Germany's Blue Belt
A model for Waterway Restoration and Sustainable Regional Development



Imprint

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Content

1 For the reader 4

2 Foundations of Germany's Blue Belt 5

2.1 The transformative Blue Belt-framework 5

2.2 The network of inland waterways: the "Blue Belt" 8

2.3 Challenges for Federal Waterways 12

2.4 Linkages and synergies with other strategies and initiatives 15

2.5 Relevant materials 17

3 Stakeholders of the Blue Belt 18

3.1 The Blue Belt Advisory Board 18

3.2 Local stakeholder integration 18

3.3 Enhancing Stakeholder Engagement 20

4 Germany's Blue Belt and the European Green Deal 23

4.1 Biodiversity Net Gain 23

4.2 Climate regulation 23

4.3 Flood resilience 24

4.4 Drought resilience 24

4.5 Health and wellbeing 25

4.6 Secondary Green-Deal Goals 25

5 From General Goals to Actions 27

5.1 Restoration Actions 27

5.2 Actions to Enhance Public Participation 28

5.3 Actions to Monitor Restoration Success 28

5.4 Actions to Mobilize Additional Funding 30

5.5 Actions for Research and Knowledge Building 30

6 Timeline 32

7 Budget 33

8 Uncertainties, Boundary Conditions and Challenges 35

1 For the reader

Germany's Blue Belt: A New Perspective for Waterways

Germany's Blue Belt is a comprehensive program focused on restoring the country's federal waterways and their surrounding floodplains. This initiative, led by the Ministry of Environment and the Ministry for Digital and Transport, aims to enhance both ecological and societal well-being.

Germany's federal waterways span nearly 7,000 kilometres of navigable rivers, serving as crucial routes for transportation, trade, and recreation. Restoring these ecosystems will create and restore a habitat network that boosts biodiversity, maintains navigability for shipping, promotes water-based tourism and recreation, adapts to climate change, and improves water quality. This "Blue Belt" will ultimately create healthier environments for both people and nature.

Implementing and Scaling the Blue Belt

Implementing such a broad river and floodplain restoration program involves numerous projects across a large geographic area, from small-scale interventions to large-scale transformations. Scaling up from individual projects to a cohesive network is crucial for meeting the ambitious goals of the programme and achieving significant socio-ecological impacts. Scaling primarily involves replicating successful restoration efforts in new locations, as well as improving or enhancing existing projects further.

Scaling within the Blue Belt encompasses more than just replication. It also addresses a range of challenges, including technical, legal, administrative, and social aspects, and tackles relevant societal issues. A key part of scaling in the Blue Belt involves developing operational models and fostering a shared understanding of integrated river landscapes. This maximizes restoration benefits for both ecosystems and communities. This also includes exploring appropriate funding mechanisms and the application of scientific research to support on-the-ground actions.

The purpose of this document

This document outlines the Blue Belt's scaling process, detailing core aspects of creating a functional habitat network that provides numerous societal benefits. It describes the program's goals, the relevant stakeholders, and the types of restoration measures and nature-based solutions, exploring how these efforts contribute to broader goals beyond biodiversity enhancement. Additionally, it highlights potential opportunities for further development of the program to address new societal challenges and remain current, relevant, and compatible with other initiatives.

The insights gained from this program are aimed to guide other countries in the EU and worldwide. By inspiring policymakers, restoration managers, political decision-makers, and representatives from various economic sectors, the Blue Belt can foster a global movement towards healthier waterways.

Collaboration and Development

This document was developed as part of the MERLIN project, funded under the H2020 program of the European Commission. Most of the groundwork was conducted by diverse working groups within the Waterway and Shipping Administration (WSV) and other federal authorities and agencies. These interdisciplinary groups, consisting of ecologists, environmental scientists, civil engineers, legal experts, financial administrators, on-site implementers, and private sector actors, continue collaborating to realize the vision of the Blue Belt program.

2 Foundations of Germany's Blue Belt

2.1 The transformative Blue Belt-framework

Based on a shared awareness for the need of a restoration program for federal waterways, the Ministry of Transport and the Ministry of Environment formulated a common vision for a new perspective of waterways—the Blue Belt program. In 2017, the Germany's Blue Belt program established a comprehensive framework to enhance the ecological, social, and economic value of the country's waterways by 2050. The program aims to transform underutilized waterways into vibrant natural spaces, boosting regional development, biodiversity, and recreational opportunities. Coordinated by an interministerial working group, the program set clear project goals, implementation processes, and responsibilities to ensure the program´s long-term success.



Figure 1 Example of a Blue Belt restoration site: Creating space for nature, recreation and other usages; © BAW

Identification of Restoration Needs and Restoration Potentials

Establishing the technical foundations for the Blue Belt was essential, aiming to identify the restoration needs of federal waterways and their floodplains. This involved a detailed analysis of current conditions and deficits, utilizing data from ecological surveys, hydrological data, and land use information. The study highlighted significant ecological conditions and large-scale restoration needs due to major deviations from natural states caused by human activities like navigation and flood protection structures.

To systematically identify restoration opportunities, a potential analysis was conducted, evaluating the entire network of federal waterways to pinpoint areas where restoration could be most effective. This approach ensured that restoration efforts were strategically targeted to maximize ecological benefits. Furthermore, suggestions from the Waterways and Shipping Authorities and third parties were considered, allowing local knowledge and expertise to influence the identification of potential projects.

Implementing Pilot Projects

Before the full operation of the Blue Belt began, pilot projects were launched as ecological stepping stones along primary waterways. Their main purpose was to assess the potential and limitations of the program and to test the integration of ecological measures into the waterway network. These projects aimed to show that ecological enhancement and diverse usage requirements can be harmonized, providing valuable insights for future planning and implementation. Details on the specific measures implemented in these pilot projects are available in a detailed documentation (German only).

Reactivation of a river branch

This project involved removing large amounts of silt using water injection methods to restore continuous flow in a branch of the river Weser. The aim was to improve habitat quality for young fish and support typical habitats like reed beds.

Ecological modification of groins

This project focused on modifying groins to improve water flow and habitat quality in the Middle Weser, particularly benefiting fish and small aquatic organisms. Nine groins were altered, and the riverbanks were partially deconstructed to create natural river structures.

Reconnection of flood channels

This initiative connected two near-shore channels and created a high-water channel to enhance the natural connection between the river and the floodplain. The project included placing large wood structures to stabilize and enrich habitats.

Connecting a gravel pit lake to the river

The project aimed to connect an old gravel pit lake to the Weser to improve the ecological condition of the floodplain and provide new spawning and feeding grounds for fish. It included creating shallow water zones and introducing large wood structures.

Creation of river islands

This extensive project focused on connecting former gravel pits and creating a river island system to restore natural river and floodplain habitats. The measures included modifying the shoreline and allowing the Weser to naturally shape its riverbed.

River bank & floodplain restoration

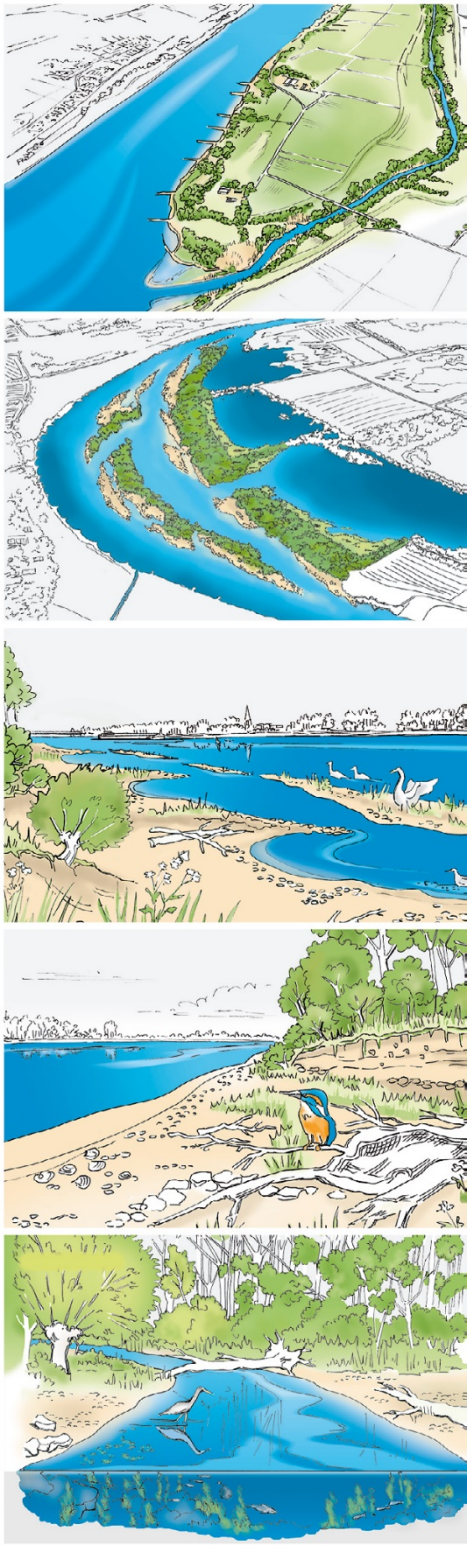
The project aimed to enhance the ecological value of a 900-meter section of the Rhine by removing stone revetments and allowing natural river processes to shape the bank. The project also improved recreational opportunities for local residents.

River bank restoration

This project involved removing artificial riverbank protections over a 2.5-kilometer stretch to extend a natural riverbank and create diverse habitats. The initiative supported the growth of riparian forests and provided new habitats for fish and birds.

Connection of a large floodplain waterbody

The focus was on improving the water exchange between the Rhine and the waterbody by enlarging inlets and outlets. The project aimed to enhance habitat quality and prevent fish kills due to oxygen depletion.



