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Danube Innovation Action Plan

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Abbreviations and Acronyms

AP	Action Plan
CSA	Coordination and Support Action
DRB	Danube River Basin
DSS	Decision Support System
EC	European Commission
EIB	European Investment Bank
EU	European Union
GIS	Geographic Information Services
IA	Innovation Action
ICPDR	International Commission for the Protection of the Danube River
KMS	Knowledge, Monitoring (and Evaluation) System
KPI	Key Performance Indicator
LOI	Letter of Intent
MoU	Memoranda of Understanding
NbS	Nature-based solutions
NGO	Non-governmental Organisation
PESTEL	Political, Economical, Social, Technical, Ecological and Legal
ROI	Return on Investment
SME	Small and Medium-sized Enterprises
WFD	Water Framework Directive
WP	Work Package

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Executive Summary

The Danube River Basin (DRB) is a highly complex socio-ecological system currently facing significant pressures from hydromorphological alterations, biodiversity loss, and the escalating impacts of climate change. To address these multi-faceted challenges, this deliverable presents the Danube Innovation Action Plan as a core component of the EcoDaLLi project, an initiative supporting the EU Mission “Restore our Ocean and Waters 2030”. While previous project stages established a long-term strategic vision, this deliverable provides the practical, operational framework required to translate those ambitions into concrete implementation pathways across the basin.

The Action Plan is structured around six interconnected innovation pillars designed to address the ecological, social, and governance gaps in the region:

1. **Integrated Danube Basin Governance** to enable cross-border alignment.

2. **Nature-based Solutions (NbS) at Scale** to restore natural ecological processes.

3. **Co-creation and Capacity Building** to foster social legitimacy and ownership.

4. **Finance and Investment Mechanisms** to bridge the gap between pilot projects and basin-wide implementation.

5. **Replication and Upscaling** to ensure the geographic spread of successful innovations.

6. **Data Sharing and Monitoring** to support evidence-based, adaptive management.

By synthesizing results from the EcoDaLLi project and related Innovation Actions, the report identifies critical barriers, including fragmented institutional responsibilities and limited stakeholder engagement. To overcome these, the plan highlights key enablers. Ultimately, this Action Plan serves as a comprehensive roadmap for policymakers, practitioners, and investors, providing the tools and strategic insights necessary to achieve a resilient, sustainable, and innovation-driven Danube Lighthouse.

1. Introduction

1.1. EU Mission “Restore our Ocean and Waters 2030”

The health of our ocean and freshwater ecosystems is deteriorating due to pollution, overexploitation, habitat destruction, and climate change. Recognizing the urgent need for action, the EU launched the Mission "Restore Our Ocean and Waters by 2030" as part of the Horizon Europe framework. The Mission is an ambitious initiative to protect and restore marine and freshwater ecosystems, prevent pollution, and support sustainable blue economies. Given the complexity of environmental challenges, co-creation and co-governance are essential to achieving the mission’s targets (European Commission. Directorate General for Research and Innovation., 2023).

The Mission "Restore Our Ocean and Waters by 2030" exemplifies a novel governance approach that embraces co-creation and co-governance. To maximize its impact, policymakers should:

1. Institutionalize participatory governance mechanisms at all levels.
2. Increase financial and technical support for stakeholder-driven projects.
3. Enhance data accessibility and knowledge-sharing platforms.
4. Foster cross-sectoral synergies to bridge science, policy, and practice.

By embedding co-creation and co-governance at the heart of the mission, the EU wants to catalyse transformative change and ensure the long-term resilience of its aquatic ecosystems.

The Mission’s objectives and targets (European Commission. Directorate General for Research and Innovation., 2023)

The Mission is structured around three core objectives:

1. Protect and Restore Marine and Freshwater Ecosystems: Improve biodiversity, restore degraded habitats, and enhance ecosystem resilience.
2. Prevent and Eliminate Pollution: Reduce plastic waste, chemical pollution, and nutrient runoff to achieve good environmental status for aquatic ecosystems.
3. Support a Sustainable Blue Economy: Foster innovative and sustainable business models that balance economic growth with environmental conservation.

The Mission is implemented through lighthouse initiatives in key European sea and river basins, leveraging cutting-edge science, data-driven decision-making, and cross-sectoral collaboration.

Co-creation refers to the active involvement of stakeholders in designing, implementing, and evaluating solutions. In the context of the mission, co-creation ensures that:

- Solutions are grounded in local knowledge and practices.
- Stakeholders have shared ownership over the outcomes.
- Innovations address real-world challenges and are scalable.

Examples of co-creation within the mission include citizen science initiatives, public-private partnerships, and collaborative policy design.

Co-governance is critical for managing complex socio-ecological systems. It involves:

- Multi-Level Governance: Aligning policies across local, national, and EU levels.
- Stakeholder Networks: Engaging NGOs, indigenous communities, academia, and industry.
- Adaptive Management: Using real-time data and feedback loops to adjust strategies dynamically.

By distributing responsibilities among actors, co-governance fosters more resilient and effective policy frameworks.

While co-creation and co-governance provide a pathway to systemic transformation, they also present challenges:

- Coordination Complexity: Balancing diverse interests and governance structures.
- Data Integration: Ensuring interoperability of environmental monitoring systems.
- Long-Term Commitment: Maintaining stakeholder engagement beyond project cycles.

Overall, the Mission aims to establish a shared and forward-looking vision that integrates the management, restoration, and sustainable use of water resources -including flood management - into a coordinated strategy (Haapasaari et al., 2024). This vision is intended to translate into clear sector-specific objectives and actionable measures that guide implementation across governance levels.

Central to this approach is strengthened collaboration, fostering more inclusive and innovative water governance. In particular, the Mission seeks to incentivize private sector engagement in planning processes and promote shared responsibility for implementing management measures and investments. Such a holistic and integrated perspective is essential for advancing progress toward the objectives of the Water Framework Directive (WFD).

At the same time, the Mission faces inherent uncertainties. River basin systems are complex and influenced by multiple interacting drivers, making environmental outcomes - especially long-term impacts - difficult to predict and assess. This uncertainty can weaken the Mission's perceived credibility and legitimacy, potentially limiting funding opportunities and reducing stakeholder motivation and sustained engagement.

Addressing these challenges requires a clearer articulation of the causal pathways linking Mission activities to intended outcomes and impacts, as well as mechanisms to use emerging evidence to iteratively refine strategies and interventions.

- In this context, this deliverable supports the integration of outputs from WP4 and WP5 through the following components: Strategic integration: Consolidation of results from WP4 and WP5 into a coherent framework linking target groups, strategic plans, and governance structures.
- Action plan development: Design of an action plan that fosters entrepreneurship in the Danube Basin, promotes cross-border cooperation, and strengthens innovation ecosystems.
- Policy alignment: Integration of long-term governance and policy perspectives to support sustainable environmental management and alignment with Mission Ocean goals (D7.3).

- Sustainable innovation uptake: Identification and promotion of sustainable and innovative solutions to enhance existing strategies and policies.
- Impact pathway: Structuring of outputs to demonstrate pathways toward environmental improvement, economic development, and strengthened regional cooperation.
- Implementation considerations: Reflection on key challenges related to coordination, cross-border integration, and long-term policy uptake.

1.2. EcoDaLLi Project

The 2030 and 2050 Green Deal goals drive the EU towards developing integrated, forward-looking solutions and setting clear, measurable targets for environmental sustainability. Within this context, EcoDaLLi, as part of the EU Mission “Restore our Ocean and Waters by 2030”, plays a pivotal role in supporting the achievement of the freshwater-related objectives of the European Green Deal. The initiative embraces a systemic and holistic approach to the restoration, protection, and long-term preservation of the entire Danube Basin. This is pursued through a framework of coordinated actions that link environmental, social, and economic dimensions in an integrated governance structure.

EcoDaLLi is a Coordination and Support Action (CSA) project and is designed to deliver a series of tools, guidelines, methodologies and recommendations tested through pilot activities, which will interlink, leverage and optimize activities among the projects funded under the Mission Ocean & Waters. The main objective of EcoDaLLi is to centralise and strengthen governance structures across the Danube region, focusing on innovative, science-based solutions that enhance ecological restoration, safeguard biodiversity, and ensure the sustainable management of the Danube Basin and the Black Sea Delta. To achieve this, EcoDaLLi aims to foster a dynamic and interconnected innovation ecosystem through the establishment of a comprehensive Practices Living Lab System, promoting collaboration among stakeholders, researchers, and policymakers. This system will be supported by a dedicated digital Portal, fully integrated with the Mission Implementation Platform and aligned with the principles of the Mission Charter, ensuring coherence, accessibility, and long-term impact.

Work Package (WP) 7 systematically integrates and synthesises the outputs generated in EcoDaLLi, especially under WP4 and WP5, into a structured visualisation framework that captures the strategic plans of target groups alongside long-term governance and policy trajectories. The resulting action plan provides an evidence-based foundation for fostering innovation across the Danube Basin. It supports the development of a resilient and adaptive innovation ecosystem by embedding principles of sustainability, circularity, and resource efficiency.

Furthermore, the action plan contributes to environmental health and socio-economic cohesion by promoting the uptake of sustainable and innovative solutions, including nature-based approaches and advanced technological applications. These interventions are designed to enhance policy effectiveness and strategic coherence, ultimately facilitating progress towards the achievement of the Mission Ocean objectives (D7.3).

1.3. Context of the Deliverable in the Project and beyond

Deliverable D7.4, the *EcoDaLLi Innovation Action Plan*, represents the operational component of WP 7 and translates the strategic vision developed within EcoDaLLi into concrete innovation

pathways for implementation across the Danube River Basin. While D7.1 established the Danube Action Agenda for Freshwater Ecosystem Protection and Restoration and D7.3 developed the long-term Danube Lighthouse Vision, D7.4 focuses on how these ambitions can be implemented through coordinated governance, innovation, financing, capacity building, and monitoring mechanisms.

The deliverable builds upon the knowledge, tools, methodologies, and stakeholder inputs generated throughout the EcoDaLLi project, particularly the outputs of WP4 and WP5. It further incorporates experiences, lessons learned, and innovative approaches developed by the Mission Ocean and Waters Innovation Actions operating within the Danube and Black Sea Basin. By integrating these results, D7.4 provides a structured framework for transforming project outcomes into actionable implementation pathways that support the objectives of the EU Mission “Restore our Ocean and Waters by 2030”.

