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RESTORE OUR OCEAN AND WATERS

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EcoDaLLi

Deliverable 2.2

NBS catalogue of implemented best practices

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Abbreviations and Acronyms

DRBMP ..... *Danube River Basin Management Plan*
NBS..... *Nature-Based Solutions*

1) Introduction

In the pursuit of sustainable and resilient development, the integration of Nature-Based Solutions (NBS) has emerged as an obvious strategy. The methodology for "Mission relevant NBS assessment" developed by EcoDaLLi and articulated in D2.1, serves as the cornerstone for designing, implementing, and evaluating these solutions. This methodology is not merely a set of guidelines but a complex framework that is adaptable to a variety of contexts, from local to transnational scales. The adaptability of this methodology ensures that it is applicable to both expansive projects, addressing widespread environmental challenges, and more focused, site-specific interventions. The flexibility in scope, referred to as "intervention" in conjunction with "project," underscores its broad applicability, aligning with the IUCN's global standards on Nature-Based Solutions.

In the **EU Mission** *Restore our ocean and waters by 2030: Atlantic, Arctic, Danube and Mediterranean lighthouses*, "lighthouses" are defined as "hubs and platforms supporting the development and deployment of transformative innovative solutions in all forms – technological, social, business, governance, ensuring fast progress towards the achievement of Mission objectives and important impact on society in the river and sea basins through science and technology". For the Danube River Basin Lighthouse area, the following two major Mission targets have been set:

1) Restore at least 25 000 km of free-flowing rivers in Europe.

2) Contribute to nature restoration targets.

In the **Danube River Basin Management Plan** (DRBMP), 2009, Update 2021, restoration needs and priorities are also defined. Longitudinal and lateral connectivity, as well as biodiversity enhancement, are salient points.

Thus, the main objective of the EcoDaLLi coordination and support action is to centralize Danube governance structures in terms of innovative solutions for improved ecological restoration, protection and preservation of the Danube River Basin by fostering a stronger innovation ecosystem within a well-connected Practices Living Lab System, supported by a digital portal, completely linked to the Mission Implementation Platform. Innovative solutions should open new opportunities for better water restoration, taking into consideration social innovation aspects, reducing climate change effects, risks and costs.

Since the **NBS approach** is a recent concept under permanent development, which stands as an upgrade of the UNO Sustainable Development Goals and the European Green Deal, stimulating "*solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience",* it is regarded as a promising approach for Mission and DRBMP defined targets.

In the line with previous, within the EcoDaLLi project WP2 is defined as:

NBS&eco-system connectivity for the protection and restoration of freshwater ecosystems and biodiversity

> *Activities here are meant to collect knowledge (best practices) regarding restoration of freshwater ecosystems with a deep understanding of role of Danube River ecosystem connectivity restoration (national & cross-border level). NBS assessment will gather relevant evidence across case studies on benefits & co-*

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benefits generated by small & large scale NBS implementation for water related risks, longitudinal & lateral connectivity.

The first task of the WP2, T2.1, was:

Methodology for Mission relevant NBS assessment

This task will develop a methodology for NBS assessment, building upon the existing knowledge in order to allow the identification of best practices regarding biodiversity conservation & restoration initiatives along the Danube river basin, including its delta. The results will be presented in D2.1.

The methodology presented in this deliverable is aimed to help NBS developers/practitioners, but should be helpful for decision-makers and authorities, as well. The methodology will be further tested and applied across the entire Danube River Basin, including all units, Upper, Middle and Lower Danube and Danube Delta.

2) Overview of the Methodology

The methodology detailed in D2.1 can be summarized in a seven-stage process that encompasses the full lifecycle of a NBS project. Each stage is designed to address the complexities of ecosystems, stakeholder dynamics, and the multifaceted nature of environmental challenges. This framework builds mostly on the foundational work of scientific publications such as:

1. *Dumitru, A., Wendling, L. (eds.). 2021b. Evaluating the impact of nature-based solutions, A handbook for practitioners. Publications Office of the European Union, Luxembourg.*
2. *Cardinali, M., Dumitru, A., Vandewoestijne, S., Wendling, L. 2021. Evaluating the impact of nature-based solutions, A summary for policy makers. Publications Office of the European Union, Luxembourg. doi:10.2777/521937.*
3. *Dumitru, A., Wendling, L. (eds.). 2021a. Evaluating the impact of nature-based solutions, Appendix of methods. Publications Office of the European Union, Luxembourg.*

All three publication are based on outcomes of previous EU cofinanced projects, related to the restoration of urban and restoration of peri urban areas. However, in many cases, these include restoration of water bodies, and riverine flora and fauna. Almost all of them focus biodiversity enhancement.

The European Commission defines NBS as follows:

Nature-based Solutions provide integrated, multifunctional solutions to critical societal challenges. They are "solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and interventions. Nature-based Solutions must therefore

benefit biodiversity and support the delivery of a range of ecosystem services" (European Commission).

This definition is not significantly different from these stated by other sources, e.g. IUCN.

It should be noted that the NBS, as an approach for restoration, is still under development, and its final stage is far from over. However, essential changes are not expected.

NBS concept umbrella, is presented in Fig. 1, from **Dumitru and Wendling** (2021b).

