS

The data and findings from the monitoring program can be useful to evaluate how successful the NbS is in achieving its goals, objectives, and KPIs. The findings can help to adjust the NbS to improve its performance and increase the value it is providing. Specifically, the main aim of the impact evaluation is to answer a particular cause-and-effect question: *What is the impact (or causal effect) of an NbS intervention on an outcome of interest?* (Dumitru & Wendling, 2021).

Different approaches to answering this question exist (GIZ et al., 2020; Dickson, et al., 2017):

Matching assessment – Evaluation based on the comparison of the NbS to a control site or more control sites where no measures have been implemented. The control site needs to be selected to be as similar as possible to the NbS site. If done properly, this approach can eliminate many potential biases, and it is generally considered the most rigorous. However, it often has higher costs and requires more resources, e.g., for choosing and monitoring matching parameters, acquiring data from outside the project area, etc.

Before-after assessment – Measuring the situation before the NbS implementation and then again afterwards. This approach works best to evaluate short-term impacts, or results that are part of a simple casual chain. However, it can only imply that a change happened, and it is susceptible to biases if the contextual factors are not properly identified. This is the approach used for most of the RECONECT Demonstrators.

Theory-based assessment – Checking the results to support the project's Theory of Change. It requires less resources and it's based on a previously produced Theory of Change. But it can lead to biases if the Theory of Change of the project is not well developed or well understood. Moreover, it can potentially lead to focus more on expected impacts and overlook the negative ones.

Participatory impact assessment – Asking beneficiaries or in general relevant stakeholders' questions about what changes have occurred. This approach is relatively cheap, and it allows to understand how the project has really affected stakeholders. Nevertheless, the impacts cannot be measured in absolute terms, and participants' perceptions and/or memories can change over time.

Interviewing key informants – Asking specific key individuals if they observed any changes, what they believe is the reason for these changes and how they happened. This method can be useful for verifying results collected through other approaches, and it doesn't require specific tools or baseline studies. However, the usefulness of its results rests on the familiarity of the informants with the project and the accuracy of their perceptions. In the case of the Demonstrator B Inn River, where the NbS was established in the 1950's, interviews with key informants were fundamental to obtain the necessary baseline information for a before-after assessment, as well as recording data on observed changes in the area.

To make sure that the evaluation results are valid, the literature proposes a set of considerations on the data that need to be considered when planning the assessment (GIZ, 2020).

- *Which data types are collected and analysed* – Data type does not only refer to the distinction between quantitative and qualitative data but also the types of information (e.g., scientific, technical, non-technical, indigenous knowledge). Because of the nature of NbS, where results are influenced by social and ecological factors, a mixed methods analysis, combining quantitative and qualitative data types and different data sources is considered the best approach (Dickson et al., 2017).
- *Which sampling strategy is being used* – the sampling strategy is the process of selecting units from a population of interest, which will be studied in greater detail. It's important because it's not possible to collect data from an entire population affected. The characteristics of the sample need to be the same as the affected population targeted by the NbS intervention.
- *How the project is controlling for bias* – biases are errors that occur during data collection, analysis or interpretation that reduce the reliability of the evaluation results. When gathering information from people possible sources of bias include: the greater availability of some stakeholders compared to others; (mis)leading questions; participants' memories changing over time; unwillingness to share some information. For ecological data, potential biases are the varying difficulty of surveying different habitats; observers putting differing amounts of efforts into data collection; local conditions (e.g., season, weather, etc.).
- *How the project is accounting for ethical considerations* – ethical considerations include getting the participants' free, prior, and informed consent for interviews and general participation; ensuring confidentiality, anonymity, and safe storage of data; considering the time participants are using for the project; the possibility of revealing sensible information (both for people but also for plant and animal species, e.g., by sharing locations of threatened species). If these ethical factors are not considered, the validity of the evaluation results and the reaching of the targets of the projects risk being negatively affected.