The Danube Innovation Action Plan is organised around six interconnected innovation pillars:

1. Integrated Danube Basin Governance
2. Nature-based Solutions at Scale
3. Skills, Capacity Building and Public Engagement through Co-creation Systems
4. Finance and Investment Mechanisms
5. Replication and Upscaling
6. Data Sharing and Monitoring

These pillars represent the key intervention areas required to address the ecological, social, economic, and governance challenges affecting the Danube River Basin. For each pillar, the Action Plan identifies major challenges, strategic actions, supporting tools and mechanisms, implementation requirements, and lessons learned from EcoDaLLi and related Innovation Actions.

The purpose of this deliverable is therefore not to develop a new vision for the Danube Basin, but to provide a practical framework for implementation. By linking innovation tools, governance approaches, restoration measures, financing mechanisms, and stakeholder engagement processes, D7.4 aims to support the long-term transition towards a resilient, sustainable, and innovation-driven Danube Lighthouse. The Action Plan is intended to guide policymakers, river basin authorities, researchers, practitioners, investors, and regional stakeholders in translating strategic objectives into coordinated action beyond the lifetime of the EcoDaLLi project.

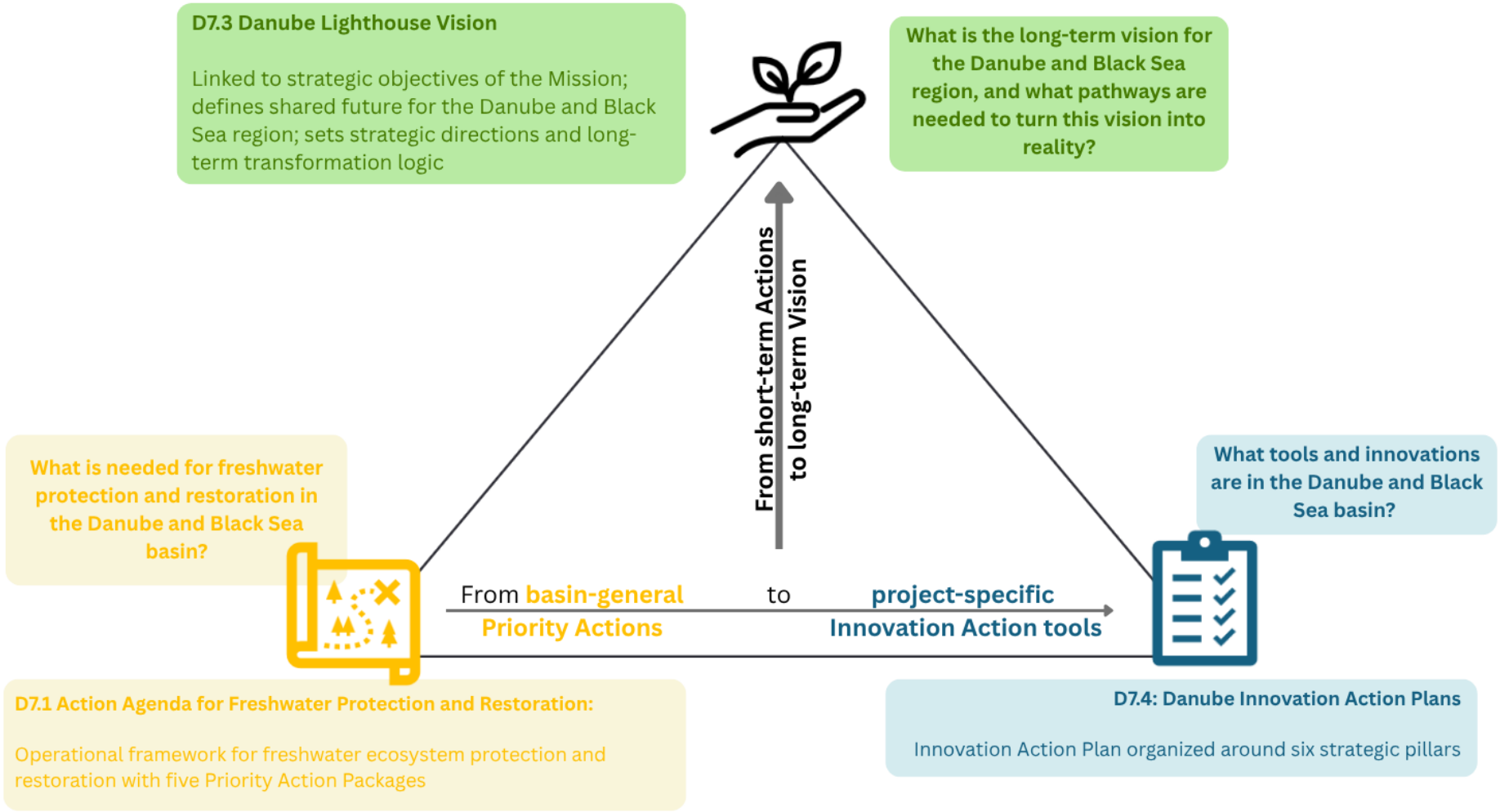

Figure 1: Schematic overview of WP7 tasks linking Innovation Action Plan, Agenda and Vision

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2. Challenges in the Danube and Black Sea Basin

The Danube River Basin (DRB) represents a highly complex socio-ecological system shaped by long-term human intervention, multi-sectoral resource use, and increasing climatic pressures. Across its extent, the basin faces interconnected ecological, economic, social, and governance challenges that collectively undermine its resilience and sustainability.

A central issue is the extensive hydromorphological alteration of the river system. Large-scale engineering works - including dam construction, channelization, levee building, and navigation infrastructure - have fundamentally transformed the Danube's natural dynamics (Habersack et al., 2016; Hein et al., 2019). The river is fragmented by numerous barriers, many of which are not passable for aquatic species, severely disrupting ecological continuity (Hein et al., 2016). At the same time, sediment transport processes have been significantly altered: impounded sections accumulate sediments, while free-flowing stretches experience ongoing riverbed incision and erosion (Habersack et al., 2016; Galia et al., 2015). This imbalance propagates downstream, lowering groundwater tables, disconnecting side arms, and degrading habitat quality, with further impacts extending to the Danube Delta and coastal zones (Galia et al., 2015).

Closely linked to these changes is the loss of hydrological connectivity, particularly between the main river channel and its floodplains. Floodplain systems have been drastically reduced and disconnected with less than 20% of their original extent remaining across the basin (ICPDR, 2009; Hein et al., 2016). In some regions, such as Germany, up to 90% of floodplains have been isolated by dikes (Brunotte et al., 2009). This disconnection impairs lateral exchange processes, diminishes biodiversity, and weakens ecosystem functions such as nutrient cycling and flood retention (Hein et al., 2019).

These structural alterations are accompanied by significant biodiversity loss, particularly affecting migratory fish species and floodplain-dependent ecosystems. The interruption of longitudinal connectivity has contributed to the decline of iconic species such as sturgeons, while habitat degradation and altered flow regimes have reduced overall ecological diversity (Hein et al., 2016). In addition, the spread of invasive species further alters ecosystem dynamics and increases pressure on native communities, compounding the effects of habitat fragmentation.

Beyond physical alterations, the basin is subject to multiple, interacting anthropogenic pressures, including agricultural intensification, forestry, land-use change, and both point and diffuse pollution (Galia et al., 2015). Water quality remains a critical challenge, with nutrient enrichment from agriculture contributing to eutrophication, and industrial and urban sources introducing hazardous substances such as heavy metals and organic pollutants. Despite improvements in wastewater treatment in some regions, significant spatial disparities persist, particularly between upstream and downstream countries (ICPDR, 2009). These pressures reinforce ecological degradation and complicate efforts to achieve good ecological status under the EU Water Framework Directive.

At the same time, the DRB is characterized by intense competition among water uses, reflecting its importance for hydropower, navigation, flood protection, agriculture, and ecosystem services. These sectors operate across different spatial and temporal scales and often pursue conflicting objectives, creating persistent trade-offs that complicate integrated management (Hein et al., 2019; Vörösmarty et al., 2023). Hydropower development, in particular, illustrates the tension between renewable energy goals and ecological integrity, as

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further expansion is often at odds with river restoration efforts. Similarly, the Danube's role as a major European transport corridor drives continued river engineering for navigation, which can conflict with habitat conservation and sediment continuity. Historically, economic and infrastructural priorities have frequently outweighed ecological considerations, increasing the complexity of achieving sustainable river basin management (DaWetRest, 2023).

These tensions are further exacerbated by climate change, which is altering the basin's hydrological regime. Rising temperatures and shifting precipitation patterns are projected to produce stronger seasonal imbalances, with wetter winters and drier summers, alongside declining snow storage and soil moisture (Probst & Mauser, 2023). This shift intensifies both flood risks and low-flow conditions, creating a dual challenge of managing hydrological extremes. In addition, climate-induced variability leads to spatial and temporal mismatches between water supply and demand, increasing competition among sectors such as agriculture, hydropower, and ecosystems (Probst & Mauser, 2023; Vörösmarty et al., 2023).

The transboundary nature of the Danube Basin introduces further complexity. Spanning multiple countries with differing institutional capacities and policy priorities, the basin faces significant governance challenges. This heterogeneity results in uneven implementation of environmental policies and slows the development of coordinated, basin-wide strategies (European Commission JRC, 2019). Although overarching frameworks such as the EU Water Framework Directive exist, sectoral fragmentation and limited integration of policy objectives remain key barriers (Dufour & Piégay, 2009; Hein et al., 2019).

Socio-economic disparities across the basin also play a critical role. Regional inequalities, particularly between upstream and downstream areas, influence both vulnerability to environmental change and adaptive capacity. Lower Danube regions often face structural challenges such as limited economic diversification, demographic decline, and weaker infrastructure, which constrain effective responses to environmental pressures (Swain, 2020).

In parallel, the basin is experiencing transformations in traditional livelihoods, especially in regions such as the Danube Delta. River regulation, land-use changes, and broader economic restructuring have altered practices such as small-scale fishing and floodplain agriculture, contributing to the erosion of traditional ecological knowledge and cultural identity (Iordachi & Van Assche, 2023). These dynamics highlight broader challenges in maintaining social-ecological resilience.