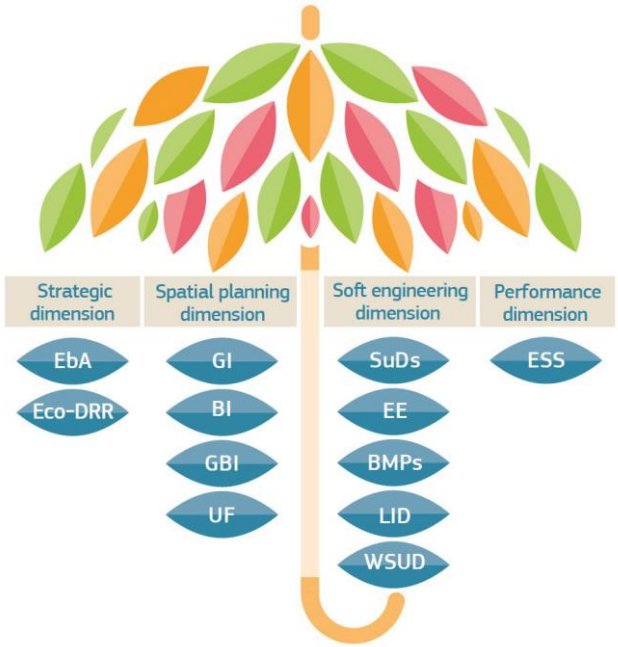

Figure 1: Nature-based solutions as an umbrella concept and the relation of NBS to key existing concepts. EbA = ecosystem based adaptation; Eco-DRR = ecosystem-based disaster risk reduction; GI = green infrastructure; BI = blue infrastructure; GBI = green-blue infrastructure; UF = urban forestry; SuDS = sustainable urban drainage systems; EE = ecological engineering; BMPs = best management practices; LID = low-impact design; WSUD = water-sensitive urban design; ESS = ecosystem services.

Very important, and seldom noticed, is that NBS is related to the nature restoration, and that the infrastructure of it should be, preferably, blue or green (Fig. 1). Pure grey infrastructure cannot be treated as NBS. Frequent is also the application of a hybrid one, combination of grey and one or both of previous ones. In review publications it was not found what the upper limit of grey share represents in the case of hybrid ones.

Related to the Mission Ocean and Waters there were elaborated some publications, with the most significant and quoted being:

European Commission. 2023. Baseline study for the implementation of lighthouses of the Mission 'Restore our ocean and waters by 2030': Atlantic, Arctic, Danube and Mediterranean lighthouses, Final report. Publications Office of the European Union, Luxembourg.

Stage 1: Problem Identification

The initial stage of the methodology focuses on the critical task of problem identification. This involves a deep dive into the specific environmental and social issues prevalent in the project area. The process begins with detailed baseline data collection, which is crucial for understanding the existing conditions and for identifying the key challenges that the project aims to address.

This stage is important in defining the scope and objectives of the NBS interventions. By adopting a participatory approach that actively involves local communities, environmental experts, and relevant authorities, the process ensures that the identified problems are both scientifically validated and closely aligned with the community's perceptions and priorities. This alignment is essential for fostering ownership and support for the project.

The Theory of Change (ToC) is a vital tool in this stage, guiding the definition of desired outcomes and the development of target indicators. The ToC helps articulate the logical pathways through which the proposed NBS would lead to the anticipated benefits, such as enhanced biodiversity, improved air and water quality, and increased climate resilience.

Stage 2: Selection and Assessment of NBS

Once the problems are clearly defined, the next step involves the selection and assessment of appropriate NBS. This stage is critical as it determines the effectiveness of the project in addressing the identified challenges. The methodology provides a strong framework for evaluating potential NBS based on a set of criteria, including their ecological effectiveness, socio-economic benefits, and feasibility.

An evidence-based approach is recommended to select NBS that not only meet ecological requirements but also provide significant social and economic co-benefits. For example, selected NBS may be designed to enhance green spaces, thereby improving air quality and providing recreational opportunities for residents. Additionally, these solutions are assessed for their potential to support local biodiversity and contribute to climate adaptation efforts.

The methodology emphasizes the importance of innovation in NBS design. In line with this, cutting-edge approaches that integrate technological advancements with natural processes are explored. For example, incorporating smart water management systems that use real-time data to optimize the performance of green infrastructure.

Stage 3: Design of Implementation Processes

The design phase is where conceptual solutions are translated into actionable plans. This stage requires careful consideration of the local context, stakeholder interests, and technical requirements. The methodology underscores the importance of co-design, where stakeholders are actively involved in shaping the solutions. This participatory approach not only enhances the relevance of the NBS but also increases the likelihood of successful implementation and long-term sustainability.

The design phase is marked by extensive stakeholder engagement. Workshops, focus groups, and public consultations are recommended to gather input from a wide range of stakeholders, including local residents, businesses, NGOs, and government agencies. This inclusive process ensures that the final designs reflect the community’s needs and aspirations.

The methodology also highlights the need for adaptive design, where the NBS can be adjusted based on emerging challenges or opportunities. To accommodate this, flexibility is built into the design process, allowing for modifications as new data becomes available or as stakeholder preferences evolve.

Stage 4: Implementation of NBS

The implementation stage is where the plans are put into action. This stage is often the most resource-intensive and requires meticulous planning and coordination. The methodology provides detailed guidance on how to manage the implementation process, including considerations for timing, resource allocation, and risk management.

A phased strategy approach is particularly important in managing the complexities associated with large-scale projects. Implementing the NBS in phases makes possible to monitor progress, identify potential issues early, and provide necessary adjustments before scaling up.

Stage 5: Stakeholder Engagement and Communication

Effective stakeholder engagement is a critical component of any NBS project. The methodology provides a comprehensive checklist for ensuring that all relevant stakeholders are identified, engaged, and kept informed throughout the project lifecycle. This includes regular communication of project progress, outcomes, and benefits to maintain stakeholders' interest and support.