The **key learnings** from these pilot projects underscore the importance of collaboration among the different stakeholders. The projects showed that balancing ecological goals with navigation and flood protection is possible through careful planning and adaptive management. However, they also revealed that legal responsibilities, planning processes, and resources can be severe bottlenecks. One crucial insight was the need for legal adjustments to enable the Waterways and Shipping Administration (WSV) to engage extensively in ecological restoration. This supportive legal framework was essential for Blue Belt' scaling up process.

Developing the Habitat Network Concept

The Habitat Network concept is central to the Blue Belt, aiming to establish an interconnected system of habitats along waterways to enhance biodiversity and ecological processes. This program adopts a dual strategy: creating core network stepping stones for habitat connectivity and species migration, while maintaining

waterway navigability, and developing secondary waterways for sustainable growth and restoration, enhancing biodiversity and recreational spaces.

The core network's approach focuses on strategic restoration locations to balance ecological needs with human activities. Conversely, the secondary network is geared towards larger-scale restoration projects to foster areas of significant ecological value, supporting sustainable regional development. The program's motto, "Something is possible everywhere," underscores its commitment to ecological restoration in both heavily utilized and lesser-used waterways.

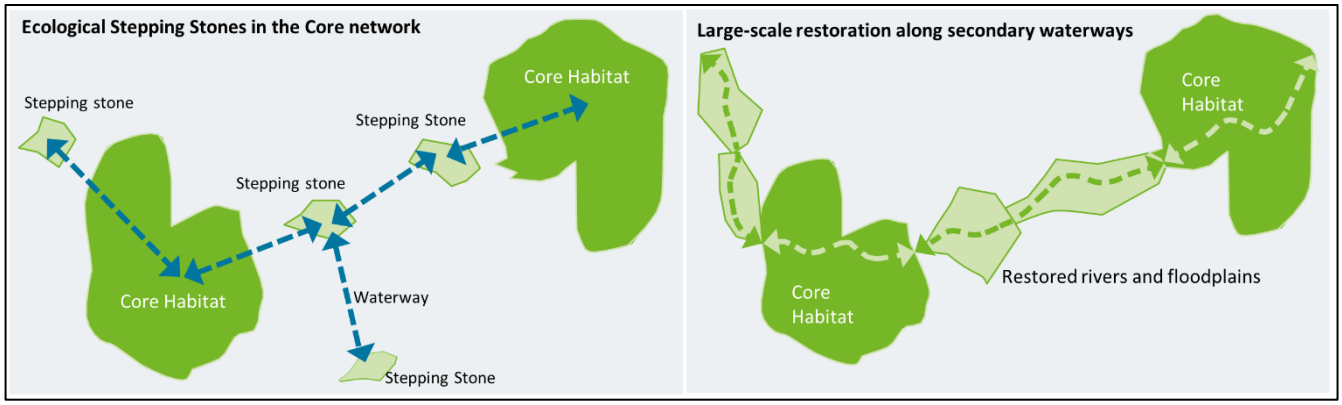


Figure 2 The Habitat Network Concept of the Blue Belt

National view and Regional perspectives

The important role of federal waterways for navigation and transport, for fostering biodiversity, regional development, sustainable resource management, tourism, and climate change adaptation necessitates adopting a dual spatial perspective: a comprehensive national view and a focused regional approach. Nationally, the extensive geographic spread of federal waterways impacts multiple jurisdictions, demanding alignment with overarching policies and strategies for cohesive management and resource optimization. On the other hand, collaboration with economic sectors, local stakeholders, and various authorities ensures a regional perspective that considers the area's strategic priorities, integrating local activities into the broader "Germany's Blue Belt" programme in a coherent manner.

Assessment Criteria for Blue Belt Measures

Projects for the Blue Belt undergo rigorous assessment to ensure alignment with the program's goals, environmental standards, and feasibility. They are chosen based on their potential to support the Blue Belt's ecological and navigational objectives and compliance with the EU Water Framework Directive, Natura 2000, and other relevant laws. Continuous evaluation and cost analysis refine future projects and policies.

Key criteria for projects include:

- Location: Must be within designated BBD area.
- Ecological Contribution: Should enhance waterway biodiversity and connectivity.
- Navigational Compatibility: Must align with current and anticipated uses of the waterways.
- Legal Compliance: Must adhere to environmental standards and regulations.

Implementation and Participation

The federal government, specifically the Ministry of Transport and the Ministry of Environment, oversees coordination, legal adjustments, and funding, while the Waterways and Shipping Administration (WSV) and the Federal Agency for Nature Conservation (BfN) together lead the implementation of Blue Belt projects, integrating them as a permanent task within their operations. Local authorities and NGOs play a crucial role in local-level planning and execution, ensuring projects meet regional needs and stakeholder interests.

Implementation
At the moment, there are 16 Blue Belt projects either implemented or in the implementation phase, with more than 30 projects being in the planning stage. Current and completed projects can be viewed on an Interactive Map showcasing ongoing Blue Belt Projects (please use QR-code for access).

Multi-Level Participation

The BBD program emphasizes participation at various levels, involving informal meetings, preliminary assessments, cooperation agreements, feasibility studies, and formal planning and approval processes. This inclusive approach ensures that all stakeholders, including federal and state authorities, non-governmental organizations, and the public, are involved in the planning and implementation phases.

Funding

Funding for BBD projects primarily comes from federal sources, including the Floodplain Funding Program of the Federal Ministry of Environment and a designated budget from the Waterway and Shipping Administration. This shared federal funding between two ministries ensures the program's long-term financial stability. The Blue Belt also requires project partners to contribute their own funds, with third-party funding used sparingly.

Science-Based Approach

To ensure the effectiveness of the BBD program, a monitoring and learning framework are established and continuously developed. This approach allows for the assessment of implemented measures, the adaptation of strategies based on new scientific findings, and ongoing research to support the program's objectives.

Public Relations and Outreach

Public relations and outreach are crucial components of the BBD program. These efforts include organizing events, publishing materials, and creating multimedia content to raise awareness and support for the program. Effective communication helps engage the public and stakeholders, fostering a broader understanding and commitment to the program's goals.



Figure 3 Open House at the Blue Belt Restoration Project 'Kühkopf-Knoblochsaue', BfG

2.2 The network of inland waterways: the "Blue Belt"

The Blue Belt is dedicated to restoring Germany's federal waterways, which are divided into maritime waterways—including coastal waters, ports, and shipping lanes within Germany's exclusive economic zone—and inland waterways. The inland waterways are further categorized into a core and secondary network, classified based on annual freight traffic volumes. The Blue Belt program specifically targets the restoration of these inland waterways.



Figure 4 The network of inland waterways: the "Blue Belt" in Germany; © WSV

The core network – "Something is possible everywhere"

Inland shipping is vital to Germany's economy, particularly for the transport of large goods, natural resources, and hazardous materials. Most of these goods are moved along the core network, known as "primary waterways," which stretches over approximately 4,500 km and includes major rivers like the Rhine, Main, Elbe, Danube, and Weser. These rivers experience high freight traffic volumes, exceeding 600,000 tons annually, and have frequent traffic. Due to their crucial navigational role and extensive modifications—including bank reinforcements, impoundments, deepening, and straightening—restoration actions on these waterways will be limited.



Figure 5 Freight transport on the Weser river – a waterway in the focus of the Blue Belt; © BAW

The focus of the Blue Belt: secondary waterways

Secondary waterways, which handle lower freight traffic volumes (under 600,000 tons per year) are primarily used for recreational boating and include smaller rivers and streams like the Aller, Lahn, Oder, Moselle, and Neckar, which span across approximately 2,800 km.

For years, many secondary waterways have ceased to serve their former purpose of freight transportation. This, however, presents future opportunities for semi-natural development, making regions with secondary waterways more attractive for leisure activities and waterborne tourism, but also for biodiversity and many other aspects, such as climate change adaptation and sustainable economic solutions. For this, unlike primary waterways, these rivers offer greater restoration opportunities and potential, making them critically important for the Blue Belt, especially when they are no longer used for freight transport.

Regulated rivers

More than half of the federal waterways are regulated by dams to meet specific usage requirements, such as defined channel depths for reliable shipping traffic. For dam-regulated rivers, one key option is restoring ecological connectivity or even decommissioning dams, though this requires careful consideration and balancing various usage demands and interests associated with each reservoir.

However, canals, making up around 2,000 km of inland waterways, are artificial and not the focus of restoration measures of the Blue Belt.

Recreational and Ecological Importance

Federal waterways serve also as recreational areas for people. Water-based tourism, including passenger and motorized leisure boating, as well as water sports like sailing, canoeing, rowing, and water-skiing, are popular activities. Additionally, fishing, hiking, and cycling along these waterways attract many visitors. Particularly scenic waterways have experienced a significant increase in tourism, drawing both short-term visitors and long-term vacationers.

Beyond their diverse recreational uses, large rivers play a crucial ecological role. They act as habitats and migration routes for many fish species such as eels, salmon, sea trout, and other organisms that rely on the ecological connectivity of waterways for reproduction and foraging. These waterways also provide habitats for various protected and endangered animal and plant species. Many sections of federal waterways are within protected areas governed by federal and European nature conservation laws. Additionally, river floodplains along these waterways host some of the most species-rich habitats in Europe.



Figure 6 Leisure boating on the Lahn, a secondary waterway without freight traffic © BfG

Floodplains along Federal Waterways

Approximately one-third of former floodplain areas remain along federal waterways and can still be flooded during significant events. However, two-thirds of these former floodplains have been lost due to levee constructions and other flood protection measures but also settlement and infrastructure. Despite these losses, federal waterways and the remaining floodplains are crucial for establishing a national habitat network and preserving biodiversity. They host over 90% of the nation's protected butterbur meadows and more than 80% of all hardwood floodplain forests, which are also protected under European conservation laws.

Key factors contributing to the high diversity of species and habitats in natural floodplains include dynamic riverbanks and the natural fluctuations between high and low water levels. Many species of flora and fauna in these areas are specialists adapted to this dynamic environment. Floodplains along federal waterways can be classified into 11 different types based on their characteristics, such as valley shape, floodplain waters, flow dynamics, and dominant vegetation units.