Despite multiple policy frameworks addressing water quality, biodiversity, and flood risk, a key overarching issue remains the lack of integrated, multi-functional management approaches. Sectoral policies are often implemented in isolation, failing to adequately account for synergies and trade-offs between ecological, economic, and social objectives (Dufour & Piégay, 2009; Hein et al., 2019).

Overall, the Danube River Basin can be understood as a highly modified and contested system, where hydromorphological degradation, ecological fragmentation, climate change, sectoral competition, governance fragmentation, and socio-economic inequalities interact. Addressing these challenges requires coordinated, transboundary and integrative management strategies capable of reconciling competing demands while restoring ecological processes and strengthening adaptive capacity.

3. Tools, Innovations and Ideas Developed within EcoDaLLi

The analysis of EcoDaLLi and its related Innovation Action projects' outcomes was undertaken to identify transferable approaches, tested solutions, governance mechanisms, and implementation experiences that can support the long-term development of the Danube Lighthouse. Rather than creating new concepts, this Innovation Action Plan builds upon existing innovations and lessons learned generated through projects operating across the Danube and Black Sea Basin.

The analysis focused on identifying innovations that demonstrate potential for large-scale implementation, replication, and integration into long-term governance and restoration frameworks. Particular attention was given to approaches that support ecosystem restoration, stakeholder engagement, financing, monitoring, and cross-border cooperation.

The resulting innovation landscape was synthesised into six strategic pillars that form the foundation of the Danube Innovation Action Plan presented in Chapter 4.

Innovation can be understood through six interlinked domains ("pillars"):

- Integrated governance innovations
- Nature-based solutions and ecological restoration tools
- Co-creation and capacity-building systems
- Finance and investment mechanisms
- Replication and upscaling frameworks
- Data, monitoring, and digital infrastructures

These pillars represent the **core operational entry points for transformation** and are mutually reinforcing rather than independent sectors.

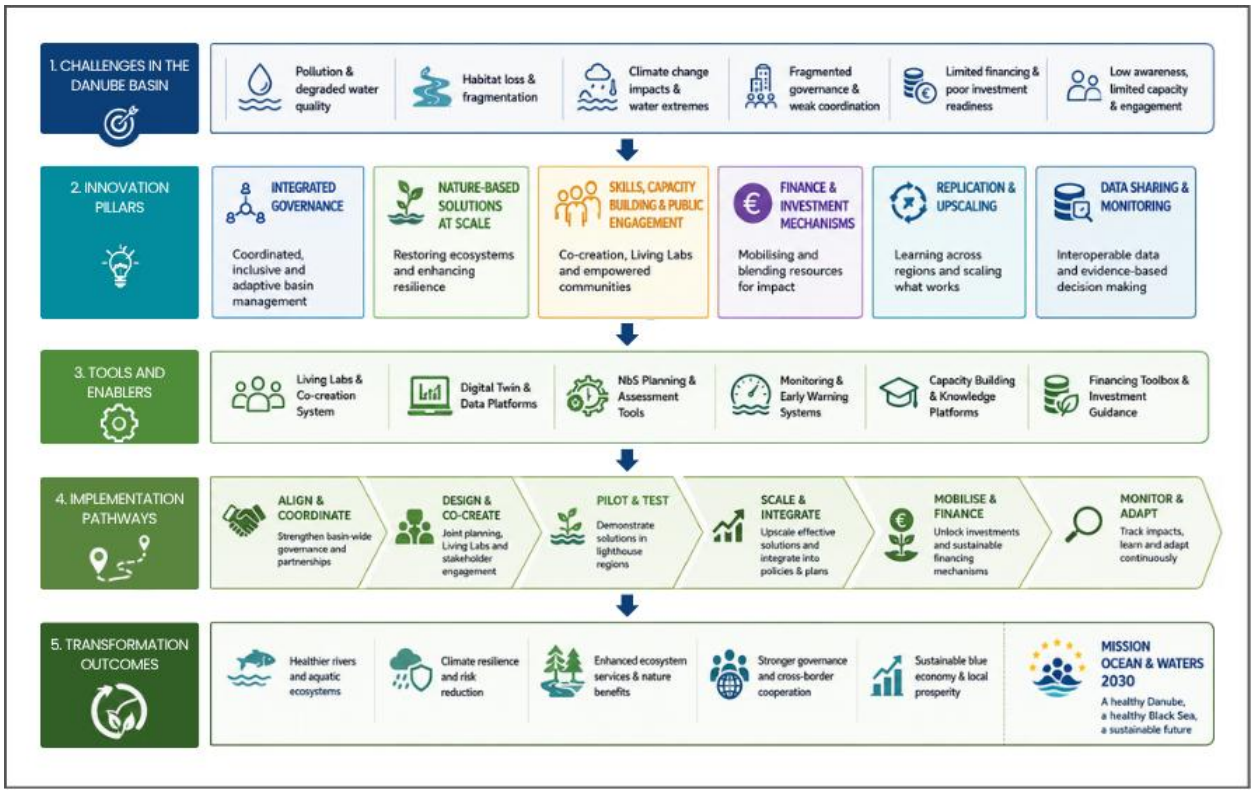

Figure 2: From Challenges over Innovation Pillars to Transformation (source: authors' own work, created with AI assistance)

The innovation in EcoDaLLi and related Innovation Actions spans governance, ecological restoration, social engagement, finance, replication, and data systems. Rather than isolated interventions, these innovations form an interconnected portfolio aimed at enabling systemic transformation of the Danube Basin.

Table 1: Innovation Pillars with innovations, outputs, target users and transformation

Innovation Domain/Pillar	Key Innovations	Main Tools / Outputs	Target Users	Strategic Role in Transformation
Integrated Governance	Basin-wide coordination, multi-level governance, science–policy interfaces	Danube Digital Twin, policy dialogues, governance frameworks, restoration action plans	River basin authorities, EU bodies, national ministries	Enables **cross-border alignment and coherent decision-making** across the Danube Basin
Nature-Based Solutions at Scale	Floodplain restoration, wetland reconnection, rewilding corridors, landscape-level planning	NbS catalogues, restoration roadmaps, demo sites, DSS tools	Planners, municipalities, environmental agencies	Restores ecological processes and strengthens **systemic river resilience**
Co-Creation & Capacity Building	Living Labs, citizen science, stakeholder co-design, peer-to-peer learning	Danube Academy (concept), workshops, stakeholder platforms, Living Lab systems	Citizens, NGOs, policymakers, researchers	Builds **social legitimacy, shared ownership, and implementation capacity**
Finance & Investment Mechanisms	Blended finance, investment readiness, NbS business models, public-private financing	Investment facility concepts, SWOT/TOWS tools, business model frameworks	Investors, development banks, SMEs, public authorities	Addresses **funding gaps and enables scaling of NbS**
Replication & Upscaling	Transfer of demo site solutions to associated regions, twinning approaches	Training packages, replication frameworks, knowledge transfer tools	Regional authorities, international partners	Ensures **scalability and geographic spread of successful innovations**
Data Sharing & Monitoring	Harmonised monitoring, citizen science integration, interoperable basin data systems	Indicator toolboxes, monitoring protocols, citizen science platforms	Scientists, agencies, decision-makers	Improves **evidence-based governance and adaptive management**
Digital & Knowledge Infrastructure	Knowledge platforms, integrated datasets, decision-support systems	Knowledge & Monitoring Systems (KMS), GIS tools, dashboards	Multi-stakeholder ecosystem	Supports **system integration and transparency across all pillars**

4. Innovation Action Plans for the Danube Lighthouse

The innovation described in Chapter 3 provides the structural foundation for transformation in the Danube–Black Sea Basin. However, innovation alone does not automatically generate systemic change. Effective transformation requires coordinated implementation pathways capable of translating tools, knowledge, and governance innovations into long-term ecological, social, and institutional impact.

This chapter therefore focuses on the operational dimension (Action Plans) of the Danube Innovation System. It organises the identified innovations into strategic implementation pillars and highlights the key challenges, actions, enabling conditions, and lessons learned associated with each pillar.

The pillars are strongly interconnected and should not be understood as isolated implementation areas. Instead, they form mutually reinforcing components of a basin-wide transformation process.

The Danube Innovation Action Plans integrate EcoDaLLi and related Innovation Actions' outputs into a coherent, multi-level system for basin-scale transformation. Innovation Action projects are collaborative initiatives bridging the gap between early research and commercialization. The Innovation Actions, whose input was integrated into this deliverable, are DANUBE4aLL, DaWetRest, Restore4Life and DALIA.

The pillars are formed by six interconnected innovation domains:

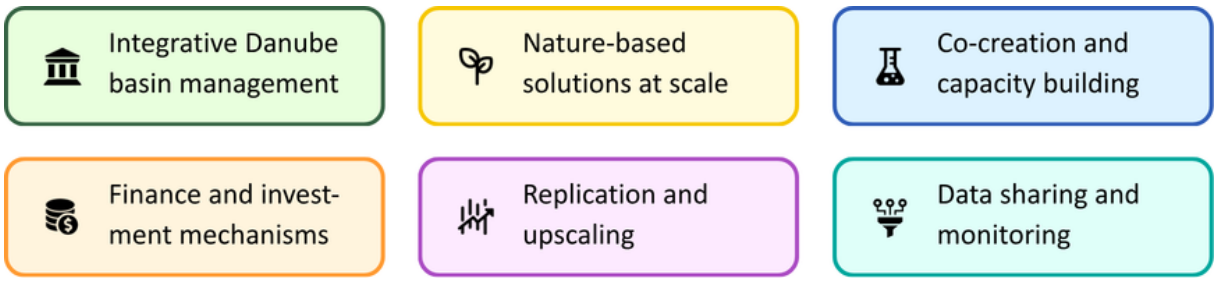

Figure 3: Innovation pillars

These pillars represent the operational entry points of transformation, addressing ecological, social, economic, and governance challenges in the basin. They are not standalone interventions but mutually reinforcing components of a single transformation system.

The following information was collected through EcoDaLLi project partners and Innovation Action project partners. A survey was sent out to collect information on challenges, key actions, KPIs, and lessons learned on each pillar (see **Annex**).