Stakeholder engagement should not be treated as a one-time activity but as an ongoing process. A Stakeholder Advisory Group (SAG) should be established to include representatives from various sectors, such as local government, academia, community organizations, and the private sector. Working groups play a key role in guiding the project, providing feedback, and ensuring that the NBS align with broader community goals.

Communication strategies need to be tailored to different stakeholder groups, recognizing that different audiences have different information needs and preferences. For example, social media and local events can be used to reach the general public, while more detailed technical reports and briefings are provided to government officials and experts.

Stage 6: Transfer and Upscale of NBS

To maximize the impact of successful NBS, it is crucial to plan for their transfer and upscaling. This can involve extending the project geographically or expanding its functional benefits. Documenting best practices, creating technical manuals, and establishing partnerships with other regions or organizations are key steps in this process.

Continuous monitoring and evaluation provide the evidence needed to justify scaling up. The collected data should be used to refine the NBS and make a compelling case for their broader application.

Stage 7: Monitoring and Evaluation

The final stage of the methodology focuses on monitoring and evaluation (M&E). This is crucial for assessing the effectiveness of the NBS, understanding their long-term impacts, and making necessary adjustments. The methodology recommends the use of RACER (Relevant, Accepted, Credible, Easy, and Robust) and SMART (Specific, Measurable, Achievable, Relevant, and Time-bound) criteria for selecting indicators.

To ensure continuous monitoring, projects should establish partnerships with local universities and research institutions.

Governance and Financing

Effective governance and sustainable financing are foundational to the success of NBS projects. Establishing a multi-stakeholder Project Core Team (PCT) to oversee the project ensures transparent and inclusive governance. Exploring innovative financing mechanisms, such as green bonds or public-private partnerships, is also crucial to ensure the financial viability of NBS initiatives.

The methodology developed in D2.1 offers a structured yet flexible framework for guiding NBS projects from conception to realization. By integrating cutting-edge research, engaging diverse stakeholders, and adhering to a systematic, stage-based approach, this methodology can significantly contribute to ecological restoration, climate resilience, and community well-being.

This methodology serves as a blueprint for NBS initiatives, offering a proven path toward more sustainable and resilient environments.

2.1 Societal Challenges Addressed

Societal challenges are a core part of NBS. Figure 2 shows one of examples presented in **Dumitru and Wendling** (2021b). It shows a list of all challenges addressed in EU projects, and those highlighted in green are the most relevant for the showcased project GROWGREEN.

Figure 2: Example of societal challenges, project GROWGREEN

In D 2.1 Chapter 4, these issues are elaborated. For urban restoration, the list consists of selected societal challenges. Those highly relevant for Mission Ocean and Waters and EcoDaLLi, are highlighted.

1. Climate Resilience
2. Water Management

3. Natural and Climate Hazards
4. Green Space Management
5. Biodiversity Enhancement
6. Air Quality
7. Place Regeneration
8. Knowledge and Social Capacity Building for Sustainable Urban Transformation
9. Participatory Planning and Governance
10. Social Justice and Social Cohesion
11. Health and Wellbeing
12. New Economic Opportunities and Green Jobs

Depending on specificity of the planned project/intervention some other societal challenges can be selected, either from those listed here or from other sources. For example, Water Quality, could be relevant for biodiversity enhancement. This can be related to the macro and micro plastic litter. The seventh challenge could also be relevant, but with slightly modified title: Knowledge and Social Capacity Building for Sustainable Transformation.

