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Abbreviations and Acronyms

BCE ..... *Before Common Era*
Dx.x ..... *Deliverable number*
DRBMP ..... *Danube River Basin Management Plan*
EU ..... *European Union*
IUCN ..... *International Union for Conservation of Nature*
M&E ..... *Monitoring and Evaluation*
NBS ..... *Nature-Based Solutions*
NGO ..... *Non-Governmental Organization*
PCT ..... *Project Core Team*
RACER ..... *Relevant, Accepted, Credible, Easy, and Robust*
Rkm ..... *River Kilometer*
SAG ..... *Stakeholder Advisory Group*
SMART ..... *Specific, Measurable, Achievable, Relevant, and Time-bound*
ToC ..... *Theory of Change*
U.K. ..... *United Kingdom*
U.S. ..... *United States*
UN ..... *United Nations*
WP ..... *Work Package*

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. However, here are used approaches, definitions and terminology used in EC publications, mostly related to the performed *Smart Cities* projects.

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 UN 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 the above section, 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-benefits generated by small & large scale NBS implementation for water related risks, longitudinal & lateral connectivity.

The first task of 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 an 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. *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.*
2. *Dumitru, A., Wendling, L. (eds.). 2021a. Evaluating the impact of nature-based solutions, Appendix of methods. Publications Office of the European Union, Luxembourg.*
3. *Dumitru, A., Wendling, L. (eds.). 2021b. Evaluating the impact of nature-based solutions, A handbook for practitioners. 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 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).

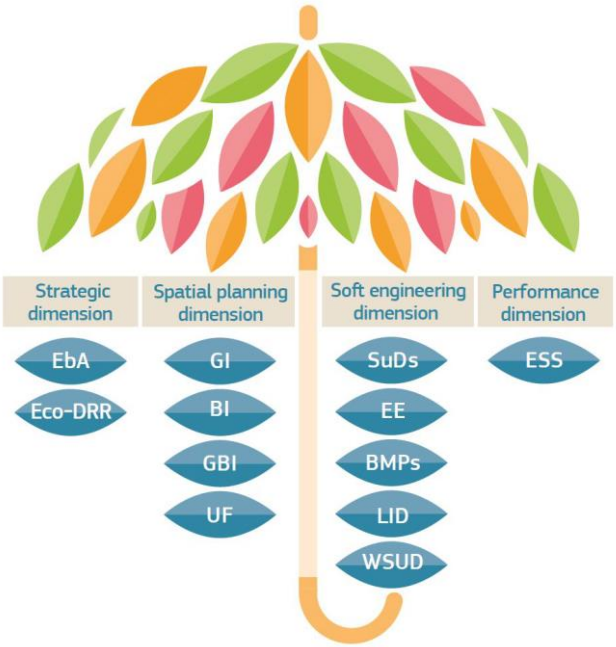

Figure 1: Nature-based solutions as an umbrella concept and the relation of NBS to key existing concepts. EbA = ecosystem based adaptation; Eco-DRR = ecosystem-based disaster risk reduction; GI = green infrastructure; BI = blue infrastructure; GBI = green-blue infrastructure; UF = urban forestry; SuDS = 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 the previous ones. In the reviewed publications, no information was found regarding the upper limit of the grey share in the case of hybrid systems.

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.

The most significant Societal Challenges relevant for EcoDaLLi listed in D2.1 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. Water Quality, for example, 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 Scale and others

Until now, most NBS have been categorized by size as either large or small, with larger ones being predominant among the finalized NBS. In D2.1, Chapter 2, this issue was addressed, and it was proposed to introduce "mini-size" as an additional category. Mini-size NBS can be particularly useful for research trials, demonstration projects, and educational initiatives.

It can be mentioned that other activities are aimed at initiation, inducement, and advocacy of application of NBS. There are numerous publications of this type. These factors are beneficial as they support the introduction of NBS, generate public interest, and promote engagement. 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 methodology described, 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:

1. **Variability in Data Availability** – Projects span different time frames, funding sources, and geographic locations. Some may have well-documented reports, while others lack publicly available data or detailed records, leading to inconsistencies.
2. **Heterogeneous Data Sources** – Information comes from multiple sources, such as government reports, academic studies, company documentation, and advocacy publications. Some sources use different terminologies, formats, and methodologies, complicating comparison and synthesis
3. **Timeframe Constraints** – Some projects are still ongoing or lack post-implementation assessments, making it hard to determine their long-term effectiveness.
4. **Lack of Standardized Evaluation Metrics** – There is not a universal framework for assessing NBS projects. Differences in how success is measured (e.g., environmental

impact, cost-effectiveness, community engagement) make it difficult to analyze projects uniformly.

3) A BRIEF HISTORY – GREY SOLUTIONS VS. NBS

Throughout history, societies have developed strategies to manage rivers and wetlands to mitigate flooding, improve water quality, and enhance biodiversity. These strategies can broadly be classified into two categories: **NBS**, which work with natural processes, and **gray infrastructure solutions**, which involve engineered structures. While gray infrastructure dominated in the industrial era, there has been a resurgence of interest in NBS in recent decades due to their sustainability and ecosystem benefits. The interplay between these approaches reflects both technological advancements and evolving environmental philosophies.

Ancient and Indigenous Nature-Based Solutions

1. **Terracing and Irrigation Systems** (Prehistoric - Present): Early civilizations, such as the Mesopotamians, Chinese, and Inca, used terracing and managed floodplains to slow water flow, reduce erosion, and support agriculture.
2. **Beaver-Based Ecosystem Engineering** (Pre-Colonial North America): Indigenous peoples recognized the role of beaver dams in maintaining wetland ecosystems, improving water retention, and preventing erosion.
3. **Floating Agriculture** (Chinampas - Aztec Civilization): Artificial islands were created in wetland environments to support agriculture while preserving water dynamics and aquatic biodiversity. Today is used as Aquaponics.
4. **Zuni Bowl Rock Structures** (Southwestern US): Indigenous groups used these structures to slow runoff, capture sediments, and improve water infiltration in arid river systems.
5. **Stepwells and Rainwater Harvesting** (South Asia, 3rd Century BCE - Present): Indian and Middle Eastern civilizations built stepwells and underground reservoirs to capture monsoon water for use during dry periods.

Medieval and Early Modern Period

1. **Dike and Levee Systems**: In the Netherlands and Germany, communities built earthen dikes to protect settlements from storm surges and river flooding, leading to modern floodplain management techniques.
2. **Rice Paddy and Wetland Management** (East Asia): Longstanding traditions in China, Japan, and Korea involved managing wetlands to support rice cultivation while enhancing biodiversity and water storage.
3. **Managed Flooding**: European landowners occasionally allowed controlled flooding of pastures and wetlands to replenish soil fertility and sustain wildlife habitats, promoting hydrological stability.
4. **London's Thames Embankment** (19th Century): One of the earliest large-scale attempts at integrating flood control with urban design, influencing subsequent city planning.

Industrial Revolution and the Rise of Gray Infrastructure

Funded by the European Union

1. **Channelization and Straightening of Rivers** (19th Century - Present): Many European and North American rivers were straightened and deepened to facilitate navigation and urban expansion, often leading to habitat degradation.
2. **Dams and Reservoirs** (Early 20th Century): Large-scale hydroelectric projects (e.g., Hoover Dam, Aswan High Dam) provided flood control and water supply, but disrupted natural sediment transport and fish migration.
3. **Concrete Embankments** (20th Century): Urban rivers were encased in concrete channels to prevent erosion and direct water flow, leading to significant biodiversity loss and increased downstream flooding risks.
4. **Stormwater Drainage Systems** (Mid-20th Century): Cities developed extensive underground stormwater networks, reducing flood risks, but also disconnecting water from natural hydrological processes, worsening urban heat island effects.
5. **Wetland Drainage for Agriculture and Development** (20th Century): Large-scale drainage projects, such as those in the Florida Everglades and European peatlands, led to the loss of critical wetland habitats.

Modern Shift Toward Nature-Based Solutions

1. **Floodplain Restoration and Reconnection** (Late 20th - 21st Century): Projects in Europe and the U.S. have sought to restore floodplains to allow natural flood mitigation (e.g., Danube River restoration projects, Lower Mississippi Basin restoration efforts).
2. **Wetland Restoration for Water Quality** (1990s - Present): Initiatives like the Everglades Restoration Project aim to restore wetland functions to improve water filtration, carbon sequestration, and biodiversity conservation.
3. **Living Shorelines** (2000s - Present): Using oyster reefs, marsh grasses, and mangroves to stabilize coastal and riverine environments, reducing storm surge impacts and erosion.
4. **Green Stormwater Infrastructure** (2010s - Present): Urban areas now integrate bioswales, rain gardens, and permeable pavement to manage water sustainably, enhancing urban resilience to climate change.
5. **Rewilding Rivers** (2020s - Present): Projects such as the European “Room for the River” initiative promote reintroducing natural meanders, wetlands, and floodplains to manage high water events effectively.
6. **Beaver Reintroduction Programs** (Recent Decades): Efforts in the U.K., U.S., and Canada have successfully reintroduced beavers to improve water retention and wetland health naturally.

Conclusion

The historical progression from indigenous and traditional nature-based solutions to gray infrastructure and back toward natural approaches reflects growing awareness of the importance of ecological balance. Today, a hybrid approach integrating both methods is often favored, recognizing that resilient and sustainable river and wetland management requires the benefits of both engineered and natural systems. By learning from historical practices and

leveraging modern technology, societies can better adapt to climate change, enhance biodiversity, and improve water security.