Within RECONECT, to evaluate the performance of the NbS, the results of the monitoring of the selected indicators are compared to their respective baseline/reference situations, accounting for the correlated uncertainties. For the most part, the reference conditions refer to the status (monitored or inferred from pre-existing data) of the projects' areas before the implementation of the NbS. This evaluation procedure allows for the assessment of the impact or change originating from the implementation of the NbS, which can be interpreted to determine NbS effectiveness in meeting the prefixed goals (more details in *Deliverable 2.6 - Co-monitoring and co-evaluation plans for Demonstrators A and B*, and sections 3.5 and 3.6 of this report). Here are some examples of the criteria used for the evaluation of indicators across challenge areas from the Demonstrator B Greater Aarhus (Table 15).

Table 15: Examples of criteria for the evaluation of monitoring outcomes from the Demonstrator B Greater Aarhus

Water indicator "Temperature and dissolved oxygen concentration"
Baseline: data from a control station in river inlet to Lake Egå and a control station in a relevant area in Lystrup.
Success criteria: the results will be compared with standard values for good ecological status in streams; the consequences of dilution with other recipient water will be evaluated.
Nature indicator "Species richness and composition"
Baseline: species richness and composition before creation of the NbS as well as to in similar reference sites.
Success criteria: if the existing and collected monitoring data the evaluation will answer the following questions: How has biodiversity of the area changed over time? How valuable is the created NBS in terms of biodiversity?
People indicator "Number of people that visit or spend time in the NBS area"
Baseline: estimates of visits from years prior to the NBS implementation.
Success criteria: if the number of visitors, together with the forms of recreation in the area have increased.

To a smaller extent, other approaches were also used to assess monitoring outcomes within RECONECT. For example, the interview methodology was used in Demonstrator A sites to assess key stakeholders' opinions about the potential and the impact of the NbS implemented.

Finally, the evaluation process in RECONECT had some additional specific characteristics, which are listed here:

- All three challenge areas (WATER, NATURE, and PEOPLE) needed to be assessed, to properly account for the holistic nature of the NbS intervention. The key evaluation indicators were chosen at the beginning of the monitoring process based on the most relevant ones for the case studies (see Table 12, Table 13,Table 14 in the previous section).
- Twinning between similar case studies was used to enhance the knowledge exchange regarding baseline data identification and registration and monitoring techniques.
- As the projects progressed, the initial co-monitoring activities were updated on issues of relevance for each site. Specifically, the updates revolved mostly around adjustments to the monitoring and evaluation plans due to the actual availability of equipment, development of new ideas, practical issues, etc. This update was

mainly meant for the project partners as a way of sharing ideas and methodologies across case studies.

5.4 Reporting

Reporting serves as the final step in the MEL phase of a NbS measure. It is during this stage that the evaluated data is collected and processed, analysed, and transformed into actionable insights for relevant stakeholders. This process encompasses several key steps to ensure comprehensive and informative reporting:

1. ***Results Evaluation -*** The first step in reporting involves evaluating the results of monitoring efforts. This evaluation, as described in section 5.3, compares current data values to baseline assessments. By presenting this comparison, the status and performance results of the NbS project are presented, providing stakeholders with a clear understanding of the project's effectiveness.
2. ***Identifying Stakeholders target of the reporting -*** Reporting must consider the diverse range of stakeholders involved in or affected by the NbS project. Primary stakeholders, such as the municipality, utility companies, and local institutes, play a crucial role in the project's success. Depending on the financing structure of the NbS monitoring, specific stakeholders may also be responsible for data collection and reporting to the monitoring team. For instance, in the Elbe case (Demonstrator A1), the Ministry of Environment and Energy Hamburg (BUE) was tasked with data collection for indicators related to WATER and NATURE, while The Hamburg Agency of Roads, Bridges and Water (LSBG) focused on data collection regarding PEOPLE.
3. ***Performance Evaluation -*** In addition to presenting monitoring results, reporting must include an evaluation of the NbS project's performance. Engagement with identified stakeholders is important during this step to ensure a holistic evaluation. The outcomes of this evaluation are then incorporated into the reporting, providing stakeholders with essential information to guide decision-making regarding further monitoring and future iterations of the NbS measure.