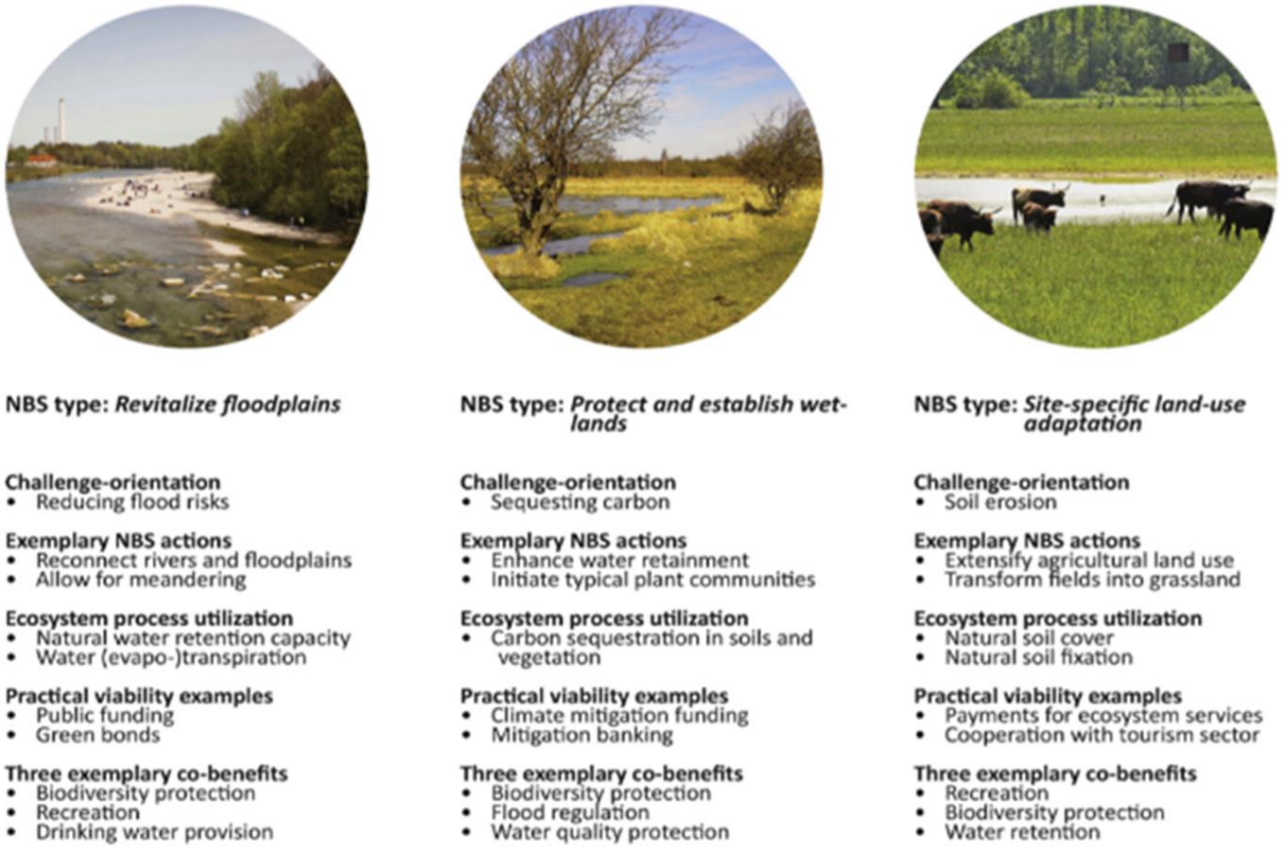

Figure 3: NBS for water management, excerpt from Albert, S. et al. 2019. Addressing societal challenges through nature-based solutions: How can landscape planning and governance research contribute? Landscape and Urban Planning, 182, 12–21.

Project developer could define other societal challenges or include some others from above list.

Major societal challenges have been thoroughly elaborated in D 2.1 Chapter 4. Figure 3 shows an example for NBS addressing Water Management and the challenges they are addressing.

2.2 NBS Type

Here are mostly treated geographic types:

1. Local, realized in settlement, community, county.
2. National, realized on country level.
3. International, realized in two or more countries.

There are also other possible classifications, like pilot, research trial, demonstration (including educational), etc.

2.3 Project size and others

Until now, most NBS were defined in terms of size as big or large, and small. Among the finalized NBS the big ones are dominant. In D2.1 Chapter 2, this issue was discussed and proposed to also include mini size as a category. Mini size can be applied for research trials, demonstration and educational NBS projects.

It can be mentioned that other activities are aimed at initiation, inducement, advocacy of application of NBS. There are numerous publications of this type. These are positive as support for introduction of NBS, creation of public interest and partiality. This is also in line with societal challenge **Knowledge and Social Capacity Building for Sustainable Transformation**, and engaging citizens.

According to the described methodology NBS related projects were chosen, characterized and showcased. 2-4 projects from each section are described in detail and a list of 27 projects is provided as well.

As the projects were implemented by various state organizations, companies, and NGOs from different sources and time scale, there are some difficulties to gather all the relevant data.

3) NBS best practice examples in the Upper/Middle/Lower Danube & the Danube Delta

The following section gives a small selection of NBS best-practice examples identified across the Danube River Basin. For a more complete list please refer to EcoDaLLis “Nature-based Solutions Catalogue of Projects and Measures” available on the EcoDaLLi portal.

3.1 Upper Danube

Type 3 NBS – “Dynamisierung der Donauauen”

The project "Dynamisierung der Donauauen" focused on restoring the Danube floodplain between Neuburg and Ingolstadt, one of the largest remaining alluvial forests in Germany, which had lost much of its natural dynamics due to river regulation in the 19th and 20th centuries. The initiative aimed to improve river continuity and floodplain dynamics through various measures, including creating new water habitats, enhancing longitudinal connectivity, and reconnecting the Danube to its adjacent alluvial forest.

A significant outcome of the project was the establishment of the "Auenzentrum," a center dedicated to research, knowledge exchange, and public engagement on floodplain conservation. The project emphasized the floodplain's importance for species protection, habitat conservation, and flood prevention.

While the project was specific to the Danube between Neuburg and Ingolstadt and not directly replicable elsewhere, it serves as a best-practice example for river renaturation and long-term environmental monitoring. The project took 15 years to complete, demonstrating the importance of patience in successful restoration efforts. Continuous monitoring has been in place since the project's inception to ensure the positive effects of the measures are documented and sustained.

The initiative involved collaboration between various stakeholders, including experts in water management and nature conservation, local government representatives, energy company E.on Wasserkraft, and the Wittelsbach Compensation Fund. The project's success highlights the importance of cross-sector cooperation, careful planning, and long-term commitment in environmental restoration projects.

Type 3 NBS – “Spittelauer Arm”

The "Spittelauer Arm" renaturalization project, part of several ongoing restoration efforts, aims to reestablish the hydrological connection between the Spittelauer Arm, its floodplain, and the Danube River. Located between Petronell and Hainburg, the project focuses on enhancing the ecological and hydrological dynamics of the area by working with existing stream flows and removing barriers to improve floodplain connectivity. The restoration utilized dismantled stones from other construction projects, reflecting an eco-friendly approach.

A key outcome of the project is the development of a strategic "guidance document for river engineering management on the Danube east of Vienna," which outlines objectives, management principles, and methods agreed upon by business and environmental organizations. This document serves as a blueprint for future restoration actions in the region.