4) DECISION TREE

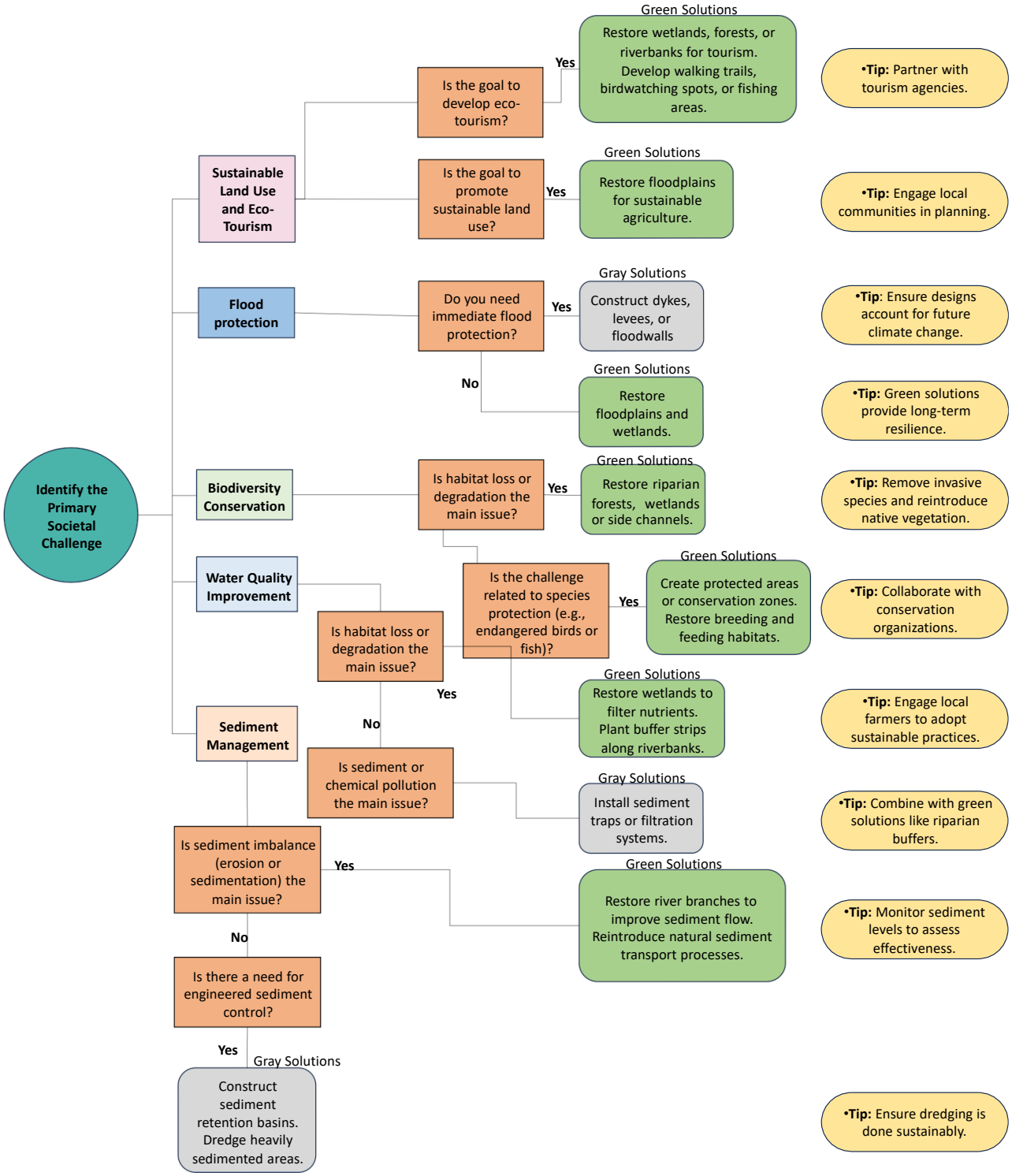

Figure 4. Guiding Framework for Selecting Nature-Based Solutions for Various Societal Challenges. Source: Albert Scrieciu and Andrei Toma

5) NBS BEST PRACTICE EXAMPLES IN THE DANUBE RIVER BASIN

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.

5.1 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.

5.2 Middle Danube

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

Project on Szabadság Island and the Béda-Karapancsa side channel was 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"

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 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.

5.3 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 project built 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.

6) CONCLUSIONS

6.1 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.

6.2 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.

6.3 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, evaluation, and managing restored areas.

6. Economic and Social Benefits

- **Enhanced Recreational Opportunities**: Restored areas, such as oxbows, backwaters 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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ANNEX - NBS projects on Upper/Middle/Lower Danube/Delta

This Anney contains the complete catalogue of NBS projects available on the EcoDaLLi portal. The interactive digital version is available here:
https://portal.ecodalli.eu/wp2_catalogue

Dynamization of the Danube floodplains between Neuburg and Ingolstadt

NBS Type 3

Trees and shrubs

- Forests (including afforestation)

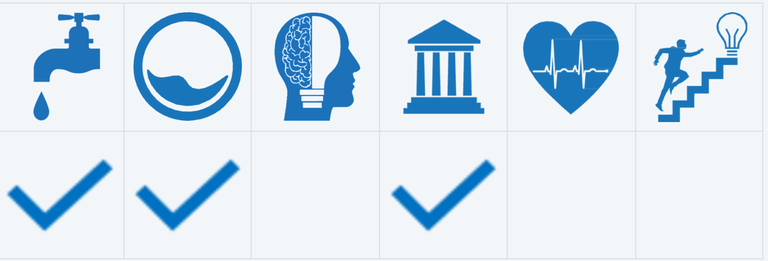
Natural or semi-natural water storage and transport structures

- Floodplains, floodplain reconnection with rivers
- Restoration of degraded waterbodies
- Restoration of degraded waterways, including re-meandering of streams and river daylighting

Website

NBS info

Country	Germany
River, water body	Danube
Stage	ME
Size	Big
Geotype	National
Innovative Solutions	No



Project summary

The Danube floodplain between Neuburg and Ingolstadt is with 2100 ha one of the largest remaining alluvial forests in Germany but has lost a lot of its natural dynamic in the 19th and 20th century due to river regulation measures. Thus, the project “Dynamisierung der Donauauen” aimed to improve river continuum and flood plain dynamics by implementing a package of different measures including but not limited to the construction of water outlets creating new habitats, improving longitudinal connection, and reconnecting the Danube to the adjacent alluvial forest.

Best practices and references

The project led to the founding of the “Auenzentrum” an initiative that serves research and knowledge exchange on the subject of floodplains of rivers and is dedicated to informing and engaging the public. A flyer containing detailed information on all activities is available in the German language.

Environmental, socio-cultural, economic impacts

The Danube floodplains have a wide range of different habitats and are of national importance for the protection of species and biotopes. They are important for the long-term conservation of many species. In addition, the project has a positive effect on flood prevention due to the amount of water diverted.

Replication and scalability

The activities were of course targeted specifically at the part of the Danube between Neuburg and Ingolstadt and can therefore not be directly replicated. However, the project can serve as a best-practice example for how to approach renaturation and how to monitor its success.

Participation process

As early as 1997 a feasibility study was carried out by the Rastatt Floodplain Institute of the Worldwide Fund of Nature (WWF). Based on this study a project groups including of experts from water management and nature conservation, representatives of the city of Ingolstadt and the district of Neuburg-Schrobenhausen, E.on Wasserkraft and the largest property owner, the Wittelsbach Compensation Fund was formed to lay the foundations for implementation of the project.

Lessons learnt

- From the beginning of the project to the finalization of all construction it took 15 years showing that patience is key to a successful restoration project.
- The project is being continuously monitored since its beginnings to ensure and document the positive effects of the measures.

Spittelauer Arm

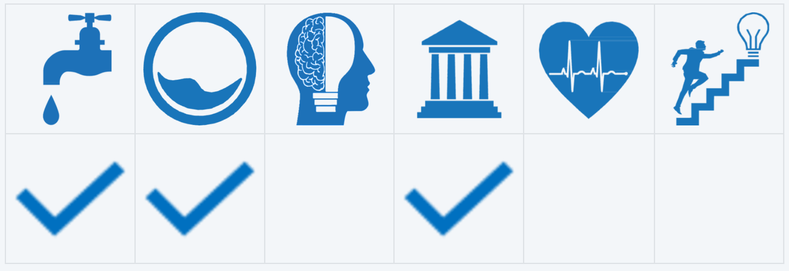
NBS Type 3

- Natural or semi-natural water storage and transport structures
- Floodplains, floodplain reconnection with rivers
- Restoration of degraded waterbodies

Website

NBS info

Country	Austria
River, water body	Danube
Stage	ME
Size	Big
Geotype	International
Innovative Solutions	No



Project summary

"Spittelauer Arm" renaturalisation action has been planned, extends from Petronell to Hainburg, and it has already been part of several renaturation actions. Overall, the restoration goals were aligned towards the ambition of reestablishing the hydrological connection of this river stream with its floodplain and the Danube River. The "Spittelauer Arm"'s basic restoration principle is based on working with the existing stream flow and removing the traverse elements to enhance the floodplain connection. In the course of this, an overall understanding of the ecological elements and river ecosystems' landscape helped to define smart restoration strategies, such as the use of dismantled stones, which were reused from other projects' construction actions in the area.

Best practices and references

As a practical reference to nurture the implementation of these kinds of actions, a "guidance document for river engineering management on the Danube east of Vienna" was drafted ("Flussbauliches Managementleitbild für die Donau östlich von Wien"). In it, the objectives as well as the management principles and working methods required to achieve the objectives were agreed between business representatives and environmental organisations. The document is considered a strategic guideline for the further course of action in the catalogue of measures. The document is only available for download in German language.