5.4.1 Reporting in RECONECT

In RECONECT, reporting on NbS projects involved sharing results with the RECONECT consortium to exchange insights and track progress. Each demonstrator and collaborator were required to report both the intended and unintended changes in the project to capture co-benefits and potential dis-services. This reporting approach ensured that all aspects of NbS impacts were adequately addressed.

To facilitate the exchange and tracking of performance across different demonstrators and collaborators, all data from NbS measures were shared and visualized on the ICT-platform "RECONECT Service Platform," operated by TeleControlNet. This platform provided stakeholders with access to both real-time and historical data, enabling analysis and feedback. The platform consisted of three types of distributed services: data access services, generic NbS network services, and tools for analysis feedback. This centralized platform played a crucial role in facilitating data sharing and enhancing collaboration among stakeholders involved in NbS projects.

Moreover, as part of their evaluation plan, the Demonstrators had to specify how and to whom the results of their monitoring will be reported. Some examples from the Demonstrator B Greater Aarhus (from *Deliverable 2.6 - Co-monitoring and co-evaluation plans for Demonstrators A and B*) are:

- For the Water indicators “Flood peak and Delay time to peak”, results will be presented to water authorities in the area as comparisons and dynamic models build upon rainfall time series, discharge time series, water level time series, and digital elevation models.
- For the Nature indicator “Habitat area”, results of the evaluation are expected to be presented to Aarhus Municipality, and Aarhus and Lystrup inhabitants by comparison of environmental variables such as size of the lake (max/min/average), terrain elevation (Danish Digital Elevation Model), water level at the inlet and outlet of the lake, flooding extent and frequency, soil type, etc.

6 Conclusions

This report aims at contributing to the ongoing effort in increasing the uptake of Nature-based Solutions by developing standardized approaches and outlining best practices supporting the planning, design, implementation, and monitoring and evaluation of NbS. The report builds on the experiences, assessments, methods, and approaches from several study cases in RECONECT, together with a wide research study and several engagements (workshops, surveys, etc.) throughout the implementation of RECONECT.

The report identifies and addresses the following gaps related to the standardisation of NbS:

1) Despite an increased focus on standards to support the development of natural infrastructure projects, policymakers and practitioners continue to struggle in applying standardized approaches and tools to implement NbS. Continuous monitoring and evaluation are key to develop the evidence base and ensure long-term application of NbS, and while it has been addressed in several standards, it is still not adequately addressed overall (Network Nature, 2024). This report provides, through a project life-cycle approach, specific methods with concrete examples of how to plan, design, implement and monitor NbS.

2) Research and scientific literature have mainly focused on NbS pre-implementation (i.e., planning and design), with implementation and operational phases being looked at to a lesser extent. This report suggests taking a holistic approach going through the four key phases of Planning, Design, Implementation, and Monitoring and Evaluation, with specific emphasis on building feedback loops to enhance Learning as a key driver for a continuous development of the evidence-base.

3) Data for large-scale NbS is scarce, compared to small-scale NbS (e.g., city scale), making it difficult to develop or outline best practices as the evidence is yet to be fully unfolded. RECONECT has specifically addressed this by developing a comprehensive list of KPI’s used by the project’s study cases and adapted to the realities, constraints, and opportunities of each case. This report builds from that outset, and proposes a set of approaches for identification, prioritization and monitoring of KPI’s and how these connect to the overall vision, planning, design, and implementation of NbS.