The project has yielded significant ecological, socio-cultural, and economic benefits, particularly in areas like Thurnhaufen, which has been transformed into an alluvial forest offering a natural retreat for residents and visitors. The broader LIFE project, of which this initiative is a part, has ecologically upgraded over 1,500 hectares of riparian forests, turning them into vital lifelines for floodplain ecosystems. These riparian forests provide multiple monetizable benefits, contributing to the overall well-being of the local environment and communities.

The project's success marks the importance of replicability and scalability in watershed restoration. It builds on previous restoration measures in the area, such as the side-arm reconnection in Haslau Regelsbrunn, demonstrating that these methods can be effectively replicated and expanded across the Danube region. The project is supported by a stakeholder forum and an advisory board, ensuring active participation and collaboration from various interested parties, including organizations related to the national park area.

Type 1 and 3 NBS – "DanubeSediment Project"

The DanubeSediment project (2017-2019) was a transnational initiative focused on restoring the sediment balance in the Danube River, particularly in the Upper Danube region of Austria and Germany. The project aimed to enhance the river's morphology, sediment, and water management by analyzing sediment transport processes, identifying key drivers of sediment discontinuity, and assessing the impact of sediment deficit and erosion.

Key outcomes include the calculation of sediment balance throughout the Danube, the development of sediment management practices, and the creation of the Sediment Manual for Stakeholders, which provides best practices and measures for managing sediment at various scales. The project also emphasized the importance of a balanced sediment regime and proposed river basin restoration strategies to improve water management and river morphology.

DanubeSediment played an important role in influencing the Danube River Management Plan (DRBMP) and the Danube Flood Risk Management Plan (DFRMP), incorporating stakeholder insights into these strategic documents. The project also facilitated knowledge transfer through international training workshops and developed interactive maps to showcase sediment data and the pressures affecting the Danube River.

The project highlights the need for integrated, transboundary sediment management approaches that involve all relevant stakeholders and consider both sediment quantity and quality. The project's findings and methodologies can be replicated in other river basins to address similar challenges and improve ecological and hydraulic conditions.

3.2 Middle Danube

Type 1 and 3 NBS – "Szabadság Island and the Béda-Karapancsa side channel"

The project on Szabadság Island and the Béda-Karapancsa side channel focused on conserving alluvial habitats of community interest by restoring the natural dynamics of these ecosystems. Historically, the island had been subjected to commercial forestry and was connected to the riverbank by a rock-fill dam, which caused sedimentation, stagnant water, and habitat degradation. The project aimed to restore ecological balance by removing invasive

species, converting a poplar plantation to a semi-natural alluvial forest, relocating water pipes, and opening the dam to improve water flow.

Key outcomes of the project include enhanced biodiversity, better climate regulation, flood risk reduction, and improved water quality. The project also increased recreational opportunities, such as rowing and angling, and promoted carbon sequestration by replacing invasive species with native ones. The initiative was a collaborative effort involving various sectors, including water management, forestry, local government, and the community.

A detailed monitoring plan was established to track biodiversity health indicators, making this one of the first projects in Hungary to use a multi-taxa approach for assessing ecological changes post-restoration. The project demonstrated that NBS are effective and widely supported by governments and businesses, leading to improved sediment balance and more natural hydromorphological processes.

However, the project also highlighted challenges, such as the ongoing need for invasive species management and the potential negative impacts of navigation on the restored side-branch. The project's success depends on continuous funding and the development of long-term strategies to maintain ecosystem integrity.

The project serves as a model for upscaling similar restoration efforts, emphasizing the importance of public awareness of wetland ecosystem services and the integration of nature-based solutions in environmental planning. While the project has made significant strides in ecological restoration, ongoing challenges like sedimentation, invasive species, and the need for sustained funding and strategic planning remain critical for long-term success.

Type 1 and 2 NBS – "Sződliget"

The project at Sződliget, located 30 km north of Budapest along the Danube Bend, focuses on the ecological restoration of a river section through the optimization of groynes—structures built to manage water flow and sedimentation. This is the first project of its kind in Hungary, addressing the negative impacts of river regulations that have resulted in habitat loss and reduced structural diversity along the Danube.

The specific site at 1675 Rkm (river kilometer) has seen significant sedimentation and siltation between two groynes, transforming a once dynamic gravel littoral zone into stagnant, muddy water. The project aims to restore the natural dynamics of this 600-meter-long habitat by increasing biodiversity, enhancing structural diversity, and creating a sustainable environment for aquatic species, particularly by improving water flow and creating a safe habitat to mitigate wave stress from navigation.

Key goals of the project include:

1. Enhancing biodiversity across approximately 50 hectares.
2. Achieving a water velocity of 10-20 cm/s in the littoral zone, providing a suitable nursery habitat for riverine species.
3. Creating an island that offers long-term protection against wave stress.
4. Ensuring that the restoration is compatible with both navigation and flood protection.

The project also aims to improve conditions for fish spawning, support sustainable fishing practices, and reduce the presence of invasive species. By restoring this section of the

Danube, the project provides a replicable NBS that balances the needs of navigation and biodiversity, with potential benefits for climate change mitigation.

The initiative involves collaboration with local communities, SMEs, and stakeholders, emphasizing participatory processes and citizen science in monitoring. Although the project is ongoing, it is expected to serve as a model for similar restoration efforts along the Hungarian stretch of the Danube, particularly in revising old water regulation structures to protect biodiversity and maintain ecological balance.