Figure 7 Floodplain oxbow in the Danube floodplains near Straubing; © BfG

2.3 Challenges for Federal Waterways

Rivers and their associated floodplains face numerous upcoming challenges, including climate change, land use change, infrastructure developments, pollution, and invasive alien species. These issues not only cause inevitable environmental shifts but also reduce the benefits that healthy rivers and floodplains provide to people, such as transportation, trade, recreation, tourism, agricultural production, water supply, and purification, which are crucial for human health, well-being, and socio-economic development. The Blue Belt program aims to help find and implement environmentally friendly solutions to these complex and interlinked challenges, supporting them comprehensively.

Neglected Shipping Infrastructure

Germany's waterborne transport infrastructure has been neglected for several decades, leading to a foreseeable need for substantial investment in technical upgrades or replacements within the core network. Coupled with ongoing land use changes in floodplains due to agricultural, settlement, or economic activities, this could significantly alter river and floodplain habitats and their biodiversity, necessitating high financial investment in ecosystem restoration. On secondary waterways, the Federal Waterways and Shipping Administration faces challenges in maintaining and operating infrastructure due to declining traffic and reduced focus.



Figure 8 The weir Hollerich at the Lahn river, which depicts a complex interplay between damming & water levels, biodiversity & conservation, ecological continuity and the replacement of crumbling infrastructure; © BfG

Climate Change and Low Water Levels

Climate change is one of the most pressing threats, impacting water levels within the navigation sector. Addressing low water levels is crucial for optimizing rivers as waterways, while flood protection is essential for densely populated regions. This necessitates coordinated and environmentally compatible measures and adaptation strategies. Climate change could lead to prolonged periods of low water levels, making navigation difficult and potentially disrupting shipping routes. Droughts could reduce the water availability needed to maintain navigable depths, while increased temperatures might affect the integrity of the waterway infrastructure. Additionally, more frequent and severe flooding events can damage infrastructure, necessitate costly repairs, and disrupt shipping schedules.



Figure 9 Low Water at the river Rhine; © BfG

Competing Usage Interests

The competing interests of ecological restoration and the use of waterways for shipping can create conflicts. Restoration efforts often involve re-establishing natural river dynamics, which can conflict with the need for

stable, navigable waterways for shipping. For instance, restoring natural habitats may not align with maintaining straight, deep channels required for efficient shipping. Balancing the ecological needs with navigational requirements will be a significant challenge. Moreover, the construction of new infrastructure to support shipping, such as dams, locks and levees, can counteract restoration efforts by disrupting natural water flows and habitats. Finding integrated solutions that address both ecological restoration and the operational needs of shipping will be critical.



Figure 10 Construction of lock chambers on the Moselle; © BfG

Restoration Priorities and Spatial Challenges

The Blue Belt prioritizes the restoration of waterways. However, areas with high traffic intensities which pose multiple threats to biodiversity, limiting the scale of restoration efforts. Restoring larger areas on secondary waterways requires comprehensive river development concepts, which may take several decades to materialize, presenting significant challenges in achieving spatial and temporal goals.

Chemical Contamination

Chemical contamination poses a significant challenge. In Germany, no surface water body currently meets the good chemical status as per the Water Framework Directive (WFD). This directive requires restoring rivers to good ecological and chemical potential by addressing pollution from both diffuse and point sources. Major issues include high nitrate levels as well as pesticides, heavy metals, and other substances. While restoring river and floodplain ecosystems alone will not fully improve the chemical status of water bodies, it can help mitigate impacts on biodiversity and enhance ecosystem functions, such as self-purification.

Invasive Alien Species

Invasive alien species, such as certain fish, invertebrates, and plants, pose additional concerns, impacting both biodiversity and the experience of nature. Addressing this issue requires significant allocation of personnel capacities and financial resources to ensure prevention, eradication, and management. However, there is a significant lack of resources to effectively respond to and manage invasive species in German primary and secondary waterways.



Figure 11 Impatiens glandulifera, an invasive plant species at the Lahn river; © BfG

2.4 Linkages and synergies with other strategies and initiatives

The Blue Belt aligns with many overarching national policies and strategies for cohesive management and resource optimization. These include:

- National Water Strategy
- National Biodiversity Strategy
- Water Tourism Strategy
- German Adaptation Strategy
- Nature Based Climate Action
- German Sustainable Development Strategy

Moreover, the program plays a crucial role in meeting the environmental objectives of the EU Water Framework Directive and Habitats Directive and will significantly contribute to the EU Nature Restoration Law.



Figure 12 The Blue Belt pilot 'Kühkopf-Knoblochsaue' at the Rhine, meeting Water Framework and Habitats Directive goals; © BAW.

The program fosters collaboration between nature conservation and water authorities at the state level, promoting a unified approach to water-related nature conservation. Additionally, the Blue Belt aims to actively complement, integrate, and align with other initiatives and programs focused on restoring freshwater and floodplain ecosystems.

Federal Water Tourism Concept

An example of such alignment is the Federal Water Tourism Concept, which focuses on promoting water sports and enhancing tourist infrastructure on secondary waterways. This concept aligns with the Blue Belt's objective of improving the ecological quality of rivers and adjacent floodplains. Both federal initiatives work towards shared goals: creating appealing waterways for recreational activities while safeguarding natural habitats along these watercourses.



Figure 13 Leisure boating on a secondary waterway; © BMDV.

Harnessing Experiences from Initiatives and Projects

Numerous projects in Germany focus on restoring larger and smaller rivers. Examples include the EU Life project "Living Lahn" and initiatives led by German NGOs like "Large Rivers for Germany" by Naturschutzbund Deutschland (NABU) and "Lebendige Flüsse" by the Deutsche Umwelthilfe (DUH). These initiatives share common goals with the Blue Belt, such as innovative river management, enhancing ecosystem services, and promoting sustainable tourism.

The Blue Belt will leverage the experiences gathered from these projects while maintaining a national perspective, especially concerning the establishment of a national biotope network. The program benefits from the substantial support and expertise of institutions such as the Federal Waterways and Shipping Administration, the Federal Ministry of Digital and Transport, and the Federal Ministry for the Environment. This enables the implementation of measures on a broader scale, capitalizing on insights from individual projects.

Gesamtkonzept Elbe (GKE)

Another crucial initiative aligning with the Blue Belt's objectives is the "Gesamtkonzept Elbe" (GKE), a comprehensive planning strategy for the sustainable development of the Elbe River system. Characterized by extensive stakeholder participation, including riparian countries, German states, authorities, environmental organizations, and economic stakeholders, the GKE addresses ecological, social, and economic concerns to ensure the Elbe's long-term viability. The stakeholder engagement processes developed within the GKE but also the measures to be implemented on the ground can also benefit the Blue Belt program.

River Basin Communities

Synergies exist also with River Basin Communities like the International Commission for the Protection of the Rhine (ICPR). The ICPR's "Action Program Rhine" coordinates measures to enhance the water quality and ecological status of the Rhine River and its tributaries across multiple countries. This program aims to reduce pollutants, restore riverbanks and floodplains, promote biodiversity, and enhance ecological connectivity, ensuring the Rhine's role as a habitat for diverse flora, fauna, and human communities.



Figure 14 Kick-off conference on the river Elbe with a diverse range of stakeholders at the "Flusskonferenz Elbe", 05.03.2013 in Magdeburg. © Andreas Lander.

2.5 Relevant materials

Information about the Blue Belt programme can be found here (German only):
https://www.blaues-band.bund.de/Projektseiten/Blaues_Band/DE/00_Home/home_node.html

Germany's waterways – economic factors and natural areas
https://www.bmdv.bund.de/SharedDocs/EN/Dossier/waterways/waterways.html

Blue Belt in a nutshell
https://project-merlin.eu/files/merlin/factsheets/MERLIN_fact-sheet_%2310.pdf

3 Stakeholders of the Blue Belt

The engagement and involvement of national, regional, and local stakeholders is a fundamental pillar of the Blue Belt, which is essential for achieving the goals of the program to facilitate successful restoration efforts and to implement sustainable solutions that are socially and economically viable within the respective regions.

As a national restoration program, the Blue Belt comprises multiple individual projects that will collectively establish a habitat network. Stakeholder participation and inclusion will be carried out for each project individually because stakeholder involvement needs to be tailored specifically to the problems and challenges on the ground. The spectrum of stakeholders is broad, ranging from authorities, associations, businesses, farmers, to the local population.

However, there are stakeholders actively involved at the overarching program level, united within the "Blue Belt Advisory Board". The task of this board is to discuss strategic questions, aspects requiring broad consensus and integration into other sectors. They also ensure that the Blue Belt continues to evolve and mainstreaming positions beyond the biodiversity or navigation sectors.

3.1 The Blue Belt Advisory Board

The Blue Belt Advisory Board is the main stakeholder body of the Blue Belt Program and comprises national representatives of the following stakeholder organisations:

- Federal Ministry for Digital and Transport (BMDV)
- Federal Ministry for the Environment, Nature Conservation, Nuclear Safety, and Consumer Protection (BMUV)
- Nature And Biodiversity Conservation Union (NABU)
- German Tourism Association
- ADAC - German Automobile Club
- Stiftung Lebensraum Elbe
- WWF Germany
- Ministry for Economic Affairs, Labour, and Energy, Brandenburg
- German Olympic Sports Confederation
- German Rowing Association
- Friends of the Earth, Germany
- Senator for Climate Protection, Environment, Mobility, Urban Development, and Housing, Bremen

The advisory board is co-chaired by the Federal Ministry for Digital and Transport (BMDV) and the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety, and Consumer Protection (BMUV).