4) Lack of knowledge on the economic value of NbS as well as financial considerations linked to upscaling of NbS are clear barriers connected to lack of standardization, ranging from lack of standard financial metrics to knowledge gaps on NbS owners and potential funders. This report addresses this by introducing an innovative NbS Business Model Framework (developed in RECONECT), covering business model development and roadmaps for implementation. The aim with this is to help in securing financing and investment and provide methodologies to carry out holistic monitoring and evaluation for all benefits of NbS, which in turn can then be monetized to consider non-market values.

5) Need for more resources and platforms for capacity building, knowledge sharing, and training to help stakeholders understand and apply the standards effectively

and to address financial capacity building, can address the lack of revenue streams for the operation, implementation, and maintenance of NbS. This lack of capacity can also be felt in the effectiveness of NbS from technical and financial perspectives to the completion of bankable and scalable best practice knowledge products (Piacentini & Rossetto, 2020).

6) A critical gap was found in relation to the lack of frameworks targeting large-scale NbS with focus on landscape dynamics in the design phase. The implementation of NbS in the context of land use and land use change involves understanding the existing land conditions, anticipating future changes, and planning interventions that enhance ecological, social, and economic outcomes. The report outlines several best practices and recommendations specific to land use and land use change, emphasizing the importance of strategic planning, stakeholder engagement, and adaptive management.

Clearly, the RECONECT experience alone is not enough to supply the current lack of standardized and universally accepted frameworks, but it can provide a first guidance to be followed (and improved) by future projects. Moreover, by sharing RECONECT's learnings, processes, and developed tools across all life-cycle phases, this report provides a foundational reference for standardization institutions in their future work. This is a step forward towards improving standardization and evaluation of large-scale NbS, which are both fundamental for a successful and widespread upscaling of these approaches.

These standards intend to assist in the processes necessary for a successful implementation of large-scale NbS in sites within Europe, given the outcomes and learnings of the RECONECT project. Together with recognized European organizations working with the development of standards, the RECONECT project aims at laying the foundations for what will eventually become the EU large-scale NbS standards for hydro-meteorological risk reduction considering the geographical and climatic variations in a pragmatic way.

7 References

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Annex A. References of Literature Review

Full list of the standards reviewed, as classified in Table 2.

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Full list of the RECONECT Deliverables reviewed, as classified in Table 3.

D1.1 Preliminary report describing holistic ecosystem-based frameworks

D1.2 Report on the social innovation approach

D1.3 Report describing the development of a database of existing knowledge and practice of NBS with the reference to the relevant policies and regulations

D1.4 Guidance document on integrating innovative technologies into existing landscape, maintenance issues and long-term sustainability

D1.5 Preliminary report on the selection and enhancements of supporting tools/ models/decision support systems for NBS implementation and evaluation as per the TRLs

D1.6 Report on the selection and enhancement of Complex Adaptive Systems (CAS) tools to support governance and policy formulation

D1.7 Final report describing holistic ecosystem-based framework

D2.1 Report describing stakeholder (involvement in cocreation) analysis

D2.2 Report describing baseline assessment, demand and supply analysis

D2.3 Report describing scope of works for Demonstrators A and B

D2.4 Report describing technical specifications and procurement processes

D2.5 Report describing preparatory actions for Demonstrators B with copies of building permits/permissions of uses/commissioning works

D2.6 Report describing co-monitoring and co-evaluation plans for Demonstrators A and B

D2.7 Report describing co-implementation activities undertaken in Demonstrators A

D3.1 Report on data availability/gap analysis

D3.2 Report describing procurement and Installation of monitoring equipment in all Demonstrators

D3.3 RECONECT Services Platform preliminary version (prototype)

D3.4 Preliminary report describing co-monitoring activities

D3.5 Evaluation protocols and manuals concerning different aspects of the coevaluation work

D4.1 Report describing stakeholder analysis

D4.2 Report describing baseline assessment and potential for NBS in Collaborators

D4.3 Report describing upscaling strategy

D4.4 Report describing Demand Analysis with a focus on Collaborators

D5.5 Report describing the potential for implementation of large-scale NBS in Europe