Type 1 and 3 NBS – "Danube floodplain Báta"

This project focused on restoring a silted oxbow on the Danube floodplain near the village of Báta to enhance ecological continuity and improve the area's environmental quality. The intervention involved dredging a 900m x 100m section of the oxbow to create an open water surface and constructing a large sluice to regulate water levels. The dredged materials were deposited nearby to minimize costs and environmental impact, and existing railroad pillars were repurposed to reduce concrete usage.

The restoration has provided recreational opportunities for locals, such as leisure angling, and improved the landscape quality. The Danube-Drava National Park Directorate plans further restoration of the oxbow's upper part, involving small-scale dredging and the construction of a bottom weir.

The project, funded by the World Bank and the Hungarian state, was a collaborative effort between the South-Transdanubian Water Management Directorate, the Danube-Drava National Park Directorate, and the Municipality of Báta. The initiative also highlighted challenges such as the difficulty of using heavy machinery on soft floodplain soils and the need for durable water retention structures that can withstand floods and debris.

This project serves as a model for similar restoration efforts, demonstrating the importance of strategic planning, community involvement, and addressing environmental challenges in floodplain restoration.

Type 1 and 3 NBS – "Mocskos-Duna"

This project aimed to improve water discharge in the Mocskos-Duna, a 4 km long oxbow on the Danube floodplain, by constructing a water retention sluice at the oxbow's mouth to retain water after flood waves. The intervention was minimal, with only a small artefact built to maximize benefits while leaving the majority of the oxbow untouched.

The project also enhanced conditions for local fish communities and supported leisure angling by a local fishing association. The planning and implementation were collaborative efforts involving the South-Transdanubian Water Management Directorate, the Danube-Drava National Park Directorate, and the Gemenc State Forest Company, which manages the nearby forest.

However, due to ongoing riverbed erosion in the Danube, the sluice level, calculated 15 years ago, is now slightly high, necessitating more frequent operation than initially expected. This project serves as a reference for other restoration projects, highlighting the importance of minimal intervention, collaboration among stakeholders, and adaptability to changing environmental conditions.

3.3 Lower Danube and Danube Delta

Type 1,2 and 3 NBS – "Protection of the pygmy cormorant and the ferruginous duck"

This project aimed to protect two globally threatened bird species—the pygmy cormorant (Phalacrocorax pygmeus) and the ferruginous duck (Aythya nyroca)—in the lower Danube region. These species were facing significant threats due to habitat degradation, human activities, and lack of cross-border cooperation in conservation. To address these issues, the project focused on restoring wetland habitats, such as reedbeds and freshwater pools, and enhancing cross-border cooperation between Romania and Bulgaria.

Key actions included creating and managing habitats to support breeding and feeding, controlling invasive species, and reducing habitat fragmentation. Sustainable land management practices were implemented, and stakeholder engagement efforts raised awareness about bird conservation and promoted sustainable behaviors.

The project successfully maintained significant breeding populations of both bird species, meeting Favourable Reference Values with 1590 and 400 breeding pairs in Romania, and 770 and 155 pairs in Bulgaria. It also expanded breeding and feeding areas by 1200 hectares in both countries. The establishment of a cross-border protected area of 44,297 hectares demonstrated integrated conservation efforts and inspired similar initiatives.

The project supported the Lower Danube Green Corridor Agreement by expanding Natura 2000 sites, restoring 1200 hectares of wetlands, and improving ecological coherence along the lower Danube. Through seminars, workshops, and public events, stakeholders were informed about the benefits of NBS and encouraged to support conservation efforts.

The project marked the importance of cross-border cooperation in conserving species with transboundary habitats. It also demonstrated the potential for scaling up conservation efforts beyond the lower Danube region and replicating the initiatives in other areas facing similar challenges. Monitoring bird populations and habitat conditions was essential to track the effectiveness of interventions over time. However, the project faced risks from political instability, changes in government priorities, and socio-economic challenges that could impact the continuity of conservation efforts.

Type 1,2 and 3 NBS – "Fusea Natural Area"

This project focused on the restoration of a gravel extraction site in the Fusea Natural Area, located in the floodplain of the Arges River in Romania. The site, which has been used for aggregate extraction since 1970, is of both economic and natural importance, as 88% of it lies within the "Arges Middle Floodplain" Natura 2000 site. The project aimed to restore the area's ecological integrity by reconnecting existing lakes and planting indigenous flora to enhance biodiversity.

The project implemented a community-based conservation model, engaging local communities to manage human activities affecting the area. Educational initiatives, including an interpretation trail, events, and the establishment of the "Fusea Training Center," promoted environmental awareness and best practices in conservation. Online campaigns extended the project's outreach, increasing public engagement and understanding of the ecological significance of the area.

Critical conservation measures included restoring and maintaining wetlands to support breeding and feeding habitats for species, reducing soil erosion, and improving water quality.

The project also addressed challenges related to the conservation of Natura 2000 sites along the lower Danube, focusing on coordinated efforts between Romania and Bulgaria. Strict management protocols were implemented to prevent water pollution and minimize disturbances to wildlife.

Monitoring protocols were established to assess the long-term sustainability of the project, ensuring continued environmental and community benefits. The project's success in habitat restoration, species protection, and community engagement demonstrated its strong potential for replication in other degraded areas. This initiative highlighted the importance of involving local communities in conservation efforts and showcased the value of ecological restoration in floodplain areas.

By facilitating wildlife movement through habitat connectivity and promoting adaptive management practices, the projectbuilt resilience against environmental risks. The collaboration with the Lafarge team and the direct involvement of local stakeholders were crucial in ensuring the project's success and scalability, providing a model for similar conservation efforts in other regions.