4.1. Integrated Danube Basin Governance

Integrated governance is essential in the Danube Basin because ecological processes, water management, and infrastructure systems go beyond national boundaries.

Key challenges:

The task force consultation and project experiences identified several governance-related barriers that continue to limit effective implementation across the Danube and Black Sea Basin.

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The most frequently highlighted challenge was the limited engagement of stakeholders, particularly the insufficient involvement of citizens, local communities, SMEs, and private sector actors in planning and implementation processes. Several projects noted that participation often occurs too late in project development, reducing ownership and long-term uptake of solutions.

Another major challenge concerns conflicting sectoral priorities, especially tensions between hydropower production, navigation, flood protection, agriculture, and ecological restoration objectives. These competing interests frequently create governance complexity and slow down implementation processes.

In addition, projects highlighted the absence of a common understanding of the key environmental problems, restoration priorities, and regional needs across the basin. This lack of shared strategic vision is further reinforced by fragmented institutional responsibilities, uneven monitoring systems, and limited interoperability of environmental data.

Strategic Actions

To address these challenges, several strategic governance actions were developed and implemented across the Innovation Actions.

A major initiative is the development of a basin-wide data platform for water, climate, biodiversity, and pollution data through the concept of a **Danube Digital Twin**. This initiative aims to improve basin-wide coordination by harmonising monitoring standards under ICPDR requirements and enabling real-time data sharing between upstream and downstream regions.

Several projects also contributed to the development and implementation of NbS and basin restoration strategies, including the preparation of a **Danube Basin Restoration Action Plan** and the promotion of large-scale ecological restoration approaches.

At the policy level, projects actively supported science–policy integration through participation in European and macro-regional policy platforms, clustering activities, and high-level conferences. These activities promoted the “new water paradigm” and strengthened the integration of freshwater management into broader policy frameworks related to climate adaptation, bioeconomy, agriculture, and territorial development. Contributions to the BIOEAST Thematic Working Group on Freshwater-based Bioeconomy further supported the integration of freshwater priorities into regional strategic agendas.

In parallel, stakeholder workshops, policy recommendation processes, and participatory governance activities were implemented to strengthen dialogue between policymakers, practitioners, scientists, and local actors.

Tools and Supporting Mechanisms

Several governance-supporting tools and knowledge systems were developed across the projects, including:

- NbS toolboxes and restoration guidance frameworks
- Prep4blue Citizens Toolbox
- GIS-based online planning and decision-support tools
- The DALIA Knowledge Hub and associated policy workshops
- PESTLE analysis frameworks for governance and policy assessment
- The Restore4Life Decision Support Platform for Wetland Restoration

- Basin-wide monitoring and knowledge-sharing platforms

Together, these tools contribute to improved decision-making capacity, enhanced transparency, and more integrated governance processes across the basin.

Monitoring and Key Performance Indicators

The projects proposed a range of indicators to evaluate governance effectiveness and implementation progress. These include:

- Applicability and usability of developed tools by practitioners and authorities
- Number of implemented restoration measures
- Number of policymakers and water authorities formally engaged through Letters of Intent (LoI) and Memoranda of Understanding (MoU)
- Stakeholder participation levels, including engagement of SMEs and local business sectors
- Number of stakeholders actively using governance and decision-support platforms

These indicators highlight the importance of measuring not only technical implementation, but also governance uptake, institutional cooperation, and stakeholder participation.

Strategic Insights and Lessons Learned

The experiences gathered across the Innovation Actions demonstrate that early and continuous stakeholder engagement is essential for successful governance and long-term implementation. Several projects emphasised the importance of involving all affected stakeholders from the beginning of project development in order to strengthen ownership, improve communication, and reduce conflicts between sectoral interests.

The workshops and policy dialogue activities further demonstrated that peer-to-peer learning is highly effective for connecting science and policymaking, facilitating the practical application of innovation tools and governance approaches in real-world contexts.

Cross-border cooperation emerged as another critical success factor, particularly in addressing transboundary environmental challenges and coordinating restoration priorities across governance levels. At the same time, projects highlighted ongoing barriers related to fragmented institutional responsibilities, limited data interoperability, and insufficient harmonisation of monitoring systems.

The experiences also confirmed that NbS can provide cost-effective approaches for climate adaptation and ecological restoration, while generating multiple co-benefits for regional development and resilience. However, long-term success depends on improving access to harmonised data, strengthening open-access monitoring systems, and embedding innovation tools into stable governance and policy structures beyond individual project lifetimes.

Several projects additionally identified the limited involvement of SMEs and the private sector as an important gap. Future governance frameworks should therefore place stronger emphasis on engaging business actors, as they represent important drivers of innovation and implementation capacity.

Looking ahead, continued efforts should focus on:

- scaling and embedding governance solutions into regional and national policies,

- strengthening data harmonisation and interoperable monitoring systems,
- improving citizen engagement and communication strategies,
- ensuring long-term sustainability of governance platforms,
- and reinforcing cross-border cooperation and peer-learning networks across the Danube Basin.

4.2. Nature-based Solutions at Scale

NbS represent one of the central transformation mechanisms for restoring ecological resilience and climate adaptability in the Danube River Basin. In contrast to traditional grey infrastructure approaches, NbS aim to restore natural hydrological and ecological processes while simultaneously generating environmental, social, and economic co-benefits.

Within the Danube context, large-scale restoration of floodplains, wetlands, and river corridors is increasingly recognised as essential for addressing biodiversity loss, flood risks, water scarcity, pollution, and climate change impacts. However, successful implementation requires coordinated governance, technical guidance, stakeholder engagement, and long-term financing mechanisms.

Key Challenges

The projects identified several major barriers limiting the large-scale implementation of NbS across the basin.

One of the most frequently highlighted challenges is the lack of clear guidance for planning and implementation. Many practitioners and local authorities still lack practical methodologies, standardised procedures, and operational frameworks for applying NbS in different environmental and governance contexts.

Another major barrier concerns insufficient technical knowledge and limited access to reliable ecological and hydrological data. Uneven knowledge levels across European regions further complicate implementation and reduce the transferability of successful approaches.

Projects also highlighted poor cross-sector coordination between environmental authorities, water managers, agricultural actors, municipalities, and infrastructure sectors. This fragmentation often delays implementation and weakens integrated landscape planning approaches.

Additional challenges include:

- low stakeholder engagement,
- uncertainty regarding long-term effectiveness of NbS,
- regulatory and policy barriers,
- insufficient financial resources,
- and limited incentives for landowners and local actors.

Scaling NbS requires not only ecological restoration measures, but also institutional coordination, knowledge exchange, and governance innovation.

Strategic Actions

To address these challenges, several strategic actions were developed and implemented across the Innovation Actions.

A major priority is the reconnection of floodplains and wetlands along key stretches of the Danube Basin, particularly in transboundary areas such as the Romania–Bulgaria corridor. These efforts aim to restore natural hydrological processes and scale up green infrastructure approaches as alternatives to hard engineering solutions.

In this context, the proposed **Danube Rewilding Corridor Initiative**, discussed within the DaWetRest project, represents an important strategic direction for large-scale ecological restoration. The initiative builds on examples from Rewilding Europe projects and aligns with the EU Biodiversity Strategy for 2030.

Several projects also focused on developing practical implementation guidance and operational toolboxes for practitioners and local authorities. Demonstration sites and pilot areas were established to test restoration approaches under real-world conditions and facilitate transferability across regions.

The DALIA project contributed significantly to promoting and validating landscape-based measures, including:

- floodplain restoration,
- managed inundation,
- infiltration zones,
- and sedimentation strips.

These measures were identified as effective and low-cost tools for water retention, climate adaptation, and ecosystem restoration.

DALIA further supported:

- integration of NbS into policymaking and planning frameworks,
- cross-border knowledge exchange,
- coordinated implementation between municipalities and landowners,
- resistance to the effects of extreme droughts,
- and communication of the ecological, economic, and social co-benefits of restoration measures.

Additional actions included stakeholder workshops, information and training activities, and the establishment of multiple demonstration sites and associated replication regions to support knowledge transfer and practical implementation.

Tools and Supporting Mechanisms

A wide range of practical tools and supporting mechanisms were developed to facilitate NbS implementation across the basin.

These include:

- Handbooks and implementation guidance documents
- Catalogues of restoration measures and best practices

- Knowledge and Monitoring and Evaluation Systems (KMS)
- GIS-based planning and assessment tools
- Wetland restoration wikis and restoration roadmaps
- SWOT and TOWS analyses for evaluating ecosystem services and business opportunities
- Ecosystem service assessments related to ecotourism, fisheries, recreation, biomass, and water-related activities

Monitoring and Key Performance Indicators

The projects proposed several indicators to evaluate restoration effectiveness and implementation progress.

Key indicators include:

- ecosystem service improvements,
- habitat quality indices,
- restored wetland and floodplain areas,
- implementation of restoration and monitoring tools across pilot sites,
- stakeholder and SME participation levels,
- and the number of business actors engaged through stakeholder registers, interviews, and cooperation activities.

Strategic Insights and Lessons Learned

The experiences gathered across the projects strongly confirmed that NbS are effective, low-cost, and scalable approaches for climate adaptation and sustainable water management.

Projects demonstrated that measures such as floodplain restoration, managed inundation, infiltration zones, and sedimentation strips can simultaneously improve:

- flood protection,
- water quality,
- biodiversity,
- extreme drought resistance,
- ecosystem resilience,
- and broader ecosystem health.

A major lesson learned is that successful NbS implementation requires coordinated, landscape-scale planning and strong cooperation across sectors, governance levels, and national borders. Isolated interventions are significantly less effective than integrated basin-wide approaches.

The workshops and pilot activities also highlighted the importance of incentives and active stakeholder involvement, particularly from municipalities, landowners, and local communities, in ensuring implementation success and long-term ownership.

Several projects additionally emphasised the important role of SMEs and local businesses. SMEs often possess extensive local knowledge, technical expertise, equipment, and operational resources that can significantly support restoration activities and implementation processes. Strengthening cooperation with these actors therefore represents an important opportunity for future scaling and long-term sustainability.

The projects further demonstrated the importance of:

- improving communication between project teams and practitioners,
- strengthening practical implementation support,
- expanding cross-border knowledge exchange,
- and improving access to harmonised monitoring systems and open-access restoration tools.