D5.7 Business models and roadmaps

D6.10 Updated exploitation, dissemination and communication plan for outreach

Annex B. Summary of best practices for the Planning and Design phases

Activity	Description	Output
PLANNING		
P1. Identify Problems, Vision, Principles and Project Scope	Establish the scope of the problem and define the vision and scope of the project by considering multidimensional constraints and opportunities. Develop principles rooted in the project's vision to inform the delivery strategy of NbS. These guiding principles should encompass not only sustainability but also enhance the liveability aspects of the site.	Document containing maps of the area of interest and its boundaries, as well as key principles to guide the delivery strategy
P2. Identify and assess governance dimensions (to include key regulations and permits required to develop the NbS)	Assess the governance aspects of the system by conducting an in-depth analysis of the strategic, legal, regulatory framework, encompassing national or regional strategies, laws, municipal development plans, and relevant institutions and stakeholders. Identify the principal barriers and opportunities within these regulations and align the project timeline with the necessary regulations and permits. Control of planning demands, technical requirements and other specifications required for permit submission should be identify in the early stage of planning. More details in Section 2.1- Regulations and Safeguards – due diligence.	A report outlining the existing regulations and guidelines, as well as the analysis of the incentives and barriers associated with them.

Activity	Description	Output
P3. Identify Stakeholders	Identify key stakeholders both within and external to the organization, ensuring comprehensive inclusion of all individuals and entities essential to the planning, design, implementation, and post-construction phases of the project. It is likely that the stakeholder analysis process requires a series of iterations as the advancement of the co-creation process might put the relevance of the initial selection into question. Further details on stakeholder identification are provided in Section 2.2 - Engagement: stakeholder analysis, co-assessment and co-planning.	Compiled stakeholder matrix
P4. Baseline Assessment	Understanding the baseline, including the intricate interconnection among various systems, is crucial before deciding among different NbS options. Building upon the map of the area of interest and boundary in P1, this step involves thorough assessments to analyse land use, ecosystem health, hazards, exposure levels, and vulnerabilities within the specified scope The assessment underscores the vital role of ecosystems in disaster risk reduction, offering insights into their importance in mitigating potential impacts. More details are covered in 2.3 - Baseline Assessment.	Data on geomorphology, topography, hydrology, biodiversity, land-use, social values, temporal and spatial scale of NbS. Maps illustrating both current and future hazard levels, exposure

Activity	Description	Output
P5. Identify suitable NbS measures	Conduct an initial exploration to identify potential interventions and opportunities for effective NbS implementation. Utilize mapping tools to pinpoint specific areas suitable for NbS interventions. Include details on costs, effectiveness, potential co-benefits, specific conditions, and articulate them in terms of timing and relevance to the contextual nuances of the area of interest.	Preliminary list of possible NbS
P6. Specify preliminary Objective and Performance Criteria	Identify the specific objectives that the NbS aims to achieve. These objectives may vary based on the unique nature, scale, timeframe, and spatial constraints of the project. KPI should be set to guide the design, implementation, operation and maintenance, monitoring and evaluation phases. It is essential to ensure that KPIs are as specific, quantifiable, and measurable as possible.	Preliminary selection of KPIs, which should be specific and measurable and covering the three challenge areas (Water, People and Nature)
P7. Develop a preliminary Business Case	Formulate a preliminary business case defining value creation across diverse project areas. This entails a meticulous overview of the outputs from previous steps, such as costs, associated risks, pros and cons, alternative options, recommended actions, identification of potential barriers and the anticipated timescales. More details are shared in 2.6 - Preliminary business case.	Qualitative and quantitative Lifecycle Cost Analysis Qualitative and quantitative Social Cost Benefit Analysis Revenue streams