4) Conclusions

4.1 Main challenges addressed

The projects outlined address a variety of significant challenges related to environmental conservation and ecosystem restoration. Here are the main challenges tackled by these initiatives:

1. **Habitat Degradation and Loss**: Many projects focus on restoring degraded habitats, such as oxbows and gravel extraction sites. These areas often suffer from severe ecological damage due to industrial activities, sedimentation, or land use changes. For example, projects in the Danube region have worked to restore floodplain oxbows and wetlands, which are crucial for maintaining biodiversity and supporting various species.
2. **Species Protection and Biodiversity Loss**: Specific conservation efforts target globally threatened species such as the pygmy cormorant and the ferruginous duck. These species face threats from habitat loss, human activities, and insufficient cross-border conservation cooperation. Projects aimed to protect these birds by enhancing their wetland habitats and improving breeding conditions, addressing the decline in their populations.
3. **Sediment Management**: Alterations in sediment flow due to human activities like river regulation and gravel extraction have significant impacts on river ecosystems. The DanubeSediment project, for instance, focused on restoring sediment balance across the river basin to improve natural sediment dynamics, which is crucial for maintaining river morphology and ecosystem health.
4. **Fragmentation of Ecological Networks**: Ensuring continuity of ecological networks and protecting against fragmentation are critical for maintaining ecological integrity. Projects have worked to reconnect habitats and restore ecological corridors, which are essential for species movement and ecosystem resilience.
5. **Water Management and Pollution**: Projects have addressed issues related to water quality and management, such as improving water discharge and reducing pollution in wetland areas. Effective water management practices are vital for maintaining healthy aquatic ecosystems and supporting both biodiversity and human uses.
6. **Community Engagement and Sustainable Practices**: Engaging local communities in conservation efforts and promoting sustainable land management practices are key to the long-term success of environmental projects. Initiatives have included educational programs, stakeholder workshops, and community-based management strategies to foster stewardship and support for conservation.
7. **Cross-Border Cooperation**: Many conservation challenges, such as species protection and habitat management, span national borders. Projects have emphasized the need for cross-border collaboration, particularly in regions like the lower Danube, to implement integrated conservation strategies and address shared environmental issues.
8. **Adaptive Management and Monitoring**: Effective conservation requires continuous monitoring and adaptive management to respond to changing conditions and evaluate

the impact of interventions. Projects have implemented monitoring protocols to track ecological health and adjust strategies based on real-time data.

These projects illustrate the complexity of environmental challenges and the multifaceted approaches needed to address them. By targeting habitat restoration, species protection, sediment management, and community engagement, they aim to create sustainable solutions that enhance ecological resilience and support biodiversity.

4.2 Lessons learnt, further opportunities and risks

The projects described provide valuable lessons, reveal further opportunities, and highlight potential risks in the field of environmental conservation and ecosystem restoration. Here is a synthesis of these aspects:

Lessons Learned

1. **Importance of Cross-Border Collaboration**: Effective conservation often requires coordination across national borders. The success of projects involving the lower Danube demonstrates that joint efforts between countries, such as Romania and Bulgaria, are crucial for addressing transboundary ecological issues and achieving comprehensive conservation goals.
2. **Community Engagement is Critical**: Engaging local communities in conservation efforts fosters ownership and stewardship. Successful projects have involved local stakeholders through educational programs, workshops, and active participation in decision-making, leading to greater support and sustainable management of natural resources.
3. **Adaptive Management is Essential**: Monitoring and adapting management strategies based on real-time data is crucial for addressing dynamic environmental challenges. Projects have shown that flexible, responsive approaches improve the effectiveness of interventions and help address unforeseen issues.
4. **Holistic Approaches to Habitat Restoration**: Integrating various restoration techniques, such as reconnecting lakes, planting indigenous flora, and managing invasive species, can enhance ecological resilience and biodiversity. A multi-faceted approach is often more effective than isolated measures.
5. **Sediment Management is Key to River Health**: Restoring sediment balance and understanding sediment dynamics are vital for maintaining river morphology and ecological functions. Projects like DanubeSediment highlight the importance of managing sediment flows to support healthy river ecosystems.

Further Opportunities

1. **Scaling Up Successful Models**: The replication of successful conservation models in other degraded areas offers significant potential for broader impact. Projects that demonstrate effective habitat restoration and community engagement can serve as templates for similar initiatives elsewhere.
2. **Expanding Conservation Networks**: There are opportunities to expand conservation efforts by increasing the size and number of protected areas, such as Natura 2000 sites. This can enhance ecological coherence and provide larger habitats for species conservation.
3. **Enhancing Public Awareness**: Continued efforts to raise public awareness and education about conservation can drive more widespread support and behavioral

changes. Online platforms, interpretation trails, and community events can amplify outreach and engagement.

4. **Integrating Ecosystem Services**: Recognizing and incorporating ecosystem services into conservation planning can enhance the benefits provided by restored habitats. Projects can leverage the value of ecosystem services, such as flood mitigation and water purification, to gain additional support and funding.
5. **Strengthening Institutional Frameworks**: Developing robust administrative and financial structures for managing conservation sites can ensure long-term sustainability. Strengthening institutional frameworks and cross-border networks can support coordinated efforts and resource mobilization.