Looking ahead, continued efforts should focus on:

- scaling NbS implementation across the basin,
- embedding restoration approaches into policy and planning systems,
- strengthening landscape-level governance coordination,
- improving technical guidance and monitoring frameworks,
- and reinforcing cooperation between public authorities, local communities, landowners, and SMEs.

4.3. Skills, Capacity Building and Stakeholder Engagement through Co-creation System

Successful transformation of the Danube River Basin depends not only on technological and ecological innovation, but also on the ability of institutions, stakeholders, and local communities to collaboratively develop, implement, and sustain solutions over time. Skills development, stakeholder engagement, and co-creation processes, therefore, represent critical enabling dimensions of the Danube Innovation Transformation System.

Participatory governance approaches, peer-to-peer learning, citizen science, and cross-border knowledge exchange help bridge the gap between science, policy, and implementation. These approaches strengthen social legitimacy, improve practical applicability of solutions, and support long-term ownership across governance levels.

Key Challenges

The projects identified several important barriers related to co-creation, stakeholder engagement, and capacity building across the basin.

One of the most frequently highlighted challenges is limited stakeholder engagement, particularly the difficulty of maintaining long-term participation of citizens, local communities, SMEs, and regional actors throughout project lifecycles.

Projects also identified weak integration between project outputs and policy or decision-making processes, limiting the long-term uptake and institutionalisation of developed solutions.

Additional challenges include:

- insufficient long-term funding for co-creation and training activities,
- poor transferability and scaling of project results,
- coordination difficulties among project partners and stakeholder groups,
- lack of standardised impact measurement frameworks,
- and limited use of Living Lab approaches within some projects, including DANUBE4all.

Strategic Actions

To address these barriers, several strategic actions and participatory approaches were developed across the Innovation Actions.

One proposed initiative is the establishment of a **Danube Academy for Water and Climate**, which would support cross-border education, training, and exchange programmes focused on water management, ecological restoration, and climate resilience.

Projects also promoted the development of citizen science platforms for river monitoring, enabling broader public participation, improved environmental awareness, and increased trust in monitoring systems and restoration activities.

Co-creation workshops and participatory processes played a central role across several projects. These activities brought together policymakers, scientists, NGOs, local stakeholders, and practitioners to jointly develop, test, and validate solutions.

Additional actions included:

- structured peer-to-peer learning activities across regions,
- stakeholder workshops and training programmes,
- scaling of results to associated regions,
- facilitation of cross-border dialogue and knowledge exchange,
- integration of local knowledge into monitoring and planning processes,
- and the use of real-life pilot case studies and demonstration sites as practical testing grounds for innovative solutions.

Tools and Supporting Mechanisms

Several tools and knowledge-support mechanisms were developed to facilitate stakeholder engagement, co-creation, and capacity building.

These include:

- Practical handbooks and implementation guidance materials
- Demonstration pilot site case studies and real-life learning examples
- Knowledge and Monitoring Systems (KMS)
- Stakeholder analysis frameworks
- Restoration roadmaps and participatory planning tools
- Decision-support systems supporting collaborative planning processes

- Workshops, training programmes, and peer-learning formats

Monitoring and Key Performance Indicators

The projects proposed several indicators to evaluate engagement, learning, and co-creation effectiveness.

Key indicators include:

- number of stakeholders engaged in project activities,
- level of participation in co-creation workshops and training events,
- extent of stakeholder engagement across governance levels and sectors,
- number of knowledge exchange activities and peer-learning events,
- and uptake of tools and approaches by practitioners and regional actors.

These indicators highlight the importance of measuring social participation, knowledge transfer, and institutional collaboration alongside technical implementation outputs.

Strategic Insights and Lessons Learned

The project experiences demonstrated that co-creation and stakeholder engagement are essential for developing solutions that are both practical and broadly accepted.

The Living Lab approaches implemented in several projects showed that bringing together policymakers, scientists, local actors, and practitioners can significantly improve communication, strengthen ownership, and bridge the gap between scientific knowledge and practical implementation.

The projects also confirmed that peer-to-peer learning and real-life pilot sites are highly effective mechanisms for validating solutions and supporting transferability to other regions. Demonstration sites and pilot case studies provided valuable opportunities for testing restoration measures under real-world conditions while strengthening stakeholder confidence and implementation capacity.

At the same time, the projects highlighted ongoing challenges related to:

- maintaining consistent stakeholder participation,
- ensuring clear communication across sectors and governance levels,
- securing long-term engagement of citizens and local communities,
- and embedding participatory processes into permanent governance structures.

Several projects further emphasised the importance of more direct, in-person interaction with stakeholders through workshops, field visits, and collaborative activities. These interactions proved particularly valuable for building trust, improving communication, and increasing long-term commitment to restoration initiatives.

Looking ahead, future efforts should focus on:

- strengthening long-term co-creation and training structures,
- integrating participatory approaches more strongly into policy frameworks,
- expanding citizen science and local knowledge integration,

- improving coordination and communication between project partners,
- and supporting the long-term sustainability and scaling of Living Lab and peer-learning systems across the Danube Basin.

4.4. Finance and Investment Mechanisms

Financial innovation and investment readiness are essential for scaling NbS and ensuring the long-term sustainability of restoration efforts across the Danube River Basin. While many projects successfully demonstrate the ecological and social benefits of NbS at pilot scale, the transition toward basin-wide implementation remains constrained by fragmented financing systems, limited private-sector engagement, and insufficient investment-ready project pipelines.

Strengthening financial mechanisms is therefore a critical component of the Danube Innovation Transformation System, enabling restoration measures to move beyond short-term project funding toward stable and scalable implementation models.

Key Challenges

The projects identified several major barriers limiting investment and financial uptake of NbS across the basin.

One of the most significant challenges is the lack of investable and bankable projects. Many restoration initiatives remain technically or ecologically focused without sufficiently developed financial structures, business models, or investment frameworks capable of attracting long-term funding.

Projects also highlighted the complexity and lack of clarity of existing funding mechanisms, particularly regarding the combination of EU funding instruments, national financing schemes, and private-sector investment opportunities.

Additional barriers include:

- high perceived financial risks and uncertainty related to NbS outcomes,
- insufficient return on investment (ROI) visibility,
- regulatory and policy uncertainties,
- limited access to blended finance and public–private financing instruments,
- and difficulties for small NbS-oriented enterprises to scale from start-up to medium-sized operations.

Strategic Actions

To address these barriers, several strategic financial and investment actions were proposed and developed across the Innovation Actions.

One of the key proposals is the establishment of a **Danube Lighthouse Investment Facility**, designed to support basin-wide restoration and innovation activities through coordinated investment mechanisms. This initiative aims to combine EU funding instruments - including Cohesion Policy and Horizon Europe - with private capital and blended finance approaches.

An important objective of this initiative is the development of bankable project pipelines capable of attracting public and private investment for large-scale NbS implementation.

The projects also highlighted the important role of financial actors such as the **European Investment Bank (EIB)** and national development banks in supporting long-term investment structures and reducing financial risk.

Additional strategic actions included:

- funding replication sites to support transferability and long-term uptake of successful approaches,
- development of financial assessment methodologies such as PESTLE analyses,
- exploration of innovative financing mechanisms including government investment guarantees,
- proposals for a “Green Exchange” supporting equity trading in NbS-related businesses,
- and strengthening awareness of NbS-related business opportunities across the basin.

Tools and Supporting Mechanisms

Several analytical and financial-support tools were developed to strengthen investment readiness and business development related to NbS implementation.

These include:

- DALIA Knowledge and Monitoring Systems (KMS)
- SWOT and TOWS analyses supporting strategic financial assessment
- Matrices linking wetland ecosystem services with NbS business opportunities
- Economic benefit assessment matrices for restoration activities
- NbS business support and investment readiness frameworks
- Financial and policy evaluation tools supporting decision-making processes

Monitoring and Key Performance Indicators

The projects proposed several indicators to evaluate financial uptake and implementation effectiveness.

Key indicators include:

- implementation of financial and monitoring tools across pilot sites,
- number of NbS-related enterprises and business initiatives,
- establishment of local micro-finance funds and cooperative financing systems,
- level of investment engagement in restoration activities,
- and participation of SMEs and private-sector actors in project implementation.

Strategic Insights and Lessons Learned

The project experiences highlighted strong regional differences in funding availability, investment willingness, and institutional capacity across the Danube Basin.

Several projects demonstrated that funding pilot and replication sites significantly supports the transferability and long-term applicability of restoration tools and governance approaches.

Replication financing, therefore, emerged as an important mechanism for testing scalability and strengthening implementation confidence across regions.

The projects also highlighted the need to increase awareness of NbS-related business opportunities among both public authorities and private-sector actors. Many ecosystem restoration activities generate economic co-benefits - including ecotourism, fisheries, biomass production, recreation, and water-related services - but these opportunities remain insufficiently recognised within existing investment frameworks.

Another important lesson concerns the role of governments and public institutions in reducing investment uncertainty. Political instability, regulatory uncertainty, and insufficient policy support were repeatedly identified as barriers limiting private-sector engagement and long-term investment confidence.

Several projects, therefore, proposed stronger public-sector support mechanisms, including:

- government-backed investment guarantees,
- blended finance structures,
- dedicated micro-finance mechanisms for NbS entrepreneurs,
- and financial incentives supporting restoration-related SMEs.

The projects further demonstrated that SMEs and local enterprises represent important but still underutilised actors within the NbS implementation landscape. Supporting these actors through targeted financial instruments, business frameworks, and demonstration case studies could significantly strengthen regional implementation capacity.

Looking ahead, future efforts should focus on:

- developing bankable NbS project pipelines,
- improving integration between ecological restoration and financial planning,
- strengthening public–private financing instruments,
- increasing awareness of NbS business opportunities,
- reducing regulatory uncertainty,
- and establishing long-term investment structures capable of supporting basin-wide scaling and sustainable transformation.

4.5. Replication and Upscaling

Replication and upscaling are essential for ensuring that successful restoration approaches and innovation tools generate long-term impact beyond individual pilot sites and project boundaries. While demonstration activities provide valuable proof-of-concept, systemic transformation of the Danube River Basin requires the transfer, adaptation, and implementation of successful approaches across multiple regions and governance contexts.