Activity	Description	Output
P8. Pre-feasibility Study	Pre-feasibility studies hinge on the collective evaluation of site assessments, vulnerability mapping, and the preliminary Business Case. If the project is deemed unfeasible, it is imperative to revisit the initial steps, recalibrate the business case, and re-valuate the associated components accordingly. The pre-feasibility study will return the most promising option, eliminating the number of options that are chosen to proceed with a more detailed feasibility study and eventually with business development. More details are shared in 2.8 - Pre-feasibility.	Pre-feasibility report on one (or a short list of) NbS project(s)
DESIGN		
D1. Update Business Case	Present supporting evidence to demonstrate the practicality and adherence to budget constraints in the lifecycle costs of NbS, showcasing the availability and support for required funding. Identify financial gaps and explore appropriate financing instruments to effectively bridge these gaps. Determine the personnel, expertise, and resources essential for different phases and distribute responsibilities among project team members through interdisciplinary scrutiny. Define the required team size and roles, considering budget and time constraints.	Financial Viability Gap Key Financing Strategy Land Required and Land Acquisition Strategy Inventory of potential public and private sources of funding Estimated budget Key Funding Strategy Budget Allocation Timeline for resource utilisation

Activity	Description	Output
D3. Feasibility Assessment	Perform a comprehensive modelling, accounting, and assessment of the benefits and co-benefits, incorporating CBA and risk assessments for individual options and combinations within portfolios. Transparently communicate uncertainties to decision-makers and stakeholders, with sensitivity analysis employed to enhance understanding and address uncertainties effectively. The outcomes of these assessments contribute to the determination of the final design of the NbS (see key outputs). This stage builds upon the information gathered in steps P4 and P8.	Reports on technical, legal and economic viability Inputs to the NbS final design, including: • Key Design Considerations • Design Constraints and Risk Factors • Landscape Design Integration • Vegetation Specification • Material Selection • Sizing Guidance • Performance Evaluation
D4. Engagement: co-design	Examining a range of design configurations for NbS is crucial, accompanied by active engagement with relevant stakeholders to understand their preferences and requirements through a participatory approach. This collaborative methodology guarantees the alignment of NbS design with stakeholders' needs and expectations.	Co-designing workshop activities and record of results
D5. Final KPIs, design a comprehensive monitoring, evaluation, and maintenance system	The review process should be iterative, continuing throughout the project lifecycle. Review the KPIs established in the Planning phase. At this stage, consider the inclusion of alternative or additional stakeholders, and explore new options if opportunities have emerged since the initial assessment. Establish a clear vision and comprehensive scope based on the information gathered, addressing both current and anticipated future risks. Continuous monitoring of both the NbS process and its outcomes is essential for comprehending effectiveness and guiding future designs. This involves comparing site conditions with	List of final KPIs Monitoring plan with measurable indicators, target values/success criteria for evaluation, roles and responsibilities, monitoring method, monitoring frequency and duration. Drafted maintenance plan with frequency, duration of tasks, roles and responsibilities.

Activity	Description	Output
	baseline data and establishing solid criteria for evaluation. Engaging the community through methods such as citizen science surveys enhances co-ownership and social resilience. Additionally, acknowledging long-term maintenance needs and interventions further ensures the sustained effectiveness of NbS. Early planning facilitates integration of design and construction, while also considering post-construction monitoring requirements. More details can be found in 3.5 - Monitoring, evaluation and final KPIs.	
D6. Procurement Plan and Preparation of Tender Documentation	Understanding the types of public tendering procedures, thresholds, rights and evaluation criteria and derive a procurement plan for the NbS project. Within the procurement plan, precise tender documentation for NbS is an important step, functioning as a detailed roadmap outlining project scope, requirements, and deliverables to potential constructor. This process requires consistent formatting, thorough documentation preparation, evaluation and subsequent approval stages. The tender document should encompass elements such as detailed project design, risk assessment, administrative documentation, methodological guidance and a comprehensive management plan. It is crucial to emphasize that every tender is unique, demanding careful adherence to specific guidelines and requirements.	Procurement Plan and Tender Documents