Risks

1. **Political and Economic Instability**: Changes in political priorities or economic conditions can threaten the continuity of conservation efforts. Projects may face challenges if funding is reduced or if political instability affects administrative support for ongoing initiatives.
2. **Invasive Species Management**: Continuous management of invasive species is necessary to prevent them from undermining conservation efforts. Without ongoing control measures, invasive species can outcompete native species and disrupt ecosystem functions.
3. **Environmental and Climate Risks**: Climate change and extreme weather events pose risks to conservation outcomes. Projects need to account for potential impacts such as altered sediment dynamics, increased flooding, or changes in species distributions.
4. **Sustainability of Community Involvement**: Maintaining community engagement and stewardship over time can be challenging. Projects must ensure that local stakeholders remain actively involved and that conservation practices are integrated into their daily lives and economic activities.
5. **Technical and Operational Challenges**: Practical difficulties, such as erosion, sedimentation, and the durability of restoration infrastructure, can impact project success. Addressing these technical challenges requires careful planning and ongoing maintenance.

4.3 Outcomes

The integration of NBS represents a transformative approach in addressing environmental and societal challenges. The methodologies developed in D2.1 and the subsequent catalogue of existing applications offer a detailed framework for designing, implementing, and evaluating NBS projects. These methodologies are characterized by their adaptability, allowing for their application across various scales—from local interventions to transnational initiatives—while aligning with global standards such as those set by the IUCN.

One of the key strengths of the D2.1 methodology is its structured approach that can be used to guide NBS projects from conception to realization. The methodology marks the importance of a participatory process, ensuring that local communities, stakeholders, and experts are actively involved in every stage of the project. This engagement not only validates the scientific basis of the interventions but also ensures that they resonate with the community's needs and priorities.

Moreover, the D2.1 framework marks the importance of innovation in NBS design, advocating for the integration of technological advancements with natural processes. This includes the use of smart systems in green infrastructure, which enhances the effectiveness and

sustainability of NBS. The methodology also highlights the need for flexible and adaptive design, allowing for modifications as new data emerges or as stakeholder preferences evolve.

The survey of existing NBS projects, as detailed in T 2.2, further reinforces the relevance of the D2.1 methodology. The use of established European Commission standards and terminology ensures that these projects are evaluated against the highest benchmarks. The inclusion of diverse societal challenges—ranging from climate resilience to social justice—demonstrates the broad applicability of NBS in addressing complex issues.

The methodologies developed in D2.1 and further detailed in T 2.2 provide a strong and adaptable framework for the implementation of NBS. By integrating scientific research, stakeholder engagement, and innovative design, these methodologies offer a proven path toward more sustainable and resilient environments. The ongoing refinement of these approaches, coupled with a commitment to inclusive governance and sustainable financing, will be critical in ensuring the long-term success and scalability of NBS projects. As the concept of NBS continues to evolve, these methodologies will serve as a blueprint for future initiatives, contributing to ecological restoration, climate resilience, and the overall well-being of communities.

The main outcomes of the projects described include:

1. Enhanced Biodiversity and Habitat Quality

- **Species Population Increases**: Projects successfully maintained and increased the populations of threatened species, such as the pygmy cormorant and the ferruginous duck, with notable increases in breeding pairs across the lower Danube region.
- **Habitat Restoration**: Significant improvements were made to wetland habitats, including the restoration of key breeding and feeding areas for target species. For example, 1200 hectares of wetlands were restored, enhancing ecological conditions for both flora and fauna.

2. Successful Habitat and Ecosystem Restoration

- **Reconnection of Aquatic Systems**: Gravel extraction sites and degraded floodplains were restored by reconnecting lakes and enhancing water flow. This included the creation of freshwater pools and the management of reedbeds, which improved habitat connectivity and ecological functions.
- **Revegetation and Habitat Improvement**: Indigenous flora was planted to support biodiversity, and key habitats were managed to prevent degradation. For example, the restoration efforts at Fusea Natural Area included planting native plants and managing human activities to improve habitat quality.

3. Strengthened Cross-Border Conservation Efforts

- **International Collaboration**: Projects demonstrated effective cross-border cooperation, particularly between Romania and Bulgaria, to address shared environmental challenges. This included the creation of a cross-border protected area and joint conservation initiatives that expanded Natura 2000 sites and improved ecological coherence.

4. Increased Public Awareness and Community Engagement

- **Educational Initiatives**: Projects included the development of interpretation trails, educational events, and training centers that promoted environmental awareness and conservation practices among local communities. This engagement led to increased public support and active participation in conservation efforts.
- **Community-Based Management**: Local communities were involved in the decision-making process and management of conservation areas, fostering a sense of ownership and stewardship. This approach was exemplified in the Fusea Natural Area project, which integrated community interests with conservation goals.

5. Improved Monitoring and Adaptive Management

- **Ongoing Monitoring**: Regular monitoring of physical, chemical, and biological indicators was implemented to track the effectiveness of conservation measures. This allowed for adaptive management strategies that could be adjusted based on real-time feedback and changing conditions.
- **Development of Best Practices**: Projects generated valuable data and best practices for habitat restoration and species conservation, including methodologies for monitoring and managing restored areas.

6. Economic and Social Benefits

- **Enhanced Recreational Opportunities**: Restored areas, such as oxbows and wetlands, provided new opportunities for recreational activities like angling, which benefited local communities and contributed to the socio-economic value of the regions.
- **Economic Support for Local Communities**: Collaborative efforts with local stakeholders, including businesses and municipalities, helped integrate conservation activities with economic development, providing mutual benefits for both the environment and local economies.

7. Scalability and Replication Potential

- **Model for Replication**: The successful implementation of conservation strategies in these projects offers scalable models that can be replicated in other regions facing similar ecological challenges. The demonstrated effectiveness of habitat restoration and community engagement provides a framework for future initiatives.

These outcomes collectively contribute to the long-term sustainability and resilience of the targeted ecosystems.

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