Replication activities, therefore, represent a critical operational layer of the Danube Innovation Transformation System, enabling the diffusion of knowledge, strengthening implementation capacity, and supporting basin-wide scaling of NbS and governance innovations.

Although not directly part of EcoDaLLi, the IAs provide important experiences and transferable models for large-scale replication and cross-regional learning.

Key Challenges

The IA projects identified several barriers limiting successful replication and upscaling across regions.

One of the main challenges concerns insufficient funding for scaling phases. While many projects receive support for pilot implementation, long-term financial mechanisms for replication and transfer activities remain limited.

Projects also highlighted weak knowledge sharing and dissemination mechanisms, which reduce the accessibility and transferability of successful approaches across regions and stakeholder groups.

Additional challenges include:

- limited technical capacity and expertise in replication regions,
- lack of standardised and transferable implementation models,
- context-specific environmental, governance, and socio-economic constraints,
- and policy or regulatory misalignment between regions and countries.

Strategic Actions

To address these barriers, several replication and knowledge-transfer actions were implemented across the Innovation Actions.

Within the DALIA project, nine demonstration sites are being replicated across ten associated regions selected through an open call process. These replication regions include countries such as Portugal, Israel, Tunisia, North Macedonia, Ukraine, and Bosnia and Herzegovina, significantly extending the geographical relevance and transferability of developed solutions.

Additional replication actions included:

- twinning workshops between demonstration sites and associated regions,
- cross-border training workshops,
- in-person meetings with businesses and stakeholders linked to restoration sites,
- and deployment of pilot approaches in multiple associated regions.

These activities strengthened peer-to-peer learning, facilitated exchange of practical experiences, and supported adaptation of solutions to different regional contexts.

The projects also emphasised the importance of involving local businesses and SMEs in replication activities, recognising their role in providing technical expertise, local knowledge, operational capacity, and implementation support.

Tools and Supporting Mechanisms

Several tools and knowledge-support systems were developed to facilitate replication, scaling, and cross-regional learning.

These include:

- DALIA Knowledge and Monitoring System integrating demonstration and associated region practices
- Wetland Restoration Roadmaps
- Ecosystem Services Assessment Toolboxes
- Carbon Sequestration Guides
- Citizen Science Toolkits
- Education and training toolkits
- Decision Support Systems and restoration planning platforms

Monitoring and Key Performance Indicators

The projects proposed several indicators to evaluate replication effectiveness and scaling progress.

Key indicators include:

- implementation of developed tools and methodologies across pilot and replication sites,
- number of associated regions applying restoration approaches,
- level of stakeholder and SME participation in replication activities,
- establishment of local financing mechanisms and cooperative structures,
- and uptake of knowledge-sharing and monitoring systems.

Strategic Insights and Lessons Learned

The projects demonstrated that replication and upscaling strategies are essential for transferring good practices beyond individual project areas and generating broader European and international impact.

Knowledge exchange, peer learning, and cross-border cooperation proved particularly effective in supporting adaptation and implementation of restoration approaches in new contexts. The experiences highlighted that sharing lessons learned and practical implementation experiences significantly strengthens regional capacity and accelerates transformation processes.

The projects also confirmed the importance of demonstration sites and associated regions as practical learning environments for testing transferability and validating restoration tools under diverse environmental and governance conditions.

At the same time, several barriers to replication remain, including:

- uneven technical and institutional capacities,
- limited long-term funding,
- insufficient awareness of NbS-related business opportunities,
- and policy uncertainty affecting investment confidence and implementation continuity.

Several projects further highlighted the importance of strengthening government support mechanisms and promoting NbS-related economic opportunities more actively at European and regional levels.

The Europe-wide dissemination of Decision Support Systems, restoration toolboxes, and knowledge platforms was identified as a key priority for future scaling efforts.

Looking ahead, future efforts should focus on:

- strengthening long-term funding mechanisms for scaling phases,
- improving standardisation and transferability of restoration methodologies,
- expanding training and peer-learning systems,
- increasing awareness of NbS business opportunities,
- supporting SMEs and regional implementation actors,
- and promoting Europe-wide accessibility of restoration tools, monitoring systems, and knowledge

4.6. Data Sharing and Monitoring

Robust data, monitoring, and impact assessment systems are essential for enabling evidence-based decision-making, adaptive governance, and effective scaling of NbS across the Danube River Basin. Without harmonised methodologies and accessible data systems, it is difficult to compare results, evaluate effectiveness, or integrate ecological knowledge into policy and planning processes.

This pillar, therefore, focuses on strengthening standardisation, improving data accessibility, and ensuring that monitoring outputs directly inform decision-making at multiple governance levels.

Key Challenges

The projects identified several structural barriers limiting effective monitoring and data integration across the basin.

A key challenge is the inconsistency and lack of standardised methodologies for monitoring ecological and socio-economic impacts. This reduces comparability between sites and limits the scalability of results across regions.

Another major issue is the limited availability of long-term monitoring systems, which restricts the ability to assess the durability and long-term effectiveness of restoration measures.

Projects also highlighted significant data fragmentation and poor accessibility, with monitoring data often distributed across different platforms, institutions, or project-specific systems.

Additional challenges include:

- insufficient technical capacity and availability of appropriate tools,
- weak integration of monitoring data into decision-making processes,
- and limited use of harmonised indicators across projects and regions.

Strategic Actions

To address these challenges, several key monitoring and assessment actions were implemented across the Innovation Actions.

A central activity included the development and application of monitoring and impact assessment systems in demonstration sites, enabling real-world testing of restoration outcomes and methodological approaches.

Projects also supported the development of toolboxes and harmonised frameworks for ecological monitoring, ensuring more consistent and comparable data collection across regions.

These activities contributed to the creation of standardised approaches for evaluating ecosystem services, restoration effectiveness, and socio-ecological impacts.

Tools and Supporting Mechanisms

Several practical tools were developed to improve monitoring capacity and data accessibility:

- User-friendly indicator toolboxes for the assessment of wetland ecosystem services
- Carbon sequestration manuals supporting climate impact evaluation
- Citizen science protocols enabling participatory monitoring and data collection (and evaluation for qualified citizens)
- Standardised indicator frameworks for ecosystem service assessment
- Methodological toolkits for field-based and participatory monitoring approaches

Monitoring and Key Performance Indicators

Key performance indicators for this pillar include:

- application of standardised monitoring methodologies across pilot sites,
- number of sites implementing harmonised indicator frameworks,
- level of data accessibility and platform usage,
- integration of monitoring results into decision-support systems,
- and participation in citizen science and participatory monitoring activities.

Strategic Insights and Lessons Learned

The project experiences demonstrated that toolboxes and monitoring frameworks are most effective when designed as living documents, capable of continuous adaptation and improvement based on field experience and stakeholder feedback.

A key lesson is that standardised, yet flexible monitoring systems are essential for enabling comparability across Europe while still allowing adaptation to local contexts.

The integration of citizen science and participatory monitoring approaches was identified as a particularly valuable mechanism for improving data coverage, increasing stakeholder engagement, and strengthening trust in monitoring results.

At the same time, the projects highlighted the need for stronger integration of monitoring outputs into decision-making processes. Without this connection, even high-quality data risks remaining underutilised in policy and planning contexts.

Looking ahead, future efforts should focus on:

- strengthening harmonisation of monitoring methodologies,
- improving long-term data infrastructure and accessibility,
- enhancing integration of monitoring results into governance and policy systems,
- expanding participatory and citizen science approaches,
- and ensuring that monitoring systems directly support adaptive management and scaling of restoration

5. Roadmap for Implementation of the Innovation Action Plans

The roadmap provides a phased pathway for advancing the Danube Lighthouse beyond individual pilots and isolated initiatives (see Figure **4**). It links governance alignment, stakeholder engagement, nature-based restoration, financing, replication, and monitoring into a coherent sequence of actions that can support implementation during and beyond the lifetime of EcoDaLLi. In doing so, it helps clarify what needs to happen first, which actors need to be involved, and how progress can be sustained over time.

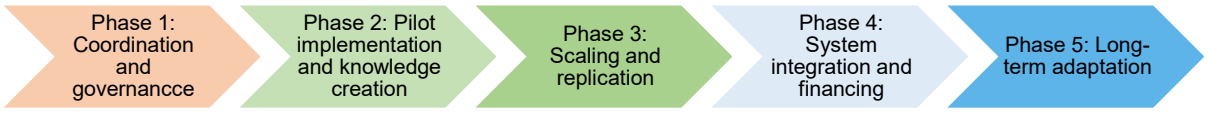

Figure 4: Phases for the implementation of the Innovation Action Plans.

Phase 1: Coordination and Governance Alignment (2025–2026)

Objective: Establish shared governance foundations and ensure coherence across Danube Basin actors and initiatives.

Key actions	Harmonisation of governance structures across Danube Basin stakeholders; alignment with EU Mission “Restore our Ocean and Waters” and Water Framework Directive; strengthening ICPDR and macro-regional coordination mechanisms; consolidation of existing Innovation Actions and platforms
Lead actors	ICPDR, national ministries, river basin authorities
Supporting actors	EcoDaLLi consortium, research organisations, Living Labs
Key outputs	Shared governance framework; stakeholder coordination platform; baseline mapping of existing tools and innovations; policy alignment roadmap
Success indicators	Number of coordinated governance meetings; formalised cooperation agreements; integration into national/regional strategies

Phase 2: Pilot Implementation and Knowledge Creation (2025–2027)

Objective: Test and validate innovative solutions in real-world contexts.

Key actions	Implementation of Nature-based Solutions in demonstration sites; deployment of Living Lab approaches; application of digital tools (DSS, GIS, monitoring systems); citizen science and participatory monitoring activities
Lead actors	Pilot site coordinators, municipalities, project consortia
Supporting actors	NGOs, SMEs, research institutions, local communities
Key outputs	Validated NbS approaches; tested governance tools; pilot datasets; operational Living Lab methodologies
Success indicators	Number of implemented pilots; stakeholder participation rates; volume of monitoring data collected; tool usability feedback

Phase 3: Scaling and Replication (2026–2029)

Objective: Expand successful solutions across regions and basin contexts.