Environmental, socio-cultural, economic impacts

Many positive impacts can be considered from the implementation of this project, such as biodiversity enhancement as well as socio-cultural and economic benefits to the residents. For instance, this especially applies to the area of 'Thurnhaufen', which is localised in the opposite front of the city of Hainburg, and turned into an alluvial forest that serves as a retreat for visitors and residents. Overall, the LIFE project enhanced many opportunities to the communities for interacting with the natural environment and helped to maintain, restore, and increase the ecological value of along the tributaries, turning them into lifelines of the floodplain forests. Riparian forests deliver multiple benefits that can be monetised. In total, the Dynamic LIFE Lines project ecologically upgrades over 1500 hectares of riparian forests.

Replication and scalability

The replicability of this kind of restoration action is key in effective watershed restoration and the LIFE project allowed various small interventions along the Upper and Middle Danube region to help in improving the ecological state of this floodplain. A historical track on environmental assessment and monitoring of the watershed helps evaluate the benefits from the implementation of the restoration practices, to demonstrate the importance of replication and scalability for the achievement of our environmental goals. This project has been preceded by several other restoration measures in the area, such as the side-arm reconnection in Haslau Regelsbrunn, finished as early as 1998. The evaluation of the results from the implementation of the previous experiences shows us that the methods applied can be easily replicated and upscaled

Participation process

All measures for the Danube east of Vienna are accompanied and supported by a stakeholder forum. Thereby, affected and interested parties have the possibility to be actively involved in the realisation of the measures and contribute to the way of implementation and evaluation within the given legal framework. Key element of the model is an advisory board, consisting of members of organisations and advocacy groups having a professional relation to the national park area.

Lessons learnt

As a main lesson, the LIFE project demonstrates that there are two essential elements for the achievement of the projects' goals, increasing biodiversity and hydrological dynamics and the regeneration of riparian buffers to transform the tributaries of the Danube into real lifelines. This translates into an important message given the importance of preserving last Europe-wide riparian forests on the Austrian Danube and showed that restoration of lifelines will significantly contribute to this aim.

Danube Sediment Management - Restoration of the Sediment Balance in the Danube River

NBS Type 1 | NBS Type 3

Monitoring

- Regular monitoring of physical, chemical or biological indicators

Website

NBS info

Country	Austria
River, water body	Danube
Stage	ME
Size	Big
Geotype	International
Innovative Solutions	No

Project summary

"DanubeSediment (Danube Sediment Management – Restoration of Sediment Balance in the Danube River) is a transnational initiative aimed at enhancing the morphology, sediment, and water management of the Danube River. Spanning across the entire river basin, this Interreg project took place between 2017 and 2019. Given the critical role of upstream areas in sediment transport, this factsheet emphasizes the efforts undertaken in the Upper Danube Region, with a particular focus on Austria and Germany. Among the main outcomes of the project is the calculation of sediment balance throughout the Danube, coupled with an analysis of sediment flow regime, including sinks, sources, and sediment redistribution within the river. Key drivers and pressures causing sediment discontinuity were analysed to improve the impact assessment of sediment deficit and erosion.

Best practices and references

The DanubeSediment project has produced a variety of documents, plans and strategies aimed at the assessment of sediment transport across the river basin and to understand the Danube River morphology. For this purpose, the project has a strong monitoring component throughout the river, producing the Analysis of Sediment Data Collected. As well, the project has produced a Handbook on Good Practices in Sediment Monitoring with the purpose of refining methodologies to improve data on spatial and temporal variation of sediment transport, through suspended sediment and bedload monitoring, therefore fostering the understanding on the main ecological and hydraulic issues in the river. Interactive maps have been produced, showcasing the monitoring stations across the Danube River and the collected data. Additionally, the project analyses the different pressures that act on the sediment regime on the Danube River and its main tributaries, providing an overview through an interactive map. The following figure showcases the erosion and sedimentation levels, along with the main pressures on the river segment located in Germany and part of Austria.

Environmental, socio-cultural, economic impacts

"The Danube Sediment Management Guidance acknowledges the level in which socio-economic development in the Danube region has altered the natural flow regime of the river. It identifies flood protection, hydropower, navigation, water supply, land use and commercial dredging as the main drivers of alterations in the sediment regimes in the river basin. DanubeSediment also has analysed the historical changes in terms of the river morphology, relating it to the different drivers. The project highlights the adoption of sediment management practices that aim to achieve a balanced sediment regime with a dynamic equilibrium between sedimentation and erosion. It proposes river basin restoration, including the revitalisation of the of river branches to improve water management and the morphology of the Danube River. The Sediment Manual for Stakeholders presents a compilation of best practices and measures for sediment management, including measures to reduce erosion at the catchment, sectional, and local scales. Collecting data and assessing the sediment balance throughout the Danube River basin allows to improve sediment transport and mitigate environmental impacts related to alterations in the nutrient transfer, improvement in the flow regime, and flood mitigation."

Replication and scalability

"The project results feed directly in the plans and strategies issued by the ICPDR, contributing to transnational water management and flood risk prevention, therefore broadening the scope of the project impact. DanubeSediment had International Training Workshops which supported knowledge transfer to key target groups in the Danube River Basin, thus communicating project results and engaging stakeholders beyond the project scope. Additionally, the approach of analysing the processes and mechanisms of sediment transport at the river basin scale can be replicated in different areas. "

Participation process

The project played a key role in the collaborative development of the Sediment Manual for Stakeholders. Furthermore, it facilitated participative processes that influenced the Danube River Management Plan (DRBMP) and the Danube Flood Risk Management Plan (DFRMP), incorporating valuable insights from stakeholders into these strategic plans.

Lessons learnt

The alteration of the sediment balance is a significant water management issue in the Danube River Basin, therefore it should be an integral part of the National River Basin and Flood Management Plans. There is a need for the implementation of integrated river basin scale sediment management concept. Transboundary level approaches are required for the implementation of actions, specially focusing on upstream-downstream flow relations. Sediment management measures should be prepared in an inclusive way, connecting all relevant stakeholders, and must enhance the adoption of holistic approaches that consider both, sediment quantity and quality.

Conservation of alluvial habitats of community interest on the Szabadság Island and side channel in Béda-Karapancsa

NBS Type 1 | NBS Type 2

Monitoring

- Regular monitoring of physical, chemical or biological indicators

Website

NBS info

Country	Hungary
River, water body	Danube
Stage	
Size	
Geotype	
Innovative Solutions	

Project summary

Conservation of alluvial habitats of community interest on the Szabadság Island and side channel in Béda-Karapancsa: Island is covered by alluvial softwood forests with certain invasive (Fraxinus pennsylvanica, Acer negundo) pressure. Until 2009 commercial forestry was going on. The island was connected with the riverbank in 1982 by a rockfill dam, which carried large capacity water pipes. The dam was blocking the river flow in the side-branch, causing fast sedimentation, poor quality of stagnant water and degrading habitats. The forests on the island were cleared 80% from the seed-shedding individuas of the invasives, the 5 ha size poplar plantation was converted to a semi-natural alluvial forest. The waterpipes were relocated, and the rock-fill dam was opened, the large capacity waterpipes were relocated, and the side-branch was dredged along.

Best practices and references

The realized improvement of the longitudinal connectivity which brought additional advantages to the biodiversity improvement and recreational uses; the successful cooperation between the various sectors (as project partners: water directorate, waterworks, national park, local government) and stakeholders (foresty agencies, inhabitants of Mohács (closest city), fairway authorities, angler (other recreation) associations); a good monitoring design was established and the relevant biodiversity indicators are monitored. As a biodiversity-focused project brought also other advantages like improvement of improvement in climate regulation, local flood risk reduction, drought mitigation, is able for further filtration of the water thus improving water quality.

Environmental, socio-cultural, economic impacts

Biodiversity health indicators improved and this was one of the first multitaxa approach for quantifying after restoration changes in taxa composition in Hungary and biomonitoring was implemented during and after the restoration measures and no adverse consequences were identified. Improvement of recreational opportunities like rowing or angling is also characteristic, with change of invasives to native species carbon sequestration was increased and flood risk reduced.

Replication and scalability

Upscaling of the project includes more aspects like people are aware of the ecosystem services of wetlend ecosystems and have successfully worked out strategies and methods of such nature based solutions which can restore the natural dynamics of riverine ecosystems. These solutions are widely supported by goverments and business sectors as well. Only such activities are allowed in floodplains and the river which are in line with natural processes and dynamics of such ecosystems. NBS based restorations are commonly accepted and integratively planned restoration works are finished or in process. Sediment balance is in better state (river management bodies' consider a jointly developed sediment management plan), more natural hydromorphological processes are ongoing. Freshwater biodiversity is on a recovery track and people can use new opportunities from new economic modells based on natural river dynamics.

Participation process

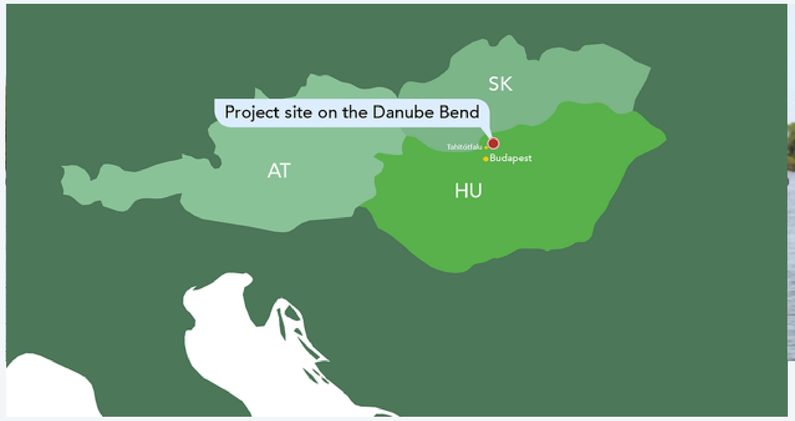
"The main stakeholder groups took part in project proposal development and the key stakeholders were also project partners. Also a wider group of stakeholders were invited on 2 stakeholders fora which were held during the project duration, they were interviewed on their expectations and recommendations. Project didn't improve navigation conditions in the main channel, but it was proven that it doesn't worsen it as well. The project addressed societal challenges and included significant restoration actions. The projects' results have benefits for locals active in angling and rowing."