Its primary roles are strategic and consultative, guiding the implementation process and advising on sector-specific requirements. This includes developing measures, river development concepts, and addressing fundamental issues. The board can recommend prioritizing restoration projects along federal waterways. A key task is aligning goals and interests across economic sectors using the waterways. Additionally, the board disseminates jointly developed results to all stakeholders, contributing to the integration of restoration activities into the strategies and goals of various authorities, organizations, and associations involved in transportation, tourism, and conservation.

3.2 Local stakeholder integration

The key to a success full implementation of the Blue Belt is "doing it together", which involves integrating the perspectives of all relevant interest groups through stakeholder involvement at the local project implementation level. Both in project conception and execution, various interest groups must be included. The following stakeholders are regularly affected by Blue-Belt measures and control and influence the process and the final decision-making:

- **Federal Waterways and Shipping Administration (WSV)** as owner of waterways or project implementer
- **Adjacent communities** as project implementers, landowners, or formally involved parties
- **Local and regional government authorities** as formally involved parties
- **Agricultural businesses and landowners along the riverbanks** as landowners

- **Tourism, leisure, and recreation associations** as well as boating and water sports clubs as economic sector
- **Companies and firms** as landowners and with specific requirements on the river and floodplain
- **Nature and environmental protection associations** as interest group for biodiversity protection
- **Fishing and angling associations** as interest group
- **Research institutes and scientific institutions** as interest groups for education, science and consultation

Indeed, most restoration projects follow formal approval processes that require engaging with affected members of the public in a predefined way. The concerns and interests of the public must be considered through established citizen participation and consultation mechanisms. This ensures that stakeholders are not just informed but actively involved and included in the development of restoration measures. Thus, citizens become an integral part of the decision-making process.

Informal participation

Restoration projects are complex, especially in multi-stakeholder landscapes, and often require years of preparation. Early and informal stakeholder participation is crucial to inform stakeholders about the project, address their concerns, and integrate their perspectives promptly. In the Blue Belt, various methods for public involvement have proven successful, tailored to the project's size and complexity.

For small-scale projects on WSV property with few competing interests, an internal procedure is typically applied for swift implementation. However, for larger projects involving multiple stakeholders, a more intensive participation process is needed. This often includes thorough stakeholder mapping to ensure all relevant parties are included.

Particularly helpful informal consultations include:

Information sessions for the general public

These sessions provide an opportunity to disseminate project information widely, raise awareness and enable an understanding of the project among community members. Such sessions foster transparency and inclusivity, ensuring that all stakeholders are well-informed and engaged in the decision-making process.

Fieldtrips and excursions

Organizing fieldtrips and excursions allows stakeholders to experience the project area and its surroundings first-hand. It facilitates a deeper understanding of the project's context and potential positive impacts, fostering meaningful discussions and an informed decision-making.

Stakeholder meetings, roundtable discussions and Workshops

These interactive sessions enable stakeholders to voice their concerns, share their perspectives, and contribute to the development of solutions collaboratively. They promote dialogue, consensus-building, and the co-creation of project strategies, enhancing stakeholder buy-in and support.

Personal conversations and bilateral meetings

One-on-one discussions provide an opportunity for stakeholders to express their individual concerns and preferences in a more private setting. These conversations allow for tailored communication and relationship-building, addressing specific needs and fostering trust between project proponents and stakeholders.

Feedback & participatory decision making

A key challenge in effective stakeholder integration is incorporating feedback from stakeholders and implementing a participatory decision-making process throughout the project design, implementation, and monitoring stages. This involves actively listening to stakeholder inputs on critical issues such as property rights, species protection, flood risk reduction, and reconciling restoration with shipping and navigation.

By considering the suggestions of relevant stakeholders in each Blue Belt restoration project, adjustments can be made to the planning and implementation of individual measures. For example, the size, location, and configuration of restoration measures can be tailored to better align with stakeholder concerns and ecological needs.



Figure 15 Stakeholder workshop with the EU Life-Project Living Lahn; © WSA Koblenz

Addressing stakeholder concerns related to property ownership might involve innovative solutions, such as selectively reinforcing riverbanks or using nature-based erosion control methods that do not negatively impact private properties. Moreover, ensuring that interventions do not impede navigability is crucial, highlighting the need for a balanced approach that integrates restoration goals with the interests of property owners along the river and the shipping sector using the waterways.

3.3 Enhancing Stakeholder Engagement

Given the numerous challenges in planning, implementing, and scaling river and floodplain restoration, stakeholder engagement remains crucial. Waterways are now recognized not only for transportation but also for supporting biodiversity, recreation, and economic activities. Therefore, it is essential for all stakeholders to consider these diverse demands, find compromises for conflicting goals, and define common targets with minimal trade-offs.

Here are some perspectives to further promote stakeholder engagement in the Blue Belt.

Conservation & Navigation

Since the Blue Belt is focused on restoring rivers and floodplains, involving stakeholders from conservation agencies and NGOs is paramount for project planning and implementation. The program has already fostered a strong relationship between the navigation and conservation sectors along federal waterways. Both sectors must, however, continue to build trust and mutual understanding. Compromises, such as utilizing nature-based solutions and considering adaptive management, will be beneficial during both planning and implementation stages. This collaborative approach can accelerate project implementation and ensure balanced, sustainable outcomes.

Water Resources and Management

In the face of increasing climate change-related risks, such as water scarcity, potential conflicts will likely escalate. Efforts to retain water within landscapes and implement natural climate mitigation, ecosystem-based adaptation, and nature-based solutions will become more critical. Federal waterways often contend with low water levels, making water scarcity a crucial issue for stakeholders in navigation, hydropower, agriculture, water supply, state authorities, municipalities, and the public. Balancing these demands amidst more frequent and severe droughts remains unclear. Consequently, these climatic and environmental changes necessitate a transformation within sectors to adapt to future uncertainties, changing demands, and conflicting interests.

Agriculture

In the agriculture sector, there is significant resistance from farmers and related stakeholders to giving up land for reconnecting floodplains and rivers. This resistance stems from concerns about the impacts of biodiversity enhancement, restoration, flood risk reduction, and the potential consequences for their businesses. For example, efforts in the Tide-Elbe region near Hamburg to relocate dikes or purchase farmland to give the Elbe River more space and adapt to changing water levels have faced strong opposition from local landowners and farmers. To address this, the Blue Belt program needs to involve farmers from the outset and clearly

communicate the benefits and compensation potentials. Providing direct financial incentives and technical support can also increase acceptance and cooperation for river and floodplain restoration projects.

Hydropower

Ecological connectivity is a central goal of any river restoration project. Restoring longitudinal connectivity requires close coordination with the hydropower sector, which relies on dams for electricity generation. However, this poses unique challenges. Hydropower companies often face difficulties in releasing water for fish ladders or dismantling dams, as this can impact electricity generation and involve significant costs, posing challenges to their business models.

To address this, it's crucial to develop innovative solutions that balance energy production with environmental restoration. Collaboration between hydropower companies and conservationists can lead to technologies and strategies that optimize water use for both power generation and ecological benefits. Implementing adaptive management practices and investing in eco-friendly infrastructure can enhance the integration of hydropower operations with river restoration efforts.

Financing Sector

A major challenge will be financing these initiatives. Traditionally, most projects have depended on public funding. However, with dwindling resources, there is a shift towards innovative or private financing solutions. The private sector is increasingly interested, but public actors must be open to collaboration to fill funding gaps for conservation, restoration, and climate adaptation. Developing national policies to integrate these innovative financing methods can enhance and scale up restoration efforts across Germany.

An innovative idea comes from Swiss Re's river insurance. For example, TNC and others successfully launched a parametric insurance scheme in Mexico, funded by the tourism sector, to restore coral reefs after disasters. This model could be applied to rivers, with shipping companies financing responses, compensation, or adaptive measures for droughts.

Collaborative Integrated Projects

Collaborative integrated landscape projects are possible solutions to overcome many of such barriers. These bring together diverse stakeholders to pool resources, collectively enhance landscapes, and harness associated benefits. These projects harmonize various objectives, such as restoration, development, and climate change mitigation, by engaging stakeholders as partners in collaborative processes. Such projects seek to create synergies, reduce trade-offs, and foster coordination at the landscape level.

A collaborative project can potentially be designed with two main steps:

1. Identify and map stakeholders: Identify key stakeholders and sectors in the landscape context of a planned restoration project with the power, resources, and interest to support and upscale the project. For example, through desk-based research, interviews, and citizen workshops.
2. Partnership development: Develop collaborative partnerships with relevant stakeholders, where each partner contributes resources in return for ownership over the project's development and its outcomes. This step involves learning about the project, envisioning, and planning the upscaling process, and formalizing partnerships.

A lighthouse project that could serve as a role model for the Blue Belt is the EU-Life Project "Living Lahn." At the Lahn River, a comprehensive stakeholder process was established, including representatives from navigation, agriculture, hydropower, and conservation to explore the potentials of restoring a river with low cargo traffic but high recreational and biodiversity value. Ecosystem services and the social benefits of restoration are intensively mapped and used to balance the needs and requirements of stakeholders, aligning with societal challenges. This example could be particularly pioneering for the development of concepts along secondary waterways.

Enhancing Local Stakeholder Integration

Despite its strong focus on stakeholder integration, the Blue Belt can further enhance local engagement by emphasizing transparency, mutual respect, and compromise. Key measures include regularly publishing project updates to ensure transparency and hosting inclusive meetings where all parties can discuss their concerns equally. Establishing a clear feedback loop to genuinely consider and address stakeholder suggestions will help build trust. For large projects, independent mediation should be considered instead of meetings led exclusively by project managers. Successful examples, such as the EU-Life Project "Living Lahn," demonstrate how these approaches can enhance cooperation and trust among stakeholders.

Creating a structured negotiation framework that emphasizes honesty and compromise will ensure balanced solutions meeting both ecological and economic needs. These measures can lead to increased project efficiency, better stakeholder satisfaction, and improved ecological outcomes. Potential challenges, such as coordinating diverse stakeholder interests, can be mitigated through careful planning and continuous communication.