Key actions	Replication of demonstration site solutions in associated regions; twinning of pilot sites with new implementation areas; development of standardised toolkits and methodologies; capacity-building programmes for regional stakeholders
Lead actors	Regional authorities, project coordinators, replication hubs
Supporting actors	SMEs, universities, basin organisations
Key outputs	Replication packages; cross-regional knowledge transfer mechanisms; expanded NbS implementation footprint
Success indicators	Number of replication sites; uptake of toolkits; cross-border cooperation activities; SME involvement levels

Phase 4: System Integration and Financing (2027–2030)

Objective: Embed innovations into institutional frameworks and secure sustainable financing mechanisms.

Key actions	Integration of tools into policy and planning frameworks; development of blended finance mechanisms; establishment of investment-ready NbS portfolios; engagement with financial institutions (EIB, national development banks)
Lead actors	European Investment Bank, national development banks, ministries of finance
Supporting actors	Private investors, SMEs, regional authorities
Key outputs	Investment-ready project pipelines; operational blended finance schemes; institutionalised governance tools
Success indicators	Volume of investment mobilised; number of finance mechanisms established; scale of NbS investment portfolios

Phase 5: Long-term Adaptation and Governance Embedding (2030+)

Objective: Ensure long-term sustainability, adaptability, and resilience of the innovation system.

Key actions	Continuous basin-wide monitoring using harmonised data systems; embedding innovation tools into permanent governance structures; long-term maintenance of Living Labs and digital platforms; adaptive policy updates based on evidence and feedback loops
Lead actors	ICPDR, EU institutions, national governments
Supporting actors	Research networks, basin-wide stakeholder platforms
Key outputs	Adaptive governance system for the Danube Basin; permanent innovation infrastructure (digital + institutional); continuous learning cycle
Success indicators	Stability of governance structures; long-term platform usage; integration of monitoring data into policy cycles

The implementation of the roadmap is subject to several cross-cutting risks and barriers that may influence the pace, effectiveness, and long-term sustainability of the proposed actions. These challenges arise from the transnational and multi-sectoral nature of the Danube and Black Sea Basin and need to be considered proactively during all implementation phases. Identifying these risks and corresponding mitigation measures helps ensure that implementation remains adaptive and resilient.

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Risks and Barriers

Key risks affecting implementation include:

- Fragmented governance across countries and sectors
- Uneven technical and institutional capacity
- Limited long-term financing for scaling phases
- Data interoperability and standardisation challenges
- Variable stakeholder engagement and ownership

Mitigation requires:

- strengthened coordination platforms
- harmonised data and monitoring standards
- dedicated investment instruments for NbS
- continuous stakeholder engagement and capacity building

Conclusion and Outlook

The Danube Innovation Action Plan presented in this deliverable marks a decisive step in the transition from strategic vision to operational implementation within the EU Mission "Restore our Ocean and Waters by 2030." By synthesising the knowledge, tools, and experiences generated across EcoDaLLi and the associated Innovation Actions in the Danube and Black Sea Basin, D7.4 provides a structured, evidence-based framework for coordinated action across one of Europe's most complex transboundary river systems.

The six innovation pillars - Integrated Danube Basin Governance, NbS at Scale, Skills and Capacity Building, Finance and Investment Mechanisms, Replication and Upscaling, and Data Sharing and Monitoring - collectively address the ecological, social, economic, and institutional dimensions of sustainable river basin management. The roadmap for implementation, spanning from foundational capacity building through to long-term governance embedding beyond 2030, charts a credible pathway for translating these pillars into durable, basin-wide impact.

A central insight emerging from the Action Plan is that individual pilots and demonstration activities, while indispensable, can only generate transformative change when they are systematically replicated, upscaled, and embedded within robust governance and financing structures. The transition from project-level innovation to systemic transformation requires sustained political commitment, harmonised monitoring, and dedicated investment instruments that accompany restoration efforts beyond the project lifecycle.

The Next Phase of Mission Ocean and Waters

With the EcoDaLLi project approaching its conclusion in mid-2026, the focus of the Mission Ocean and Waters in the Danube Lighthouse must shift decisively towards upscaling and systemic integration. The Innovation Actions currently operating across the basin - including DaWetRest and partner projects - have generated a rich portfolio of validated approaches, tools, and demonstrated outcomes. The next phase of the Mission must build on this foundation through three interconnected priorities.

From pilots to basin-wide replication. The demonstration sites established during the current project generation represent proof-of-concept environments. The period 2026–2029 must prioritise the structured replication of successful NbS, governance tools, and monitoring frameworks across associated regions and new geographies within the basin. This requires the development of standardised replication packages - including toolkits, methodological guides, and decision-support systems - that allow regional actors with varying institutional capacities to adapt and deploy proven approaches without starting from scratch. Twinning arrangements between established pilot sites and new implementation areas offer a particularly effective mechanism for facilitating knowledge transfer and building local ownership.

Securing sustainable finance for scale. Perhaps the most critical bottleneck in the transition from pilot to scale is the absence of long-term, basin-wide financing mechanisms. The next Mission phase should prioritise the development of blended finance instruments - combining EU funds, national development bank resources, and private investment - specifically designed for NbS at scale. The groundwork laid through EcoDaLLi in identifying investment-ready project pipelines and engaging with institutions such as the European Investment Bank should be actively built upon, with the goal of establishing operational financing schemes by 2027–2028 that can sustain restoration and governance activities independently of project funding cycles.

Embedding innovations in permanent governance structures. The tools, platforms, and governance models developed within the current Mission generation risk losing continuity if they remain tied to project infrastructures. A core priority for the next phase must therefore be the formal integration of key outputs - including the Living Lab system, digital monitoring platforms, and the Knowledge and Monitoring System - into the permanent institutional architecture of the Danube Basin, particularly through structures such as the International Commission for the Protection of the Danube River (ICPDR) and relevant national and regional authorities. This institutionalisation is the essential precondition for achieving the long-term adaptive governance vision articulated in D7.3.

Ultimately, the success of the Mission "Restore our Ocean and Waters by 2030" in the Danube Lighthouse will be measured not only by the ecological outcomes achieved at individual restoration sites, but by the degree to which the innovation ecosystem built through projects like EcoDaLLi has become self-sustaining - capable of continuous learning, adaptation, and expansion. This Action Plan provides the operational compass for that journey. The task ahead is to ensure that the momentum, knowledge, and partnerships built during the current phase are carried forward into a new generation of coordinated, basin-wide action.

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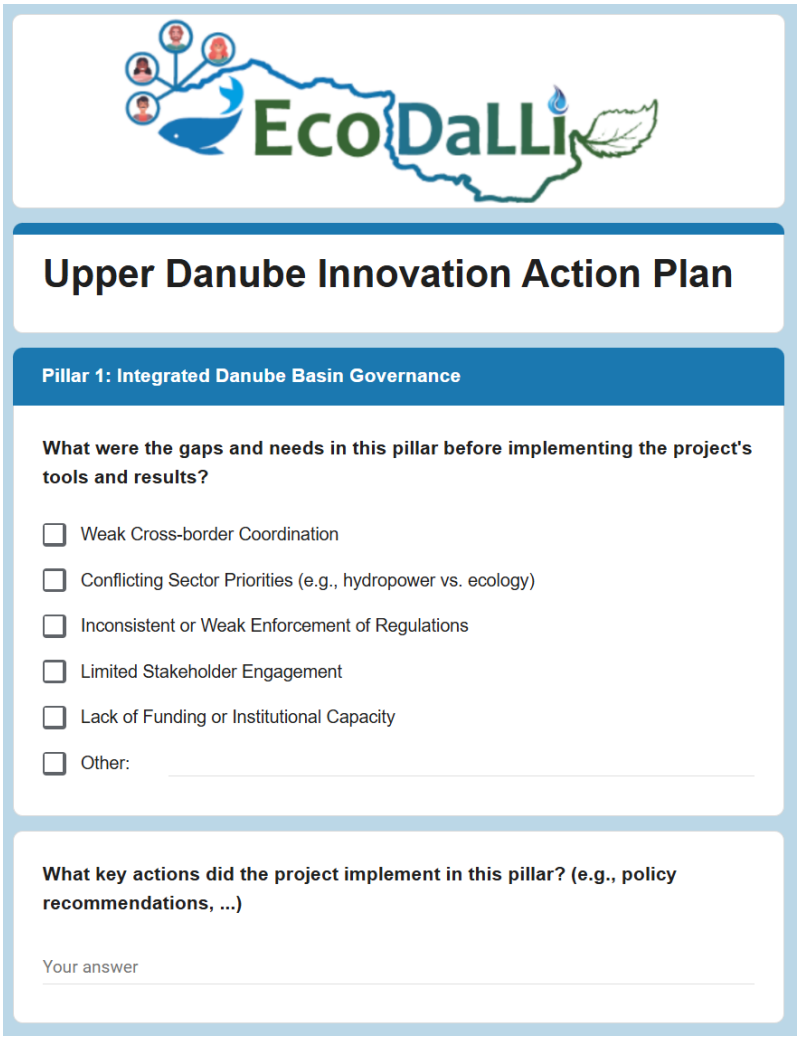
Annex I - Upper Danube Innovation Action Survey



Upper Danube Innovation Action Plan

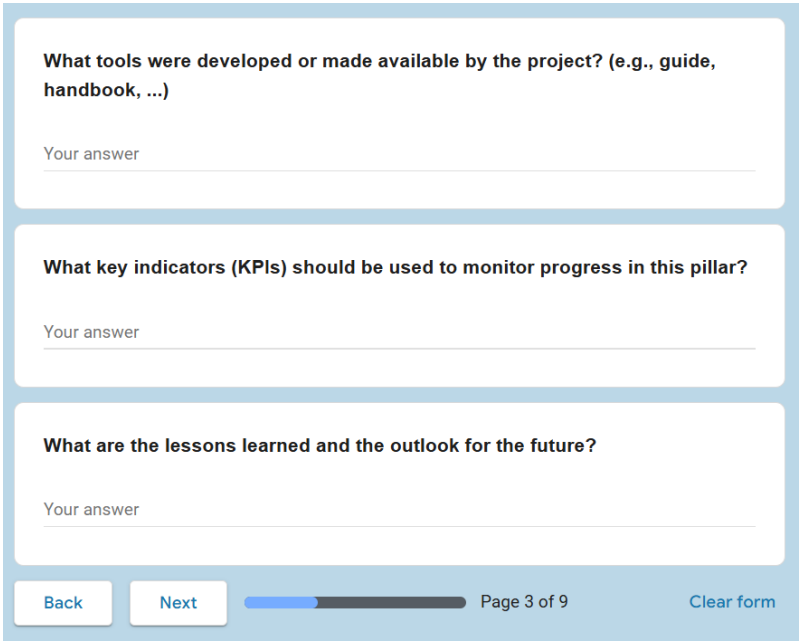
Pillar 1: Integrated Danube Basin Governance

What were the gaps and needs in this pillar before implementing the project's tools and results?