Lessons learnt

"By planning monitoring of indicators of health & wellbeing were not included in the project, therefore only subjective follow up can be realized. As for biodiversity improvement a general weakness is that invasive species require constant management otherwise it is not only a constraint for biodiversity but also for flood risk and other uses of the area. Maintenance of the navigation route has impacts on the side-branch. The groynes cause sedimentation upstream of it, and this impact is still not mitigated and no safeguards on trade-offs were assessed during the project. Perceived threats result from lack of further funding if unfavourable changes arise in ecosystem integrity (e.g. with the forefront of invasive species) and there is no intention to develop NbS strategy. A balanced climate regulation is threatened by deepening of the main river channel, groine which enables an intensive sedimentation and expansion of the land on the cost of river channel. This process also threatens the flood and drought resilience of the area and hinders opportunities for health & wellbeing for especially local communities which visit usually the project site and its surrounding."

Danube4All

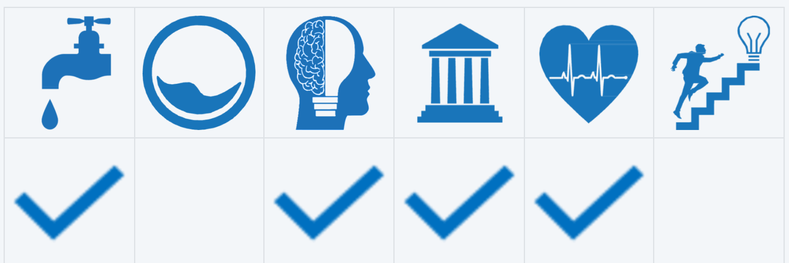
NBS Type 1 | NBS Type 2



Website

NBS info

Country	Hungary
River, water body	Danube
Stage	ME
Size	
Geotype	
Innovative Solutions	



Project summary

Project site is at Sződliget, 30 km north of Budapest along the Danube Bend. Work here will focus on the re-dynamization of the river section through ecological groyne optimization - the first implementation in the field in Hungary. River regulations resulted in loss of habitats and loss of side arms all along the Danube river. Danube has a channel character in many sections with low structural diversity. One of the typical situation is located at the 1675 Rkm. Two groynes have been built in the Danube right side littoral zone as a river regulation infrastructure. Between the groynes sedimentation and siltation have been found. Gravel littoral zone turned into slow flowing or standing water with mud. The dynamic character of the river has been totally lost in this 600 m long habitat. Nevertheless, it is well known that navigation has a negative impact on ecology. The main impact is wave stress for aquatic species. Navigation impacts are significantly higher in channelized sections.

Best practices and references

1. Increasing biodiversity of the area (app. 50 ha) following by the increased structural diversity
2. 10-20 cm/s velocity in littoral zone (nursery for reophilous species) even at low water level
3. The island will provide a safe habitat against wave stress
4. The island will be sustainable in the long term
5. The restoration is compatible with both navigation and flood protection interests

Environmental, socio-cultural, economic impacts

Richness of biodiversity and habitats increases while the section will be suitable as fish spawning area. Also it helps to maintain the fairway conditions. This provides also more opportunities for anglers and less invasive species will be present. It will be a good example to be replicated representing an NBS for navigation and biodiversity as well. And the richer is the biodiversity the better it can mitigate also climate change effects.

Replication and scalability

Lots of old water regulation structures are along the Hungarian Danube stretch which could be revised and reshaped thus protecting siltation and riverbed narrowing and juvenile fish and macroinvertebrates from waves caused by heavy ship traffic..

Participation process

DANUBE4all will closely cooperate with the local communities, inhabitants, SMEs, and stakeholders to optimise the final design, strengthening participation before, during and after implementation of the measures e.g., by involving Citizen Science in monitoring programs

Lessons learnt

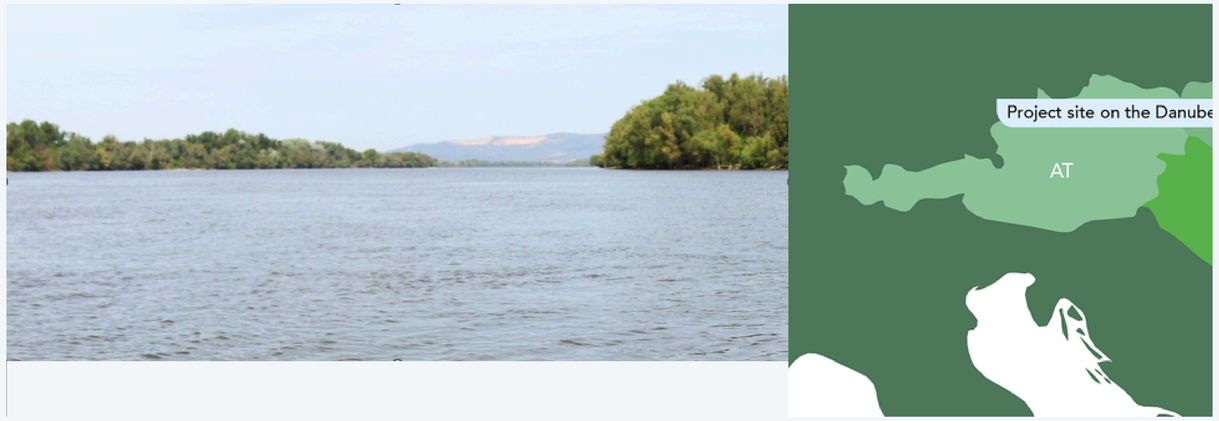
Project is ongoing, these can be concluded in a later stage.

Revitalisation of Endangered Aquatic Natural Habitats along the Báta Danube

NBS Type 1 | NBS Type 2

Protection and conservation strategies

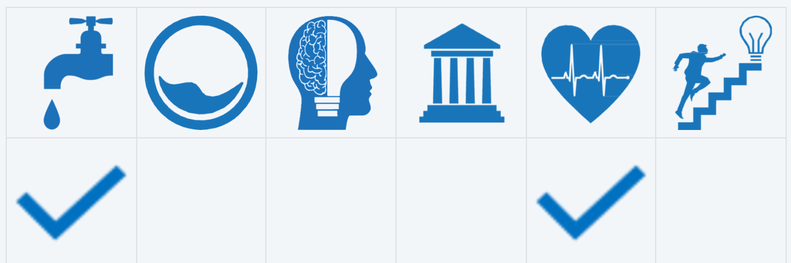
- Ensuring of continuity of ecological networks (protection from fragmentation)
- Monitoring: Regular monitoring of physical, chemical or biological indicators



Website

NBS info

Country	Hungary
River, water body	Danube
Stage	RF
Size	Small
Geotype	Local
Innovative Solutions	



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Best practices and references

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2. 10-20 cm/s velocity in littoral zone (nursery for reophilous species) even at low water level
3. The island will provide a safe habitat against wave stress
4. The island will be sustainable in the long term
5. The restoration is compatible with both navigation and flood protection interests

Environmental, socio-cultural, economic impacts

Richness of biodiversity and habitats increases while the section will be suitable as fish spawning area. Also it helps to maintain the fairway conditions. This provides also more opportunities for anglers and less invasive species will be present. It will be a good example to be replicated representing an NBS for navigation and biodiversity as well. And the richer is the biodiversity the better it can mitigate also climate change effects.

Replication and scalability

Lots of old water regulation structures are along the Hungarian Danube stretch which could be revised and reshaped thus protecting siltation and riverbed narrowing and juvenile fish and macroinvertebrates from waves caused by heavy ship traffic..

Participation process

DANUBE4all will closely cooperate with the local communities, inhabitants, SMEs, and stakeholders to optimise the final design, strengthening participation before, during and after implementation of the measures e.g., by involving Citizen Science in monitoring programs

Lessons learnt

Project is ongoing, these can be concluded in a later stage.

Revitalisation of side arms and backwaters of Béda-Karapancsa (Mocskos Duna)

NBS Type 1 | NBS Type

Protection and conservation strategies

- Ensuring of continuity of ecological networks (protection from fragmentation)
- Establishment of protected areas or conservation zones

Monitoring

- Regular monitoring of physical, chemical or biological indicators

Website

NBS info

Country	Hungary
River, water body	Danube
Stage	RF
Size	Small
Geotype	Large

Innovative Solutions

Project summary

The aim of the project was improving the water discharge of Mocskos-Duna, which is an app. 4 km long oxbow on the Danube's floodplain. During the project a water retention sluice has been constructed into the mouth of the oxbow to retain the water after the floodwaves.

Best practices and references

Within the planning process we have focused on the principle to reach the largest benefit by the smallest intervention. So only a relatively small size artefact has been built, the other part of the oxbow remained untouched.

Environmental, socio-cultural, economic impacts

The certain section of the oxbow used for leisure angling by a local fishing association. The improved water also create more favourable condition for the fish communities.

Replication and scalability

The constructing of water retention artefact has been done in case of other restoration projects.

Participation process

The planning and implementation has been developed with the cooperation of South-Transdanubian Water Management Directorate and the Danube-Drava National park Directorate. The Gemenc state forest company- who is responsible for the management of nearby forest- was also involved in planning procedure.

Lessons learnt

The permanent riverbed erosion of river Danube resulted, that the level of the sluice calculated 15 years ago is a slightly high now and the sluice has to be operated more frequently than it was expected a decade ago.