4 Germany's Blue Belt and the European Green Deal

The Blue Belt will not only contribute to national strategies and support legal obligations but also to the European Green Deal by helping to implement its goals. The European Green Deal, initiated by the European Commission, outlines a comprehensive set of policy measures. The first set of goals is targeted for 2030, with more ambitious targets set for 2050. The aim is to promote sustainability within the European Union's economy, transitioning towards a low-carbon and resource-efficient future.

Several objectives of the European Green Deal are closely linked with those of the Blue Belt programme, specifically:

Biodiversity Net Gain: Protecting and restoring biodiversity, including ecosystems and wildlife habitats, to halt biodiversity loss and ensure the long-term health of ecosystems.

Climate Regulation: Achieving net-zero greenhouse gas emissions by 2050, meaning that the EU's total greenhouse gas emissions are balanced by removing an equivalent amount from the atmosphere.

Flood & Drought resilience: Taking measures of flood hazard reduction and drought risk reduction with a focus on nature-based solutions.

Health & well-being: Promote the access to nature-based recreation and ecotourism by ensuring healthy and accessible river ecosystems

Other goals include, for example, reducing pollution, increasing renewable energy usage, improving energy efficiency, promoting a circular economy, advocating for sustainable food practices, and encouraging cleaner transportation options to reduce emissions and improve air quality.

Details on how the Blue Belt contributes to these goals are provided below. Chapter 5 outlines examples and possibilities to achieve these goals.

4.1 Biodiversity Net Gain

Since the Blue Belt is a restoration programme, it strongly contributes to the biodiversity goals of the European Green Deal. However, Blue Belt measures not only enhance biodiversity through improved habitat diversity and connectivity but also bolster flood resilience by increasing water retention and floodplain capacity, reducing flood and drought risks. The removal of dikes, dams, and weirs facilitates ecological connectivity, boosting sediment transport, water quality, and groundwater recharge, while also strengthening migratory routes. These nature-based solutions not only support ecosystem services but also attract recreational activities, enhancing regional tourism and promoting environmental sustainability.

Specific goals for biodiversity enhancements (e.g., regarding population trends for individual species or species groups) are not formulated within the program. Instead, the Blue Belt aims to create supportive boundary and environmental conditions for enhancing and restoring biodiversity along rivers and floodplains. Ambitious goals have been set for this purpose:

- By 2050, the federal waterways are an integral part of the transnational biotope network.
- By 2035, the condition of floodplains has improved by at least one rating class at 20% of assessed sections along federal waterways. Additionally, by 2035, 15% of floodplains along federal waterways are restored to their natural functions.
- By 2050, infrastructure which is not utilized within the network of federal waterways is either repurposed or dismantled in conjunction with restoration measures.
- Federal waterways provide continuous passage for migratory aquatic species, and ecological spatial connectivity among rivers, watersheds, along riverbank, and between floodplain habitats is established.

The accomplishment of these goals will be quantified and assessed according to specific criteria through a monitoring and evaluation program, which is separately developed by both Ministries for waterways and floodplains. These two monitoring programs will assess changes in the condition and expansion of riparian and floodplain habitats, enhancements in floodplain condition, and improvements in watercourse structure as well as on specific aspects of biodiversity (see also section 5.3).

4.2 Climate regulation

The Blue Belt aims to support the EU Green Deal goal of achieving net-zero greenhouse gas emissions by 2050. While the Blue Belt program does not include specific climate-related targets, it contributes to the Federal

Climate Protection Act, which aims for climate neutrality by 2045, and aligns with other key federal climate protection strategies and programs, such as the Federal Ministry of Environment´s Action Program for Natural Climate Protection (ANK), which set goals of implementing measures combining natural climate solutions and conservation activities for all ecosystem types in Germany, including urban contexts, agriculture and forestry to enhance carbon sequestration and natural climate protection.

To take advantage of the synergistic goals of these programs, laws and strategies, natural climate solutions and nature-based solutions should be mainstreamed and aligned with the goals and objectives of the Blue Belt Program. This includes interdisciplinary research addressing both climate, ecological and restoration questions, pilot projects targeting climate-related goals, and enhanced communication about the climate change adaptation and mitigation benefits of restoration.

Key aspects include:

- Integrate Carbon Sequestration into Restoration Projects: It should be a focus of the Blue Belt to implement river and wetland restoration projects that enhance ecosystem resilience to climate change and support biodiversity. For this, specific goals for the storage of carbon, for example for annual CO2 sequestration, should be formulated, e.g. hectares restored to capture and store carbon
- Water Retention: Measurable goals need to be defined and integrated that address the improvement of water retention and flood risk reduction through restored rivers and floodplains.
- Climate-related Ecosystem Services: The Blue Belt would benefit from specific goals that consider climate-regulating services such as cooling effects from increased vegetation and improved soil health that supports carbon storage.
- Research and Monitoring: A comprehensive research strategy is needed to quantify the greenhouse gas sequestration benefits of restoration activities and monitor their long-term effects.

4.3 Flood resilience

The Blue Belt already significantly contributes to flood resilience through river and floodplain restoration. By restoring ecosystem functioning the water storage capacity of ecosystems can be enhanced, the program supports the reduction of downstream flooding and increases ecosystem resilience to extreme weather events. This is achieved by actions, such as relocating dykes, creating technical or nature-based retention systems or restoring natural flow regimes.

However, to ensure these ecosystems are better equipped to handle climate change-related flooding and reduce potential flood risk impacts on downstream communities, more explicit goals and concrete, time-bound measurable targets are needed. Specific goals could address:

- Increasing the storage capacity of restored rivers and streams (measured, for example, in cubic meters of water stored).
- Setting targets for the area of newly designated floodplain areas resulting for example from dyke relocations (quantified in hectares of floodplain gain).
- Enhancing wetland restoration with goals focused on rewetting wetlands and peatlands to improve their water storage capacity (measured in hectares).

Furthermore, a robust monitoring and evaluation framework should be implemented for accurate assessment of these goals.

4.4 Drought resilience

Extreme temperatures, droughts, and low water levels, along with their impacts on navigation, biodiversity, and human health, have become increasingly relevant for society. While the Blue Belt focuses primarily on restoration, it should take a more proactive role in addressing these societal and climate change challenges, given their close connection to restoration efforts.

To meet the climate goals of the EU Green Deal, it is essential to restore and maintain hydrological conditions in floodplain forests, meadows, and wetlands, which are crucial for carbon sequestration and ecosystem resilience. Degradation of these ecosystems, mainly due to land use changes and dehydration, has reduced their ability to act as carbon sinks and mitigate negative drought impacts. Restoration actions are aimed to slow down river runoff, increase water retention, and provide a stable water source during droughts, benefiting sectors such as agriculture, hydropower, navigation, and water supply.

While many Blue Belt measures indirectly retain water in the landscape, the program has not yet set measurable goals for increasing drought resilience, but instead focuses solely on biodiversity. The goals for flood resilience can largely be applied to drought resilience, as both are closely interrelated. Flood resilience focuses on immediate water control, while drought resilience emphasizes long-term water storage and availability. Restoration of floodplain forests, meadows, and wetlands enhances both flood and drought resilience by improving water retention and ecological stability.

4.5 Health and wellbeing

The Blue Belt enhances not only ecological restoration but also recreation, human health, and leisure. Recognizing the multifaceted benefits of restored river landscapes, the program integrates water tourism, passenger shipping, sailing, motorboating, canoeing, rowing, fishing, hiking, and cycling. Secondary waterways are being repurposed to enhance recreational use.

Primary goals include promoting water tourism, developing infrastructure for non-motorized activities, and creating attractive natural spaces for regional development. However, explicit, quantifiable goals are lacking. To enhance success, the program should set measurable objectives, such as kilometres of accessible waterways, usage monitoring, and health benefits like reduced stress and increased physical activity.

Enhanced communication about health and recreational benefits, active involvement of local communities, and partnerships with local governments, tourism boards, and health organizations are essential. Explicitly setting and monitoring measurable targets will significantly boost the program's impact on public health and well-being.

4.6 Secondary Green-Deal Goals

While all Green Deal goals are important, the Blue Belt focuses primarily on those most aligned with its core mission. Consequently, some secondary Green Deal goals may only be addressed indirectly or not as comprehensively, ensuring that the main objectives of the BBD remain clear and effective.

Zero Pollution

While not a primary focus, the Blue Belt contributes to reducing water pollution through the restoration of natural water filtration systems in wetlands and floodplains. No clear goals are formulated, however, in this regard. To strengthen this contribution, the program should formulate clear goals for reducing nutrient and chemical runoff into waterways and improving water quality parameters. Including indicators such as nutrient concentrations and surface water chemical status in the program's monitoring framework would provide a comprehensive assessment of its impact on water quality.

Green Growth

The Blue Belt aims to promote regional development by restoring natural landscapes along waterways, fostering eco-tourism, recreational opportunities, and local economic activities. Restored river landscapes attract tourists, boost local businesses, and create jobs in hospitality and recreational services. Developing trails, parks, and water sports facilities encourages outdoor activities, improving quality of life for residents and drawing visitors.

To enhance its impact, the Blue Belt could:

- Set quantifiable targets for economic benefits, such as jobs created and increased local business revenues.
- Develop strategies for collaborating with federal states and NGOs, including joint projects and funding mechanisms, with clear partnership goals.
- Establish goals for community involvement in planning and implementation.
- Define objectives for sustainable infrastructure development, like trails and parks, with specific targets.

Sustainable Transport

The Blue Belt supports sustainable transport by encouraging the use of waterways for eco-friendly transportation and recreational activities. The program could benefit from more explicit goals related to sustainable transport, such as increasing the use of waterways for passenger and freight transport to reduce road traffic and emissions. Setting targets for the development of infrastructure that supports sustainable transport modes, such as cycling paths and boat docking facilities, would strengthen this aspect.