- [ ] Weak Cross-border Coordination
- [ ] Conflicting Sector Priorities (e.g., hydropower vs. ecology)
- [ ] Inconsistent or Weak Enforcement of Regulations
- [ ] Limited Stakeholder Engagement
- [ ] Lack of Funding or Institutional Capacity
- [ ] Other:

What key actions did the project implement in this pillar? (e.g., policy recommendations, ...)

Your answer



What tools were developed or made available by the project? (e.g., guide, handbook, ...)

Your answer

What key indicators (KPIs) should be used to monitor progress in this pillar?

Your answer

What are the lessons learned and the outlook for the future?

Your answer

Back Next Page 3 of 9 Clear form

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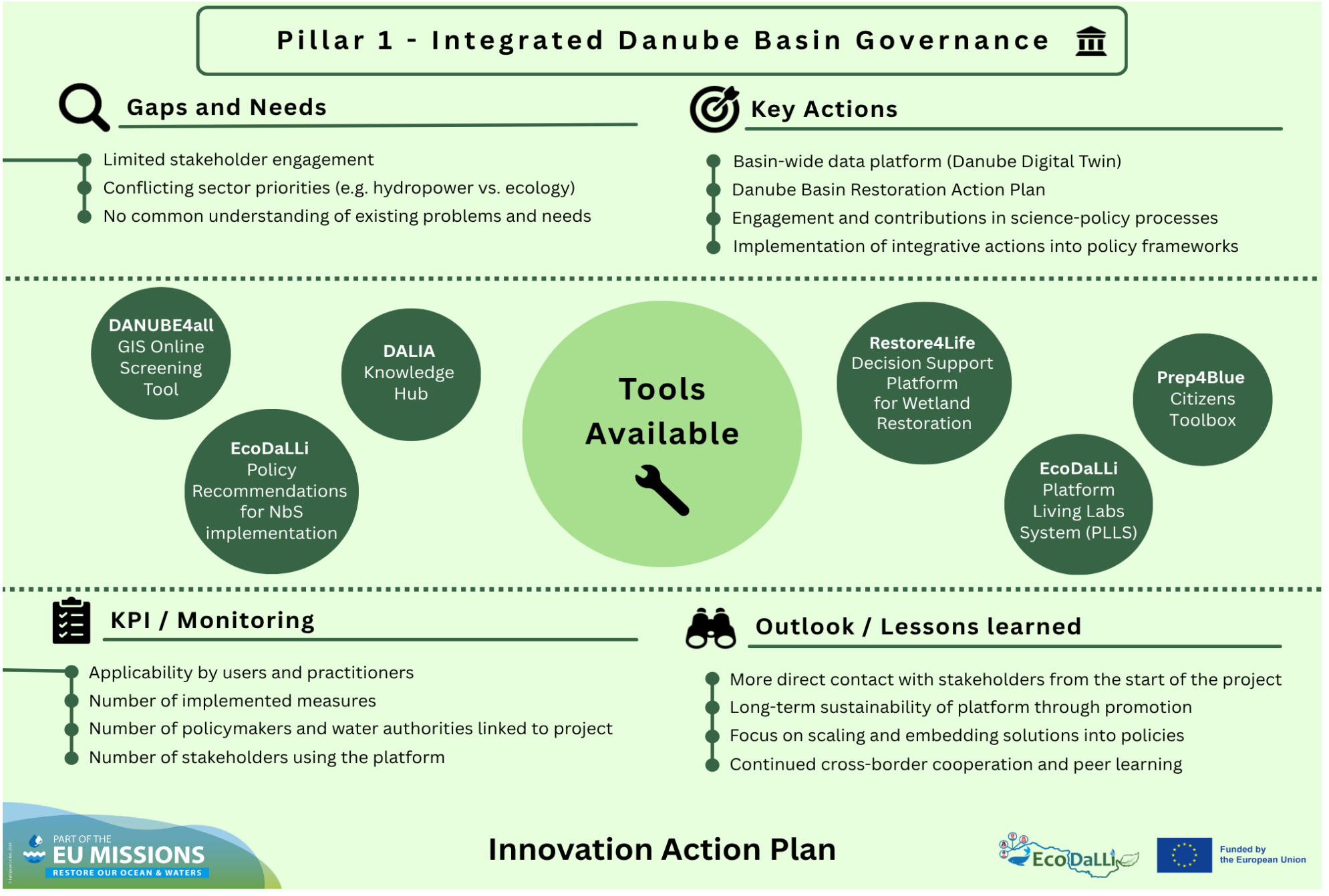
Annex II – Pillars of Innovation Action Plan



Pillar 2 - Nature-based Solutions at Scale

Gaps and Needs

- Lack of clear guidance for planning and implementation
- Insufficient or unequal technical knowledge or data
- Poor cross-sector coordination
- Uncertainty about effectiveness

Key Actions

- Demo Sites
- Reconnection of floodplains and wetlands
- Promotion and validation of landscape-based measures
- Stakeholder workshops

Tools Available

DALIA
Knowledge and Monitoring Systems

DANUBE4all
Catalogue of restoration measures

Restore4Life
Wetlands restoration wiki

Restore4Life
Roadmap for wetland restoration

KPI / Monitoring

- Habitat Quality Index
- Number of businesses in the stakeholder register
- Number of contacts and interviews with SMEs in project area
- Wetland area or number of ES restored

Outlook / Lessons learned

- More direct communication with practitioners
- NBS are effective, low-cost and scalable tools
- Successful implementation requires coordinated planning
- More contact with local SMEs for expertise and resources

PART OF THE EU MISSIONS
RESTORE OUR OCEAN & WATERS

Innovation Action Plan

EcoDaLLi
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Pillar 3 - Skills, Capacity Building and Public Engagement through Co-Creation System

Gaps and Needs

- Limited stakeholder engagement
- Poor knowledge transfer or scaling of results
- Coordination challenges across partners
- Insufficient long-term funding

Key Actions

- Launch of Danube Academy for Water & Climate
- Stakeholder co-creation workshops & participatory processes
- Real-life pilot case studies (DPS sites) as testing grounds
- Integration of citizen science and local knowledge

Tools Available

DALIA
Case studies provided by demo pilot site, KMS and workshops

Restore4Life
Restoration roadmap

Restore4Life
Stakeholder analysis

Restore4Life
Decision support system

KPI / Monitoring

- Number of stakeholder engaged
- Co-creation activities
- Knowledge exchange

Outlook / Lessons learned

- More direct contact with stakeholders in person through PLLS
- Co-creation and stakeholder engagement is essential for developing practical and accepted solutions
- Peer-to-peer learning and pilot sites are highly effective

Pillar 4 - Finance and Investment Mechanisms

Gaps and Needs

- Lack of investable and/or bankable projects
- Complex or unclear funding mechanisms
- High perceived risk / uncertainty and/or insufficient ROI
- Difficulty of growing from start-up to medium size

Key Actions

- Danube Lighthouse Investment Facility
- Suggestion of new approaches such as government guarantees
- Suggestion of Green Exchange for trading equities in NbS businesses

Tools Available

- **DALIA** Knowledge and Monitoring System
- **Restore4Life** NbS business opportunities support framework
- **Restore4Life** SWOT / TOWS analysis
- **Restore4Life** Matrix of wetland ES vs NbS business opportunities
- **Restore4Life** Matrix of potential economic benefits

KPI / Monitoring

- Implementation of DALIA tools on different pilots
- Setting up local micro-finance funds and cooperatives
- Number of NbS related enterprises

Outlook / Lessons learned

- Funding pilot sites helping the transferability & replicability of tools
- Need to increase awareness of NbS business opportunities
- Garner Support from government for promotion
- Political uncertainties hamper economy

Pillar 5 - Replication and Upscaling

Gaps and Needs

- Insufficient funding for scaling phases
- Lack of transferable models or standardization
- Context-specific constraints
- Policy or regulatory misalignment across regions

Key Actions

- Demo sites in several associated regions
- In person meetings with businesses associated with restoration
- Twinning workshops between demo sites & associated regions
- Training workshops

Tools Available

- **DALIA** Knowledge and Monitoring Systems
- **Restore4Life** ES Assessment Toolbox
- **Restore4Life** Wetland Restoration Roadmap
- **Restore4Life** Education Toolkit
- **Restore4Life** Carbon Sequestration Guide
- **Restore4Life** Citizen Science Toolkit
- **DANUBE4all** Upscaling Procedure
- **DANUBE4all** Citizen Science Toolbox

KPI / Monitoring

- Implementation of tools on different pilots
- Setting up micro-finance funds and cooperatives

Outlook / Lessons learned

- R & U strategy is essential tool to promote good practices
- Exchange of knowledge & experiences foster global sustainability
- Need to increase awareness of NbS business opportunities
- Garner support from government for promotion of tools

Pillar 6 - Data Gathering, Sharing and Monitoring

Gaps and Needs

- Inconsistent or non-standardized methodologies
- Data-fragmentation / poor accessibility
- Insufficient technical capability or tools
- Lack of clear impact measurement

Key Actions

- Monitoring and impact assessment in demo sites
- Toolbox development
- Standardize methodologies cross-border

Tools Available

- **Restore4life** Indicator Toolbox for Wetland ES
- **Restore4life** Citizen Science Protocols
- **Restore4life** Carbon Sequestration Manual
- **DANUBE4all** Problem Analysis tool
- **DANUBE4all** Measure Assignment tool

KPI / Monitoring

- ...
- ...
- ...
- ...

Outlook / Lessons learned

- Toolboxes as living documents which enable effective monitoring
- Simplify task of data gathering and assigning measures further
- ...
- ...