Revitalisation of side arms and backwaters of Béda-Karapancsa (Mocskos Duna)

NBS Type 1 | NBS Type 2

Protection and conservation strategies

- Ensuring of continuity of ecological networks (protection from fragmentation)

Monitoring

- Regular monitoring of physical, chemical or biological indicators

Website

NBS info

Country	Romania
River, water body	Danube
Stage	RF
Size	1000 ha
Geotype	Local
Innovative Solutions	

Project summary

The project tackled the urgent task of preserving two globally threatened bird species, the pygmy cormorant (Phalacrocorax pygmeus) and the ferruginous duck (Aythya nyroca), in the dynamic ecosystem of the lower Danube region. These species faced serious threats including habitat degradation, human activities, and insufficient cross-border cooperation in conservation. Despite being priority species for LIFE Nature funding in the EU, their populations in the wetlands of southern and southeastern Europe, particularly along the lower Danube, were declining. The project aimed to support cross-border cooperation between Romania and Bulgaria to implement coordinated conservation efforts across key Natura 2000 sites. It focused on restoring and enhancing important wetland habitats for breeding and feeding activities through initiatives like creating freshwater pools and managing reedbeds. These efforts were needed for the long-term survival of these species in the region.

Best practices and references

The NBS strategy prioritized habitat restoration and enhancement for Phalacrocorax pygmeus and Aythya nyroca. Wetland habitats along the lower Danube, like reedbeds and freshwater pools, were restored to create sanctuaries for these birds, supporting biodiversity. Sustainable land management practices were emphasized to address habitat degradation and promote ecosystem health, including controlling invasive species and reducing fragmentation. Stakeholder engagement focused on raising awareness about bird conservation and encouraging sustainable behaviors. Monitoring and adaptive management were key, allowing for assessment and adjustment of strategies based on real-time feedback. This approach optimized conservation efforts and ensured long-term sustainability.

Environmental, socio-cultural, economic impacts

The project successfully maintained breeding populations of P. pygmeus and A. nyroca along the lower Danube, with 1590 and 400 breeding pairs in Romania, and 770 and 155 breeding pairs in Bulgaria, respectively, meeting Favourable Reference Values. Moreover, it expanded their breeding and feeding areas by 1200 hectares each in both countries. A cross-border protected area of 44,297 hectares in Romania and Bulgaria demonstrated integrated conservation efforts, inspiring similar initiatives. Fisheries management was enhanced through seminars, workshops, and stakeholder engagement, benefiting targeted and other priority species. These efforts secured the favorable conservation status of the species in line with EU Birds Directive. The project advanced the Lower Danube Green Corridor Agreement by expanding Natura 2000 sites, restoring 1200 hectares of wetlands, and improving ecological coherence along the lower Danube.

Replication and scalability

Participation process

Through seminars, workshops, and public events, stakeholders were informed about the benefits of NBS and encouraged to support conservation efforts.The project began by establishing necessary structures and financial frameworks for Natura 2000 site support. Efforts included understanding species' needs, engaging stakeholders, and developing strategies to address mortality issues. Progressing, the focus shifted to strengthening cross-border networks along the lower Danube, fortifying administrative and financial mechanisms, and preventing water pollution.

Lessons learnt

- The project demonstrates importance of cross-border cooperation in conservation efforts for species with transboundary habitats.
- Engagement of stakeholders through seminars, workshops, and outreach activities important for garnering support.
- There is an opportunity to scale up conservation efforts beyond the Lower Danube region and replicate initiatives in other areas facing similar challenges.
- Monitoring of bird populations and habitat conditions were essential to track effectiveness of interventions over time.
- Political instability, changes in government priorities, and socio-economic challenges pose risks to continuity of conservation efforts.

Danube Sediment Management - Restoration of the Sediment Balance in the Danube River

NBS Type 1 | NBS Type 2

Protection and conservation strategies

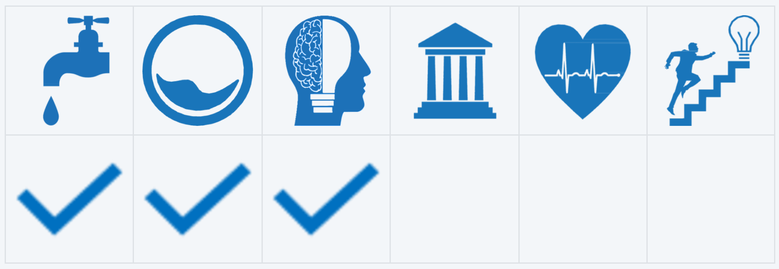
- Ensuring of continuity of ecological networks (protection from fragmentation)
- Maintenance or enhancement of natural wetlands
- Monitoring: Regular monitoring of physical, chemical or biological indicators

Website

NBS info

Country	Romania
River, water body	Argeș
Stage	RF
Size	100 ha
Geotype	Local

Innovative Solutions



Project summary

The project aims to develop and implement a model for gravel extraction site restoration and community based conservation for the Fusea Natural Area. Historically used as an extraction point for aggregates since 1970, the Fusea site located in the floodplain of the Arges river (Danube tributary, South of Romania), in the Dambovita County, is a mixed area of economical and natural value, covering 1 square km. While 88% of the site is included in the “Arges Middle Floodplain” Natura2000 site, there is also a functional gravel extraction point of Lafarge Group Romania and an area of community interest for the villages situated on its border.

Best practices and references

The project restored the gravel extraction site by reconnecting existing lakes and planting indigenous flora for biodiversity. Collaborative efforts with local communities managed human activities impacting the area. An interpretation trail and educational events promoted understanding of ecological significance. Online promotion amplified outreach, while the "Fusea Training Center" served as a hub for environmental education and best practices in conservation.

Environmental, socio-cultural, economic impacts

The project aimed to overcome key challenges in conserving Natura 2000 sites along the lower Danube. This included establishing administrative and financial structures for coordinated efforts between Romania and Bulgaria. Extensive research and stakeholder engagement were conducted to understand species status and requirements. Critical breeding habitats at sites like Blahnita, Olt-Danube, Belene, and Suhaia were restored and managed. Wetlands were maintained or restored to provide feeding grounds, minimizing disturbances and preventing deliberate killing of species. Strict management measures were implemented to prevent water pollution. Environmental impact measures included soil erosion reduction and water quality improvement. Long-term sustainability was evaluated through monitoring protocols and institutional frameworks for continued management, ensuring lasting environmental and community impact.

Replication and scalability

The project has a good replication potential because of its effective implementation of conservation measures, habitat restoration, minimizing disturbances, preventing species killing, and managing water pollution to ensure the survival and ecological integrity of target species in key Natura 2000 sites along the lower Danube.The project primarily aimed at enhancing biodiversity by restoring a gravel extraction site, focusing on measures like reconnecting lakes and planting indigenous flora. Monitoring methodology can also be replicated: flora and fauna recovery monitoring in restored areas provided great information on indigenous species presence and ecological interactions. Facilitating wildlife movement through lake reconnection and strategic planting aimed to improve habitat connectivity, emphasising its impact on ecosystem resilience.

Participation process

This site is a good opportunity to show the value of ecological restoration of degraded floodplain and to ensure a community based system of managing the environmental services of the area with the direct involvement of the Lafarge team. Community engagement, including local involvement in decision-making, aimed to promote ownership and stewardship. Promotion activities tracked public engagement, showcasing effectiveness in raising awareness about ecological restoration.

Lessons learnt

- Engaging with local communities early and consistently proved essential in building trust, understanding their needs, and ensuring their active participation.
- Scaling up similar initiatives in other degraded areas offers the potential to maximize impact and address broader environmental challenges.
- Building resilience into project designs and maintaining adaptive management practices can help mitigate environmental risks and ensure continued progress.

Restoration of Rusenski Lom River near Ivanovo

Type 1 & 2 & 3 NBS

NBS Type 1 | NBS Type 2

Protection and conservation strategies

- Ensuring of continuity of ecological networks (protection from fragmentation) Maintenance or enhancement of natural wetlands)
- Maintenance or enhancement of natural wetlands

Website

NBS info

Country	Bulgaria
River, water body	Rusenski Lom
Stage	ME
Size	Medium
Geotype	Large
Innovative Solutions	Yes

Project summary

In the mid-20th century, the lower flow of the Rusenski Lom River underwent regulation with dykes, but this proved unsuccessful in some areas due to frequent flooding and high groundwater levels. Consequently, much of the reclaimed land was converted into fishponds, which were economically inefficient and often destroyed during periods of high water. As a result, many of these fishponds now lie abandoned. This situation is evident along the Rusenski Lom river near the Ivanovo rock monasteries, where an asphalt road and visitor infrastructure sit atop river protection dykes. Despite these measures, floods frequently inundate the area, damaging access roads and infrastructure. The flood of 2006 was particularly devastating, washing away bridges and alcoves on the island, and causing partial breaches in the dykes, leaving flooded land submerged for over a year.

Best practices and references

WWF started restoring the river and measures were completed in 2009. In this case, the water itself suggested the solution to the problem. The dike was further opened in three places. It is the first example in Bulgaria for application of the principle “more space for the river – more safety for people”, proven yet in mid-20th century.

Environmental, socio-cultural, economic impacts

Thanks to this approach, now during high water the river may spread out, settle down and go back into its bed without flooding the surrounding land. At the same time, overflows in the floodplain terrace provide feeding places for the black stork, habitats for rare water plants and breeding places for a number of fish and amphibian species.

Replication and scalability

This project was implemented on a relatively small scale. Although there are some local specificities, the project is not uncommon and the techniques and approaches used are well established. In other words, there is great scope for replicating the good results and applying them elsewhere, including on a wider scale.