Financing

While the Blue Belt solely relies on public funding for its initiatives, exploring innovative financing solutions, including private investments and public-private partnerships, could enhance the program's sustainability and impact. Setting goals for securing alternative funding sources and developing financial mechanisms that support long-term restoration and maintenance of waterways would be beneficial.

Inclusive Participation

The Blue Belt acknowledges the importance of stakeholder involvement but lacks specific goals for inclusive participation. To address this, the program should set clear targets for stakeholder engagement, ensuring that diverse groups, including local communities, businesses, and environmental organizations, are actively involved in the planning and implementation phases. Establishing measurable goals for the number and diversity of stakeholders involved, as well as the frequency and quality of engagement activities, would enhance transparency and inclusivity.

5 From General Goals to Actions

This section details how the Blue Belt program's general goals translate into specific actions. It outlines actions that could be taken to implement the Blue Belt program “on the ground” and how restoration projects and nature-based solutions can actively contribute to the broader EU Green Deal goals, extending beyond biodiversity. It will highlight the innovative synergies created by these restoration efforts, demonstrating how they can simultaneously enhance biodiversity and address other societal needs, such as improve water quality, mitigate flood risks, enhance recreational opportunities, and support local economies.

5.1 Restoration Actions

Concrete restoration actions are the core of the Blue Belt program. The "Catalogue of Blue Belt Measures" is a key tool and guideline, listing numerous measures to create a national habitat network along Germany's federal waterways and floodplains.

It includes twelve groups of measures with a total of 39 specific actions, such as restoring natural water flow, removing bank reinforcements, developing floodplain waters, and naturally flooding polders. These actions aim to balance the needs of navigation, conservation, flood and environmental protection. All Blue Belt measures must align with the types listed in this catalogue to ensure they meet the program's criteria for sustainable waterway restoration.

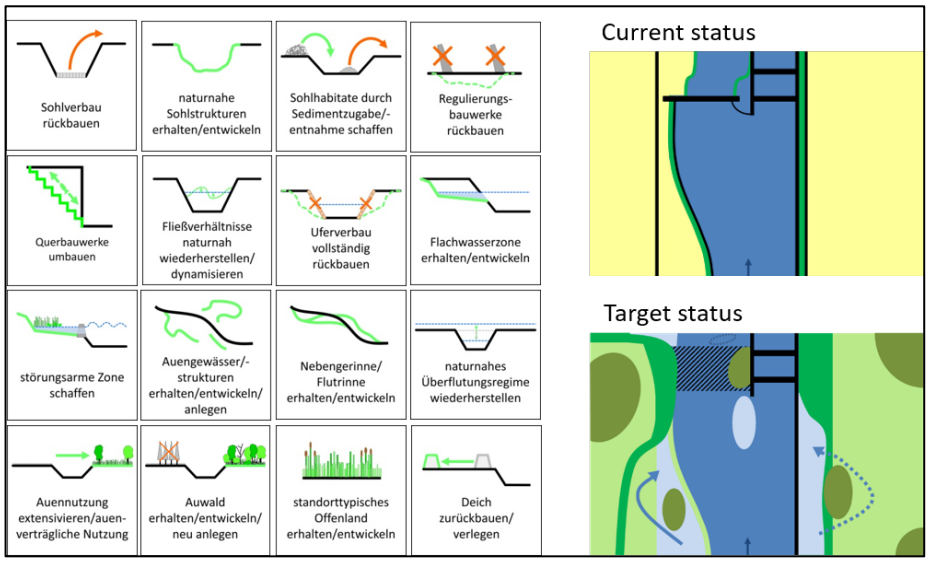


Figure 16 Schematic overview of potential restoration measures that aim to improve habitat connectivity in secondary waterways, while ensuring the usability of motorized recreational traffic.

Examples of key measures for restoring river and floodplain ecosystems in the Blue Belt include:

- **Removing or modifying bank reinforcements** to restore natural riverbanks and enhance connectivity between aquatic and terrestrial habitats. This restoration supports species that rely on both environments, improving ecological heterogeneity and resilience.
- **Restoring floodplain water bodies** and side channels supports dynamic landscapes, crucial for species migration, connectivity, and habitat diversity.
- **Removing or relocating dikes and dams** reintegrates rivers into their natural floodplains, allowing natural flooding dynamics to resume, which is essential for nutrient flow and habitat restoration. Additionally, removing weirs restores river continuity and migratory pathways for aquatic species, promoting genetic diversity and ecological connectivity.
- **Restoring natural flow dynamics** re-establishes the natural variability of flow conditions, maintaining diverse habitats necessary for a wide range of species.
- **Restoring natural flood regimes** supports the cyclical high and low water patterns that sustain dynamic ecological processes and robust floodplain ecosystems.



Figure 17 Blue Belt Project "Kuehkopf-Knoblochsaue" before (left) and after (right) the removal of riverbank rip raps, © BAW.

5.2 Actions to Enhance Public Participation

There are numerous options to enhance public participation at the program scale, within the individual states that are part of the program, and at the project level. These options can be integrated throughout all project phases, from conception to monitoring and evaluation. Below are a few examples that could enhance and complement the current public engagement activities of the Blue Belt program.

Integration of Citizen Science

As a comprehensive monitoring guideline for the Blue Belt is currently being developed, there is significant potential to incorporate environmental education and citizen science into its long-term strategy. Citizen science can greatly enhance the quantity and quality of monitoring and evaluation data while fostering community involvement, stewardship, and supplementing limited public resources and capacities. The app iNaturalist, an AI-based tool developed by scientists to identify flora and fauna, has been widely accepted by citizen scientists, academia, and practitioners alike. It effectively collects essential biodiversity data that can contribute to ecological monitoring efforts.

Engaging Local Communities

In addition, formats, such as BioBlitz events can support fundraising efforts, as well as engage local communities in the monitoring and "Natur erleben" of Blue Belt projects. A BioBlitz event invites citizens, and communities living adjacent to the project sites, to collect as much spatially explicit biodiversity data in a specific timeframe, usually ranging from 12 to 36 hours, as possible. This event can help identify indigenous, endemic and invasive alien flora and fauna species and when repeated help detect spatially explicit changes over time. Specifically, the collection and seasonal monitoring of site-specific data is often a very costly matter. Formats that engage the public, create a sense of stewardship and help overcome monitoring challenges, can contribute to a long-term success and higher acceptance rate of restoration projects.

Environmental Education

Environmental education and engagement programs, such as the Junior Ranger program, adopted from the US, Environmental Education Youth Camps, Public Tours from the Project Implementers, fundraising activities, such as running for all ages, can engage a diverse set of citizen groups and offer a range of engagement options to experience nature and learn about the restoration project.

Creating Public Access to Restoration Sites

Additionally, integrating components for public access to the restoration site within the project design, such as through creation of trails, offering recreation activities, setting up of educational signages to educate and create acceptance for short- to mid-term restoration activities limiting access to certain parts of the project site (e. g. planting of native tree saplings, re-directing trails to reduce soil erosion, excavation activities), can create benefits for human health and well-being, while ensuring diverse public engagement with the natural environment and restoration project site.

5.3 Actions to Monitor Restoration Success

Monitoring the success of restoration efforts is a fundamental component of the Blue Belt program. This process aims to enhance the efficiency of the implemented measures, integrate the latest scientific insights, and leverage a learning framework. By systematically evaluating the outcomes, the program ensures that best

practices are identified, adjustments are made as needed, and continuous improvements are achieved. This approach maximizes the ecological and environmental benefits of the restoration projects.

When is Monitoring Required?

Monitoring is regularly required when projects are implemented. Not all projects are monitored with the same intensity, and not all measures need to undergo monitoring per se. It is particularly recommended when:

- The project's impact has not already been demonstrated by comparable projects.
- The project has a key function for further measures.
- The project is part of a cascade of measures, where the impact of several individual measures needs to be assessed.
- It is necessary to observe the impacts of restoration on navigation or other uncertainties that need to be monitored.

Who is Involved?

Monitoring is primarily conducted by the Waterways and Shipping Offices (WSÄ) and project owners. Depending on the project, various stakeholders may also be involved, including:

- Federal Institute of Hydrology (BfG): Provides scientific and technical support and conducts its own surveys in the fields of biodiversity, morphology, hydrology, and water quality.
- Federal Waterways Engineering and Research Institute (BAW): Involved in the conception of monitoring and the assessment of changes. Responsible for geotechnical aspects and the impact on waterways and navigation.
- External experts and scientists: Engaged for specific studies and accompanying research.
- Citizen Science initiatives can also be valuable contributors to monitoring

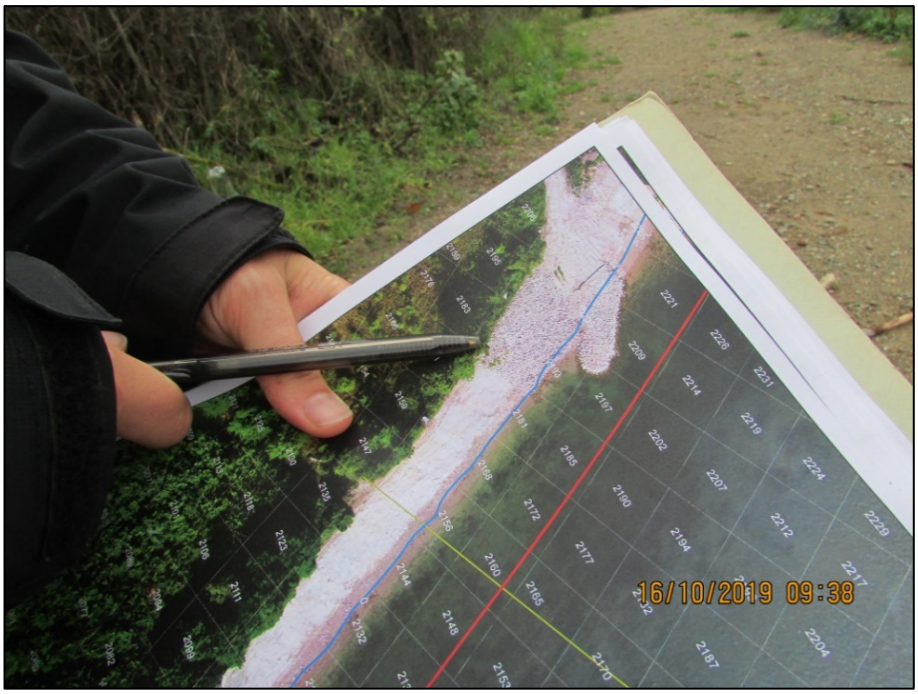


Figure 18 Monitoring restoration success; © BfG.