Participation process

The project was implemented in 2009 by the Rusenski Lom Nature Park Directorate, “Friends of Rusenski Lom” Club and WWF with the support of the Bulgarian Ministry of Culture, and was funded by WWF and the German Federal Ecological Foundation DBU. Apart from the institutions and organisations mentioned, there were no other stakeholders actively involved. The project has gone through coordination procedures with the state administration and local authorities, but there has been no public consultation process.

Lessons learnt

This is a project that has been implemented on a small area and yet has a clear socio-economic and environmental positive service. Often small projects are questioned as to whether their implementation will have a measurable effect. This is an example of a project that was not subject to public consultation and yet the lack of such consultation did not adversely affect the project.

Wetlands restoration and nature protection, with Persina Nature Park and Kalimok/Brushlen Protected Site

Type 1 & 2 & 3 NBS

NBS Type 1 | NBS Type 2

Protection and conservation strategies

- Ensuring of continuity of ecological networks (protection from fragmentation)
- Maintenance or enhancement of natural wetlands

Website

NBS info

Country	Bulgaria
River, water body	Danube
Stage	ME
Size	Large
Geotype	Local
Innovative Solutions	Yes

Project summary

The Bulgarian Wetlands Restoration and Pollution Reduction Project, a pilot initiative under the GEF Black Sea/Danube Strategic Partnership, aims to control nutrient inflow to the Black Sea. The project focuses on wetlands restoration and nature protection, with Persina Nature Park and Kalimok/Brushlen Protected Site as key areas. It received funding from GEF, the World Bank, and other donors, totaling USD 13.28 million. By reconnecting wetlands to the Danube and promoting sustainable land use, the project aims to reduce trans-boundary nutrient loads and restore biodiversity.

Best practices and references

The project implements best practices in wetlands restoration and management, aligning with international conventions like the Ramsar Convention on Wetlands. It collaborates with local communities, government agencies and NGOs (Green Balkans, WWF and others). The initiative draws on successful experiences from other countries, such as Austria and Hungary, in wetlands restoration along the Danube River.

Environmental, socio-cultural, economic impacts

Restoring wetlands in Persina Nature Park and Kalimok/Brushlen Protected Site has significant environmental impacts, including biodiversity enrichment - new colonies of the Dalmatian Pelican were established at both project sites. The nutrient reduction in the Danube River does not seem to be among the most significant contributions of this project. Socio-culturally, the project fosters community engagement through mostly education and support for the traditional fishing practices.

Replication and scalability

The project serves as a model for other riparian sites facing similar challenges in biodiversity and wetlands degradation. Its success in Persina Nature Park demonstrates the feasibility of wetlands reconnection to the Danube linked with protected areas management. By sharing best practices and lessons learned, the project contributes to other efforts in the Danube basins to manage wetlands like Kalimok wetlands and Srebarna Lake.

Participation process

The consultative process in this project has taken place within a relatively limited range of stakeholders. These are state structures and local authorities. No private land or other property was affected in this project, which was a prerequisite for significantly more streamlined procedures. Communication with the local community proved to be very important in securing a positive attitude and support in ensuring the project outcomes.

Lessons learnt

The establishment of a protected area (Persina Nature Park) and a state administration, which, among other things, is responsible for maintaining and developing the products of this restoration project, has proved to be the key to its successful implementation over the last more than 20 years.

Restoration in Babina and Cernovca Islets

Type 1 & 2 & 3 NBS

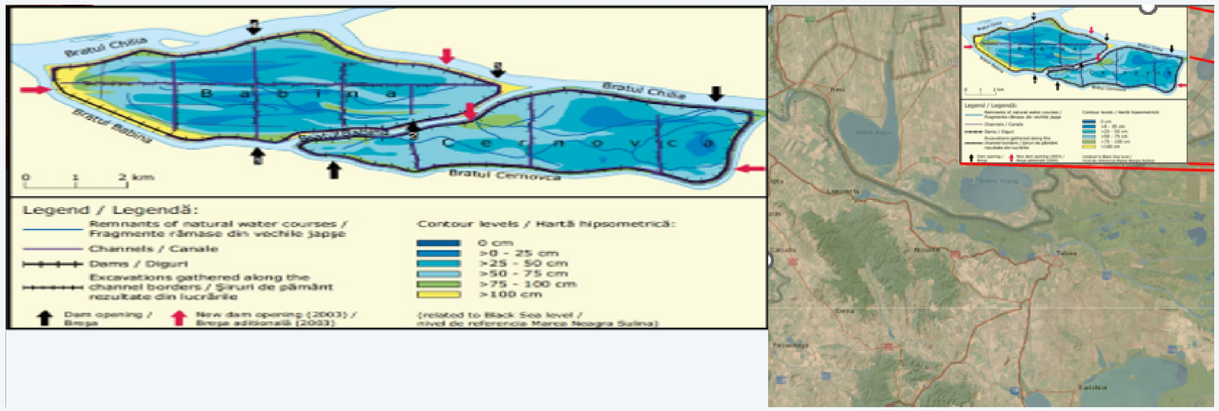
NBS Type 1 | NBS Type 2

Protection and conservation strategies

- Ensuring of continuity of ecological networks (protection from fragmentation)
-
- Maintenance or enhancement of natural wetlands

Monitoring

- Regular monitoring of physical, chemical or biological indicators



Website

NBS info

Country	Romania
River, water body	Danube Delta
Stage	ME
Size	Large
Geotype	Local
Innovative Solutions	

Project summary

The objective of ecological restoration in Babina and Cernovca Islets was to restore the natural, site-specific hydrological, biogeochemical and ecological functions, to ensure the redevelopment of the ecosystem and its functions and thus to promote the development of site-specific habitats and their biodiversity. More-over, the redevelopment of the natural resources should enable the local populations to proceed to their sustainable, traditional use.

Best practices and references

Babina and Cernovca Islets was the first projects in the Danube Delta where new paths were stroke, away from an intensive, site-unspecific use back to near-natural structures, exemplar for nature conservation with and for man. It caused a change of mind and offered new incentives to restore further flood prone areas that had been altered by man, in the Danube Delta but also in Fore-Delta.

Environmental, socio-cultural, economic impacts

Restored natural functions allow the redevelopment of natural resources and values that are to the benefit of the local populations and of major importance for the local, regional and national economy. Given their natural functions and values that are traditionally used with regard to sustainability, the restored wetlands also satisfy fundamental socio-economic functions. For the local populations of the Delta the restoration of abandoned agricultural polders and fish ponds is a good option as compared to the abandoned polders that could not be used as planned. Fish resources play a decisive role as they constitute the local populations' fundamentals of life. Reed cutting and use, especially with respect to the traditional construction methods in the Danube Delta, are among the major occupations of the people living in the Delta. Moreover, eco-tourism is of increasingly high importance. The landscape of the Delta, with its mosaic of waters and large reed areas, white willow gallery forests, dunes, the characteristic fauna of varying habitats and in particular its avifauna with large mixed, species rich colonies, benefits from a constantly growing interest. The areas comprised in the rehabilitation programme may thus also contribute to the development of an environmentally friendly sustainable eco-tourism.

Replication and scalability

The natural functions, once restored, develop certain existential values - natural and ideal resources - from which the local people can benefit, but also important for the local, regional and national economy. Through these traditionally and sustainably used resources and values, wetlands perform important socio-economic functions, providing the material basis for the local population. In this sense, ecological restoration is an alternative for abandoned agricultural and fish farms, which can no longer be used for the purpose for which they were intended.

Participation process

A management master plan that had been elaborated in a first phase for the Danube Delta Biosphere Reserve in 1992, comprised a number of areas to be restored, such as abandoned agricultural polders and unprofitable fish farms. Among these, the agricultural polders Babina (2100 ha) and Cemovca (1560 ha) were selected as pilot project areas for ecological restoration and were realized in a productive co-operation between the Danube Delta National Institute for Research and Development in Tulcea and the Institute for Floodplain Eco- logy of WWF Germany. Respective preparatory studies were conducted from 1992, allowing first restoration measures to be implemented already in 1994 in Polder Babina and in 1996 in Cernovca.

Lessons learnt

The prerequisite for starting a restoration process is a concise planning and implementation of the necessary measures to be taken. In the spring of 1994, the Babina polder located in the northeastern part of the Danube Delta and previously used for agricultural purposes, was reconnected to the flood regime of the Danube River. In doing so, fresh ground was not only broken in terms of restoring the drained wetlands of the Danube Delta. Rather many crucial questions arose regarding the further development of the area. In terms of area development, how long would it take for the characteristic habitats to reappear? When will this wetland that was drained years ago be fully operational again and how long would it take Babina Island to return to its characteristic functions?

Re-evaluation the polders from Danube Floodplain and Delta

Type 1 & 2 & 3 NBS

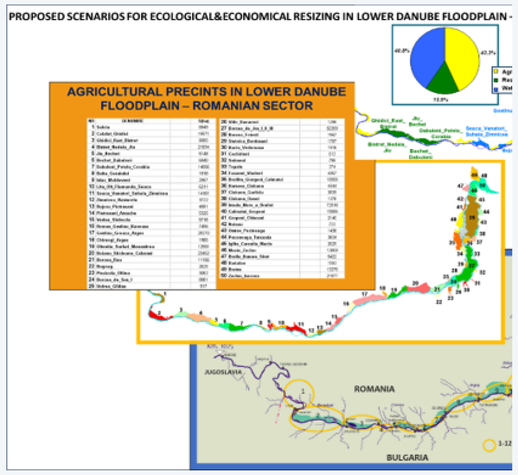
NBS Type 1 | NBS Type 2

Protection and conservation strategies

- Ensuring of continuity of ecological networks (protection from fragmentation)
-
- Maintenance or enhancement of natural wetlands

Monitoring

- Regular monitoring of physical, chemical or biological indicators



Website

NBS info

Country	Romania
River, water body	Danube Delta
Stage	IN
Size	Large
Geotype	National
Innovative Solutions	

Project summary

The ecological and economical Program of re-evaluation the polders from Danube Floodplain and Delta was conceived and launch to give assistance to the Romanian Government in the process of strategically long-term planning for fulfilling the goals of the Water Framework Directive as well as for effective implementation of tasks regarding prevention, protection and mitigation of flooding effects, stipulated in the National Strategy for Flooding Risks Management. The main objective of the program was to create the strategy of implementation of the integrated management concept (adaptative and ecosystemic) and sustainable development in Lower Danube Floodplain– Romanian Sector and also to elaborate priorities and criteria which show the ecologic, economic and social interests in order to evaluate the necessary and available resources, in order to increase the projects viability.

Best practices and references

Stipulated results:

- defending localities against flooding;
- increasing touristic interest of the area and development of necessary infrastructure;
- benefits for local peoples referring to increasing of occupation level and developing of traditional activities as fishing, industrial fish processing, processing of reed, wood, osier etc.;
- Monitoring Integrating System in conditions of hydrologic risk;
- Rehabilitation and preservation of biological diversity specified for Lower floodplain of Danube River.

Environmental, socio-cultural, economic impacts

In the same time the program “Ecological and economical restoration of Lower Danube floodplain – Romanian sector” in order to implementing National Strategy of Management regarding Flooding Risk is in connection with European Union Directives (Water Framework Directive, Directives regarding Natural Habitat’ Conservations, Wild Flora and fauna, Birds Conservations), and also the Objectives of Natural Strategy for Sustainable Development. Danube River and its Valley in the Romanian Sector represented the subject of researchers for arrangement of the floodplain in order to its economical valorization, most of them stopped in 1970. With the view of implementing this Program, it insist on knowing at detailed level, the state of socio-economical and ecological systems, elaboration of digital model of the land and also hydraulic model, without can’t be possible elaboration of the strategy against flooding.

Replication and scalability

The entire project, with the generated objectives and issues, contributes to:

- Uphold the shape, develop, integrate and consolidate an excellency network, recognized by the international norms.
- Growing the management system capacity for this field in Romania, to accumulate information, results and experience in highest scientifically and technical domains in order to spread them towards economical and social intern domain.
- An optimum focus and capitalize of the highest scientifically potential from Romania
- Harmonize to the EU Directives and requirements (Water Framework Directive, Floods Directive and Natura 2000)

Participation process

The diversity of the fields addressed through the imposed theme determined permanent meetings between partners to achieve a unique methodology in addressing these diverse topics, but also good information in the fields: remote sensing, soil quality, hydrology, economy and environmental protection.

Lessons learnt

- Reconsidering the defense lines of localities against floods
- Evaluation of the suitability of premises designed for economic activities in order to resize them as mixed premises (agricultural/polders for water storage)
- Qualitative assessment of the environmental impact (regarding erosion, water balance, biodiversity conservation, etc.)
- Calculation of the overall grade of each project and/or variant of the project.

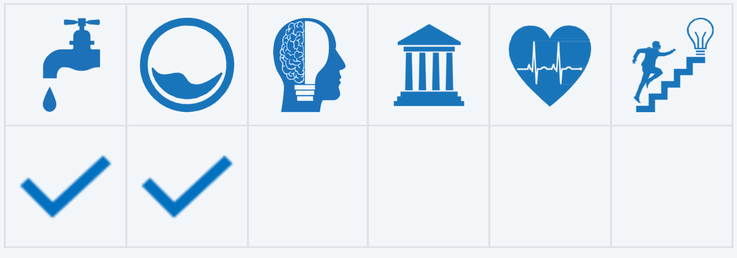
DTP-Danube Floodplain Project

NBS Type 1 | NBS Type 3

Website

NBS info

Country	DE, AT, HU, RS, BG, RO
River, water body	Danube
Stage	ME
Size	Big
Geotype	Local
Innovative Solutions	No



Project summary

The current DTP-Danube Floodplain Project (DFP) links attempts of improving flood retention and restoration, while water quality is not yet in focus. IDESproject aims to add water quality targets to this effort and improve water quality by developing an integrative floodplain management based on Ecosystem Services (ES). The transdiciplinary nature of the project links aspects related to the management of flood plains for both water retention (management) and improvement of water quality through the reduction of nutrients.

Best practices and references

Environmental, socio-cultural, economic impacts

Replication and scalability

Participation process

Lessons learnt

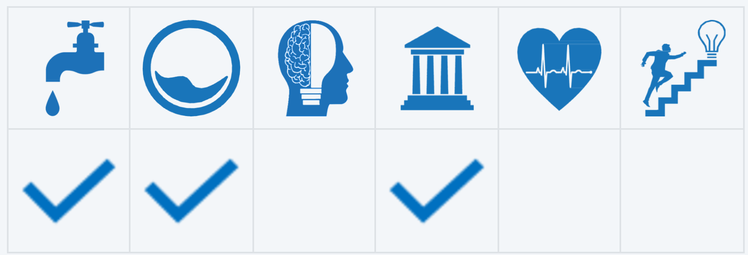
Danube Habitat: Preserving-Developing the Danube of Baden-Württemberg

NBS Type 1 | NBS Type 2 | NBS Type 3

Website

NBS info

Country	Germany
River, water body	Danube
Stage	IN
Size	Big
Geotype	National
Innovative Solutions	No



Project summary

The Integrated Danube Programme is a holistic concept that takes into account flood protection and ecology in equal measure. Measures for renaturation are used for flood protection and appropriately designed technical flood protection often improves ecology. Under the motto "Danube Habitat: Preserving-Developing" the IDP is intended to protect people from the floods of the Danube and develop the habitat of the Danube as a natural and cultural heritage. In the IDP, the Danube of Baden-Württemberg Viewed as a whole. Individual projects such as flood protection measures, renaturation measures, the construction of fish ladders and bypass channels or the designation of nature reserves are seen in the context of an improvement of the entire Danube water system and listed in an overall view of the IDP.

Best practices and references

Environmental, socio-cultural, economic impacts

Replication and scalability

Participation process

Lessons learnt

Multiplication of the ecosystem services in Danube-Auen National Park in Vienna

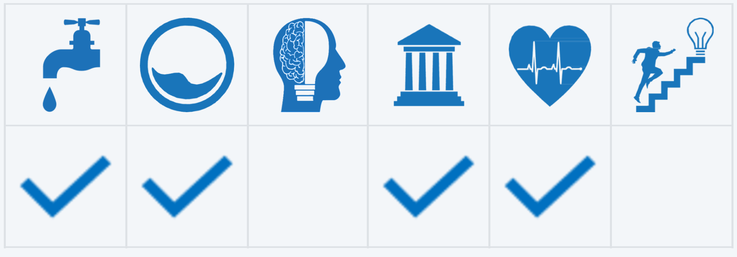
NBS Type 1 | NBS Type 3

Website

NBS info

Country	Austria
River, water body	Danube
Stage	ME
Size	Big
Geotype	Local

Innovative Solutions



Project summary

The Danube-Auen National Park in Vienna aims to multiple ecosystem services combine with trees with regulating services, such as water protection, retention, carbon sequestration, and micro, local, and regional climate regulation. The National Park fosters an environment providing habitats and biodiversity for animal and plant species to enhance supporting ecosystemfunctions. The National Park's blue and green infrastructure further aims to provide cultural functions by offering open spaces for recreational value, allowing urban dwellers to find aesthetic pleasure, a sense of place and inspiration.

Best practices and references

Environmental, socio-cultural, economic impacts

Replication and scalability

Participation process

Lessons learnt

MERLIN - Mainstreaming Ecological Restorationof freshwater-related ecosy

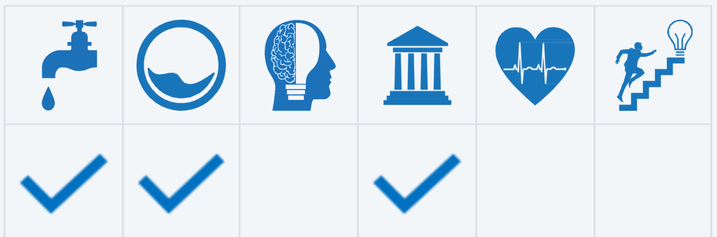
NBS Type 3

Website

NBS info

Country	Austria
River, water body	Danube
Stage	REP
Size	Big
Geotype	Local

Innovative Solutions



Project summary

MERLIN "Mainstreaming Ecological Restorationof freshwater-related ecosystem

Best practices and references

Environmental, socio-cultural, economic impacts

Replication and scalability

Participation process

Lessons learnt

LIFE IRIS

NBS Type 2 | NBS Type 3

Website

NBS info

Country	Austria
River, water body	Danube
Stage	REP
Size	Big
Geotype	Local
Innovative Solutions	Yes

Project summary

In the area of tension between flood protection, hydropower use, shipping and nature conservation, the interests, responsibilities and planning framework conditions on the Danube in Upper Austria are particularly complex. For the first time in the history of the river, the project LIFE IRIS offers the opportunity to develop a joint action plan as result of a GE-RM planning process. Preparatory work for the planning process has been carried out and is now to be integrated – supplemented by further surveys and analyses – into a concept of measures, which is also coordinated and agreed with stakeholders. Additionally a pilot measure with added value for flood protection and river ecology will be implemented. It is planned to create a gravel island and a side branch in the downstream section of the hydropower plant Ottensheim. By lowering the terrain, pioneer areas for gravel islands and floodplain forest sites will be created and the flood runoff will be improved.