What is Measured?

Monitoring the Blue Belt projects involves collecting and assessing various indicators that measure the state and changes in the project area. These indicators are divided into abiotic and biotic categories and are measured before, during, and after implementation by qualified personnel. The surveys follow a standardized protocol and are designed for long-term success monitoring, typically occurring before, immediately after, and 3, 5, and 10 years post-implementation. Principles are outlined in a monitoring concept and adapted to local conditions at the project level:

- Abiotic indicators:
  - Hydraulic parameters: flow velocity, water levels, and discharge rates.
  - Morphological parameters: sediment composition, riverbed and bank structure, depth and width variations, and the length of the shoreline.
  - Chemical parameters: water temperature, oxygen content, nutrient levels, and pollutant concentrations.

- Geotechnical parameters: soil stability and sediment transport.
- Biotic indicators:
  - Flora: vegetation types, abundance, and distribution.
  - Fauna: fish populations, aquatic and terrestrial insects, and avifauna.
  - Other aquatic organisms: phytoplankton and zooplankton populations.

How is Reporting Done?

Monitoring results are documented in reports. These reports contain all essential information regarding goal achievement and measure assessment. The preparation of the reports follows clear principles:

- Objective and Purpose: The reports describe the objective and purpose of the monitoring.
- Procedure and Indicators: The indicators and methods used for success monitoring are outlined.
- Results and Evaluation: The collected data are analyzed and evaluated to illustrate the success of the measures. Both positive and undesirable changes are documented to enable timely adjustments.
- Comprehensibility: The reports should be understandable and comprehensible to all addressees.

Integrating further Green Deal Goals into the Blue Belt Monitoring

Currently, the Blue Belt monitoring is primarily focused on river and floodplain restoration and the impacts on navigation, with other Green Deal goals not being monitored. To expand the scope, the Green Deal goals such as climate regulation, flood resilience, drought resilience, and health and wellbeing should also be subjected to thorough monitoring.

To achieve this, a comprehensive monitoring concept should be developed that integrates these objectives into existing biodiversity monitoring frameworks. This concept should include regular assessments at multiple intervals: baseline data collection before restoration actions, interim evaluations at 5-year intervals, and a comprehensive review every 10 years.

The monitoring should be conducted by a multidisciplinary team comprising ecologists, hydrologists, climate scientists, and public health experts to ensure a holistic evaluation of the impacts. Government agencies, research institutions, universities and local environmental organizations and also citizens should collaborate to perform these monitoring activities, ensuring that the data collected is robust, transparent, and actionable.

5.4 Actions to Mobilize Additional Funding

In addition to the overall program funding there are specific actions that can be taken at the project scale to secure and generate additional financial support.

NGOs that are planning a project within the Blue Belt can utilize fundraising activities to obtain funding at different stages of the project. Specifically, in the critical design stage, fundraising and donations can help finance the project design and draft. During the construction phase, asking for in-kind donations or contributions, e. g. construction companies sponsoring their machinery, time, expertise, or by creating novel revenue-streams, e. g. novel agricultural products obtained through a sustainable management and collaboration of farmers in floodplains, as well as applying Innovative financing mechanisms, e. g. CO2 certificates, can forms critical actions to mobilize additional funding and contribute to a sustainable, diversified, and long-term financing of restoration projects, while de-risking the Individual financing component.

5.5 Actions for Research and Knowledge Building

The Blue Belt places a strong emphasis on leveraging scientific research, utilizing established methods and the latest knowledge to understand ecosystem dynamics, identifying restoration potentials and to inform its restoration strategies. While the Blue Belt does not have dedicated funds for research, it engages in networks with various institutions to facilitate and coordinate research. Through these collaborations, the Blue Belt provides researchers access to specific sites for studies, shares data, participate in joint research activities, assists with data analysis and collection, and helps enhancing communication among researchers.

The program aims to apply research findings directly into practical applications through a learning framework. This approach allows for flexible management, enables learning from past actions, and facilitates adaptation to new challenges. It encourages a dynamic exchange of ideas, continuously improving both the planning and implementation of restoration projects.

Research fields

The Blue Belt engages in a range of scientific fields from natural sciences to technology and socio-economic factors. Key areas of study include:

- **Habitat restoration and biodiversity**: Investigating current state and threats to riparian and floodplain ecosystems, exploring the restoration potentials, and evaluating the impacts of restoration activities on biodiversity.
- **Ecosystem Dynamics:** Examining species and matter flows, pollutant transfer, and sediment balance in river-groundwater-floodplain systems.
- **Ecosystem Services and Nature Based Solutions**: Enhancing the use of ecosystem services to support restoration management and expanding knowledge about the ecological effectiveness of NbS in comparison to engineered infrastructure or restoration efforts.
- **Technology:** Developing automated methods for capturing (hydro-)morphological parameters and new monitoring techniques, including detection of habitats and invasive species.

Collaborative, interdisciplinary Research

The Blue Belt's interdisciplinary specialist group promotes collaboration between practitioners and researchers to advance research activities. This central body is coordinating research efforts, setting priorities, formulating key research questions, and ensuring that activities are aligned with the specific goals of the program. Actions also include:

- **Regular Interdisciplinary Exchanges**: Organizing biannual meetings and additional annual forums to discuss research needs and integrate findings into BBD projects.
- **Partnership Development**: Strengthening collaborations with universities, research institutes, and funding agencies to ensure a continuous flow of innovation and resources.
- **Systematic Identification of Research Needs**: Mapping out research demands that emerge from practical implementations within the BBD, ensuring that research initiatives directly support field requirements.

Dissemination and Practical Application

To effectively transfer research findings into practical applications and ensure the sustainability and efficiency of the BBD implementations, the specialist group undertakes several key actions:

- **Publication and Reporting**: Developing and distributing reports, recommendations, and brochures that encapsulate research findings and practical recommendations for floodplain and waterway restoration.
- **Information Platform Management**: Maintaining an updated section on the BBD website dedicated to accompanying research, which includes links to relevant project reports, upcoming events, and funding opportunities.
- **Knowledge Sharing Events**: Planning and executing regular exchange events to facilitate networking among stakeholders and disseminate cutting-edge research and practical solutions for water and floodplain management.

6 Timeline

The Blue Belt program was conceptualized to run for approximately 30 years until 2050. Within this timeframe, both floodplain and river restoration measures will be implemented, and the goals formulated in the program should be achieved by then. Specific interim goals are set to be achieved by 2035, including the following:

Technical foundations of the Blue Belt
By 2018, a nationwide technical concept for the "Biotope Network of Water Bodies and Floodplains" was developed.

Establishment of a funding programme
To improve connectivity, restoration measures in the floodplains should be implemented alongside projects on federal waterways. Efforts will be made to attract project partners who can contribute their land. For this purpose, a funding program was established by the Federal Ministry for the Environment in 2018.

Legal and organizational prerequisites
By 2020, the legal and organizational prerequisites for carrying out restoration measures on federal waterways have been established.

Pilot projects
Continuous implementation of restoration projects as "ecological stepping stones" in the core network of federal waterways. Public lands should be included and considered in an exemplary manner.

Floodplain Development
By 2035, the condition of floodplains in 20 percent of the assessed sections should be improved by at least one condition class, and 15 percent of the floodplains along federal waterways should be restored to their natural function.

7 Budget

The Blue Belt Budget

Both the Federal Ministry of Digital and Transport (BMDV) and the Federal Ministry of the Environment, Nature Conservation, Nuclear Safety, and Consumer Protection (BMUV) share the planning and implementation costs. Responsibilities are divided spatially and administratively: the BMUV funds floodplain and wetland projects, while the BMDV finances river restoration. Scientific monitoring and consultation are provided by various federal authorities and agencies, each with its own budget and resources.

Overall the Blue Belt budget is composed of four components:

1. The investment costs for implementing measures in and along rivers and floodplains, these may include costs for planning, material, staff, and third-party contractors.
2. The budget for monitoring and quality control, which includes the development of a monitoring scheme, the collection of monitoring data, such as on ecological, hydromorphological or chemical indicators, as well as accompanying scientific research.
3. The costs for personnel to implement measures, coordinate activities, translate experiences into policy advice for decision-makers, and engage the public through hearings and educational tours.
4. The potential follow-up costs versus the savings potential of natural solutions. While technical infrastructure requires regular maintenance, control, and updates with a large budget, natural solutions and restored rivers offer similar benefits with less frequent and costly maintenance.

A preliminary study commissioned by both ministries estimated that the Blue Belt Program would require a total budget of €15 billion to fully achieve its objectives, equating to an annual budget of € 50 million for river restoration and € 12-15 million per year for floodplain and wetland restoration.

The costs of restoring waterways and floodplains

Within the first phase of the Blue Belt, pilot projects were implemented to showcase the potential but also the barriers of restoring rivers and floodplains. Over 14,5 million € was provided by BMUV and BMDV to plan and implement these projects and enabling agencies to implement scientific monitoring and consultation. There was an additional funding for staff so that already in the beginning projects managers, scientists and consultants could be hired within the responsible authorities.