Best practices and references

Environmental, socio-cultural, economic impacts

Replication and scalability

Participation process

Lessons learnt

LIFE Netzwerk Donau: New habitats are created

NBS Type 1 | NBS Type 2

Website

NBS info

Country	Austria
River, water body	Danube
Stage	RF
Size	Big
Geotype	National

Innovative Solutions

Project summary

3 fish passes, 4 locations, 5 measures: between 2016 and 2020, project manager VERBUND worked with partners to implement extensive improvements to waterbodies and species diversity on the Danube in Austria. The measures represent so-called “ecological stepping stones” and interconnect four Natura 2000 areas.

Best practices and references

Environmental, socio-cultural, economic impacts

Replication and scalability

Participation process

Lessons learnt

LIFE+ Traisen

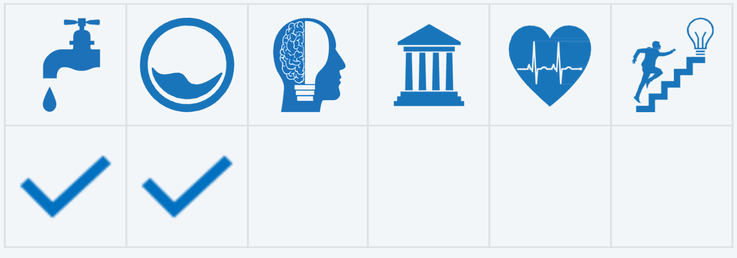
NBS Type 1 | NBS Type 2 | NBS Type 3

Website

NBS info

Country	Austria
River, water body	Danube
Stage	ME
Size	Big
Geotype	National

Innovative Solutions



Project summary

Between 2009 and 2019, the LIFE+ Traisen project gave rise to a unique river landscape with a mosaic of existing and new habitats. Many kinds of flora and fauna have already settled into the area. Many endangered kinds of flora and fauna have found a new home here. The river landscape will now continue to develop naturally and undisturbed. A natural river course with densely vegetated banks: that's what the area around the mouth of the Traisen looks like today. This was made possible by the LIFE+ Traisen project – Austria's largest land restoration project to date.

Best practices and references

Environmental, socio-cultural, economic impacts

Replication and scalability

Participation process

Lessons learnt

Life Wild Island

NBS Type 1 | NBS Type 2

Website

NBS info

Country	Hungary
River, water body	Danube
Stage	REP
Size	Small
Geotype	National

Innovative Solutions

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Project summary

The Fertő-Hanság National Park Directorate carries out a project on one of the Danube islands and sidearms called Erebe. The development, financed by the international Life Wild Island project, aims to increase the amount of water replacement, dredging of the sidearm and the creation of spawning grounds in order to restore the habitats of the island.

Best practices and references

Environmental, socio-cultural, economic impacts

Replication and scalability

Participation process

Lessons learnt

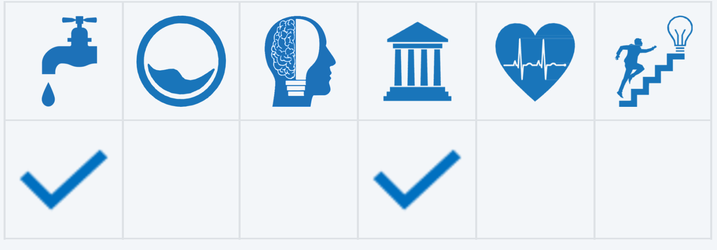
RECONECT

NBS Type 1

Website

NBS info

Country	Serbia
River, water body	Sava
Stage	NBSa
Size	Small
Geotype	National
Innovative Solutions	Yes



Project summary

RECONECT aims to rapidly enhance the European reference framework on Nature-Based Solutions (NBS) for hydro-meteorological risk reduction by demonstrating, referencing, upscaling and exploiting large-scale NBS in rural and natural areas.

Best practices and references

Environmental, socio-cultural, economic impacts

Replication and scalability

Participation process

Lessons learnt

Wetlands Restoration and Pollution Reduction Project

NBS Type 1 | NBS Type 2 | NBS Type 3

Website

NBS info

Country	Bulgaria
River, water body	Danube
Stage	IN
Size	Medium
Geotype	Local
Innovative Solutions	Yes

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Project summary

The Bulgarian Wetlands Restoration and Pollution Reduction Project, a pilot initiative under the GEF Black Sea/Danube Strategic Partnership, aims to control nutrient inflow to the Black Sea. The project focuses on wetlands restoration and nature protection, with Persina Nature Park and Kalimok/Brushlen Protected Site as key areas. It received funding from GEF, the World Bank, and other donors, totaling USD 13.28 million. By reconnecting wetlands to the Danube and promoting sustainable land use, the project aims to reduce trans-boundary nutrient loads and restore biodiversity.

Best practices and references

Environmental, socio-cultural, economic impacts

Replication and scalability

Participation process

Lessons learnt

Wetlands Restoration and Pollution Reduction Project at Persina Nature Park

NBS Type 1 | NBS Type 2 | NBS Type 3

Website

NBS info

Country	Bulgaria
River, water body	Danube
Stage	ME
Size	Big
Geotype	International
Innovative Solutions	Yes

✓	✓ <	✓ <	✓		✓ <

Project summary

Best practices and references

Environmental, socio-cultural, economic impacts

Replication and scalability

Participation process

Lessons learnt

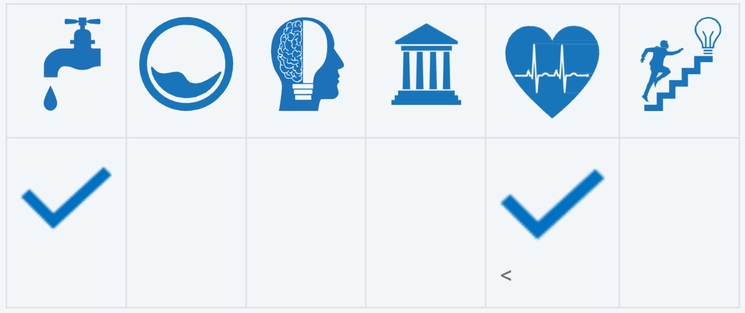
Restoration on Rusenski lom

NBS Type 1 | NBS Type 3

Website

NBS info

Country	Bulgaria
River, water body	Rusenski Lom
Stage	ME
Size	Medium
Geotype	Local
Innovative Solutions	Yes



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Project summary

The project was implemented in 2009 by the Russenski Lom Nature Park Directorate, Club „Friends of Russenski Lom" and WWF with the support of the Ministry of Culture and was funded by WWF and the German Federal Ecological Foundation DBU The main issues are the following: •In the mid 20th century most of the lower flow of Russenski Lom River was fully diverted;•High water floods the road;•When water overflows the dike it can no longer go back into the river;•The flood in 2006 washed away the bridge and the alcoves on the island once again;•In this case, the water itself suggested the solution to the problem;•It is the first example in Bulgaria for application of the principle "more space for the river – more safety for people", proven yet in mid 20th century.

Best practices and references

Environmental, socio-cultural, economic impacts

Replication and scalability

Participation process

Lessons learnt

Restoration of Kaikusha Marsh in Persina Nature Park

NBS Type 3

Website

NBS info

Country	Bulgaria
River, water body	Danube
Stage	RF
Size	Big
Geotype	Local

Innovative Solutions

✓	✓				✓

Project summary

Kaikusha Protected Site is a marsh that remained after the draining of Svishtov-Belene lowlands. There visitors and tourists can see a typical marsh vegetation and many waterfowls. In the autumn of 2011 under GREEN BORDERS Life+ project Persina Nature Park Directorate had started the implementation of activities to restore the water regime of the marsh. There will be build a small visitor infrastructure. This place will be the second restored wetland in Persina Nature Park.

Best practices and references

Environmental, socio-cultural, economic impacts

Replication and scalability

Participation process

Lessons learnt

Carasuhat agricultural polder

NBS Type 1 | NBS Type 3

Website

NBS info

Country	Romania
River, water body	Danube
Stage	RF
Size	Big
Geotype	Local

Innovative Solutions

✓	✓	✓	✓	✓	✓
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Project summary

The community of Mahmudia village does not have direct access to the Danube Delta due to conversion of wetlands into agricultural polders. The community is very supportive to the restoration of Carasuhat polder, giving up their land to be flooded again as part of a WWF project.

Best practices and references

Environmental, socio-cultural, economic impacts

Replication and scalability

Participation process

Lessons learnt

Gîrla Mare wetland

NBS Type 1 | NBS Type 2 | NBS Type 3

Website

NBS info

Country	Romania
River, water body	Danube
Stage	RF
Size	Big
Geotype	Local

Innovative Solutions

✓	✓			✓	✓
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Project summary

The ecological reconstruction of the Gârla Mare-Vrata wetland, with a first stage recently completed by WWF-Romania, contributes to the restoration of biodiversity and to the area's attractiveness for the ecotourism

Best practices and references

Environmental, socio-cultural, economic impacts

Replication and scalability

Participation process

Lessons learnt

Babina and Cernovca agricultural polder

NBS Type 1 | NBS Type 2 | NBS Type 3

Website

NBS info

Country	Romania
River, water body	Danube
Stage	RF
Size	Big
Geotype	Local

Innovative Solutions

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Project summary

The objective of ecological restoration in Babina and Cernovca Islets was to restore the natural, sitespecific hydrological, biogeochemical and ecological functions, to ensure the redevelopment of the ecosystem and its functions and thus to promote the development of site-specific habitats and their biodiversity. More-over, the redevelopment of the natural resources should enable the local populations to proceed to their sustainable, traditional use.

Best practices and references

Environmental, socio-cultural, economic impacts

Replication and scalability

Participation process

Lessons learnt