Next to implementation and staff costs, monitoring costs are also a significant expense. For the pilot projects this included, for example, fauna and flora assessments, data collection from riverbanks or by boat, zoo- and phytoplankton studies, ecotoxicology, chemical measurements, digitizing riverbanks, sediment and groundwater sampling, equipment, and sample transport. Overall, the BfG only spent around €1.5 million on monitoring these projects, with individual project costs ranging from approx. €90,000 to over €600,000 and personnel costs totalling almost €500,000. Approximately 15 % of all expenditures for the implementation of the measures were allocated to monitoring.

Personnel and material costs vary significantly across projects due to factors such as the project's scale, type of measures involved, and other considerations like the need for ordinance investigations or the extent of contaminated sediment. The estimated costs per project generally range from mid five-figure to several millions of euros.

Maximizing Synergies and Funding Opportunities

Avoiding and minimising replacement costs for waterborne transport infrastructure offers significant saving potential. Nature-based solutions, which mimic natural features through human planning and construction—such as technical-biological bank protections, ecologically modified training walls, beneficial use of sediment, and creating near-natural retention areas—provide cost-effective alternatives to grey solutions while promoting biodiversity and additional benefits. This could yield synergistic effects worth several hundred million euros.



Figure 19 Replacement of riprap with willow plantations at the Rhine; © BfG

However, technical solutions are still favoured along inland waterways. Projects are often selected based on cost-benefit analyses that overlook restoration, environmental protection, and ecosystem service benefits, focusing mainly on financial aspects and GHG emission reductions alone. The BMDV, however plans to update its federal transportation infrastructure plan to include a strategic environmental assessment that accounts for ecosystem service benefits, potentially enabling budget provisions for upscaled restoration.

Despite the Blue Belt's conceptualization by both ministries, budget restrictions limit its full potential. Private sector financing offers significant potential to complement public funding and upscale restoration more rapidly. Private actors, being more agile and less bound by regulatory restrictions, can advance restoration efforts more efficiently. However, barriers exist, such as reluctance among conservation actors to cooperate with corporations and regulatory constraints that slow down processes.

Despite these challenges, various private actors, including drinking water and beverage companies, fund river, floodplain, and wetland restoration projects. For example, the brewery Krombacher, which uses large amounts of riverine surface water for production, has funded over 1,600 restoration projects since 2003, with many implemented by organizations like NABU.

8 Uncertainties, Boundary Conditions and Challenges

The Blue Belt Program operates in a multi-stakeholder national landscape and must balance diverse interests. Implementation of restoration projects faces complex boundary conditions, outlined below:

Financial Conditions

The program needs a 15 billion euro budget, with 50 million euros annually for river restoration and 12-15 million euros for floodplain and wetland restoration. Competing with other state expenditures, efficient fund use and innovative financing are crucial.

Challenges: Increasing costs and reduced financial margins in the public sector may paralyze implementation. Legislative changes and climate-induced market conditions could boost restoration costs while lowering economic efficacy. Financial restrictions on long-term monitoring can limit understanding of restoration dynamics.

Opportunities: Private investments and models like CO2 certificates and cross-sector partnerships should be explored. Prioritize projects with high ecological and socio-economic returns, seeking co-funding opportunities to maximize impact. Additionally, consider public-private partnerships and innovative financing mechanisms, including environmental impact bonds and carbon credit trading, to diversify funding sources and enhance financial sustainability.

Transport Infrastructure

Navigable waterways traditionally serve navigation. Ecological tasks have only recently been added to the Waterways and Shipping Administration. However, strict navigation requirements still limit restoration options. Balancing ecological goals with maintaining waterways for transport therefore is essential, but also complex and often cumbersome.

Challenges: The primary focus on navigation within the Waterways and Shipping Administration can unintentionally restrict the speed and scope of waterway restoration. This traditional emphasis on navigation may hinder the adoption of multifunctional measures, potentially decreasing the overall effectiveness of the Blue Belt Program. In secondary waterways, where transport is becoming less important, ambitious announcements could quickly lead to disappointment among both implementers and the public.

Opportunities: Integrated planning frameworks should harmonize transport and ecological objectives by investing in green infrastructure and nature-based solutions like adjustable weirs and multifunctional floodplains. Key to success is developing infrastructure that supports both navigation and restoration without compromising transport efficiency. Additionally, better coordination within the Waterways and Shipping Administration (WSV), enhanced collaboration, and fostering acceptance of these new tasks are crucial for achieving integrated objectives.

Lack of Land

Limited land for floodplain restoration, often privately owned, poses one of the greatest challenges. In many areas there a reluctance of landowners to "give away" their land to restoration, especially if there will be no or only limited compensation. Moreover, coordination with landowners or land acquisition can be costly, time-consuming or even impractical.

Challenges: Resistance from sectors like navigation and agriculture, and their unwillingness to compromise, can impede implementation and reduce regional acceptance. Dominance of powerful lobbies over biodiversity interests could result in "greenwashing" with marginal ecological impacts.

Opportunities: To implement restoration measures on private lands, administrations could explore public-private partnerships, land swaps, and long-term lease agreements, providing financial incentives and potentially also tax benefits for the landowner. Effective public outreach and education programs can raise awareness and support among landowners, while legal frameworks offering environmental incentives can facilitate cooperation. Cooperative management models involving landowners in planning and execution ensure shared responsibility and commitment to the restoration goals of the Blue Belt.

Climate Change and Multiple Stressors

Due to climate changed induced severe droughts and floods, the program must integrate water retention, flood risk mitigation, CO2 storage, and climate regulation, with enhanced monitoring.

Challenges: These tasks complicate planning due to uncertainties about restoration effectiveness. To date, it is widely uncertain to what extent traditional river and floodplain restorations are effective under climate change scenarios. Additionally, multiple impacts such as invasive species and shifts in farming intensity due to climate change can affect implementation, costs, and overall efficacy of restoration efforts.

Opportunities: Nature-based solutions like wetland restoration and reforestation can improve ecological resilience, carbon sequestration, and water management. Scenario planning and resilience assessments should anticipate climate change impacts, adjusting efforts with new information. Integrating adaptive management strategies will allow the program to remain flexible and responsive to emerging climate data and challenges.

Stakeholder Integration

Success of the Blue Belt requires broad stakeholder involvement through consultations, workshops, and education programs. However, this involves complex coordination and communication, extending planning and implementation times.

Challenges: Over-prioritizing biodiversity conservation in restoration efforts may inadvertently restrict public access to restored areas, potentially leading to reduced public support and questioning the relevance of the Blue Belt Program. Extended stakeholder involvement, while crucial for inclusive decision-making, runs the risk of prolonging implementation timelines and increasing project costs. Unresolved stakeholder demands and conflicts over resource allocation could significantly hinder progress and undermine the program's overall effectiveness.

Opportunities: Establishing multi-stakeholder advisory boards and working groups can facilitate inclusive decision-making, regular dialogue, and feedback. Implementing phased plans allows for incremental progress, maintaining continuous momentum and engagement. A centralized coordination framework with clear communication protocols and regular stakeholder meetings is crucial. Enhanced public outreach and educational initiatives can further build support and understanding among all stakeholders.

Legal and Organizational Conditions

Although a supportive legal framework was established in 2020 enabling the WSV to implement restoration measures on federal waterways, coordination among ministries, authorities, NGOs, local communities, and the private sector remains challenging due to jurisdictional issues and resistance to change.

Challenges: Hierarchical administrative structures and a strong adherence to jurisdictional boundaries, coupled with rather inflexible decision-making processes and intricate legal considerations, have the potential to delay planning processes. These factors prioritize thoroughness and legal compliance, essential for robust and legally sound restoration initiatives, yet they may significantly slow down the achievement of Blue Belt Program goals.

Opportunities: Implementing streamlined decision-making processes that foster agility while maintaining legal rigor could expedite planning and implementation within the Blue Belt. Establishing collaborative frameworks across administrative hierarchies and sectors, supported by clear communication strategies, can enhance efficiency and responsiveness. Additionally, fostering a culture of proactive legal review, risk management and adaptive management can help navigate complex legal considerations without compromising project timelines.

Technical and Scientific Foundations

Restoration projects are often prioritized based on the availability of personal resources rather than scientific or technical evidence. This approach can lead to random rather than strategic restoration efforts and inefficient resource allocation. Developing a scientific and technical foundation for a habitat connectivity concept is essential for systematically guiding restoration activities, but this can be difficult to implement in practice due to logistical and resource constraints.

Challenges: Restoration efforts prioritized based on resource availability rather than genuine restoration needs may result in fragmented projects with limited impact. Without clear prioritization and systematic approaches, there is a risk of inefficient resource allocation and reduced overall program effectiveness.

Opportunities: Shifting focus towards prioritizing restoration based on genuine ecological needs can enhance project coherence and maximize ecological benefits. Developing systematic approaches and clear prioritization criteria will ensure efficient resource allocation and effective restoration outcomes. Establishing robust

coordination frameworks across stakeholders and fostering interdisciplinary collaboration can optimize resource utilization and enhance the success of restoration initiatives.

Long-term Monitoring and Evaluation

Monitoring the success of restoration efforts is crucial for the Blue Belt. However, monitoring is costly, and its benefits are not universally recognized by all stakeholders. Moreover, the focus has mainly been on ecological and abiotic aspects related to waterways, while other Green Deal objectives such as health, wellbeing, and climate regulation have not been adequately assessed. This limits our ability to capture and anticipate Green Deal benefits.

Challenges: Financial constraints could restrict long-term monitoring efforts, affecting our understanding of restoration dynamics and hindering the development of learning frameworks and adaptive management practices. Insufficient methods, data, and assessment processes related to other Green Deal goals further complicate effective monitoring. This shortfall may impede comprehensive evaluations of restoration impacts and their contributions to the overall goals of the Blue Belt.

Opportunities: Establishing a robust framework with baseline assessments, regular reviews, and adaptive monitoring strategies is crucial. Engaging citizen scientists, universities, research centers, and local communities in monitoring efforts will enhance data collection and stakeholder involvement. Implementing a comprehensive monitoring and evaluation system will support adaptive management, ensuring the long-term sustainability and effectiveness of restoration efforts.