Report describing the potential for implementation of large-scale NbS in Europe

Deliverable D5.5

WP5

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Abstract (for dissemination, 100 words)	This deliverable provides recommendations for assessing the potential for implementation of large-scale NbS and successfully upscaling NbS in Europe and beyond. It develops a methodology for replicating NbS and applies it with the five EU RECONECT Collaborators. The methodology combines a quantitative analysis of spatial suitability of NbS and a qualitative assessment of enablers and barriers for NbS implementation. Key learnings are then cross-referenced with insights from other EU projects including Demonstrators. Key lessons learnt include the need for participatory, multi-stakeholder and iterative approaches for a successful and effective upscaling of NbS.
Keywords	Upscaling, Replication, Nature-Based Solutions, Barriers, Enablers

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Executive Summary

RECONECT is an interdisciplinary international project that aims to contribute to the European reference framework on large-scale NbS by stimulating a new culture for land use planning that links the reduction of risks with local and regional development objectives in a sustainable way. To maximize the impact of RECONECT, it is critical that successful NbS projects are upscaled in Europe and beyond. This is supported by the RECONECT upscaling strategy and framework, that set directions for successful scaling of NbS.

This deliverable intends to bring these directions to a more hands-on level by developing an innovative, participatory approach for upscaling NbS that can be applied in different contexts. This approach is linked to RECONECT co-creation pathway and supports a wide range of stakeholders (e.g., policymakers and practitioners) in assessing the potential for replicating NbS in their respective areas, and in getting a deeper understanding of good practices for successful upscaling.

The approach proposed draws upon a replication methodology that combines a quantitative analysis of spatial suitability for NbS, and a qualitative assessment of governance-related barriers and enablers for the co-creation and upscaling of NbS. The assessment of barriers and enablers draws upon inputs from several stakeholder consultation initiatives, including: a survey conducted by Ramboll in July 2020 with Demonstrators; a survey and interviews carried out by IHE-Delft and Ramboll with Collaborators over 2020-2021; and an extensive survey from UFZ conducted in June 2021 among more than 220 stakeholders from Europe and beyond. The approach is tested with the five RECONECT EU Collaborators, and lessons learned are used to provide recommendations for successful upscaling, and more generally for investigating the potential for implementation of NbS in Europe and beyond. These recommendations can be of high interest to several target audiences including, but not limited to, policymakers and practitioners.

Overall, the preliminary assessment of the replication potential for the five EU collaborators shows promising results for several NbS types. These results lay the foundation for further assessing the replication potential in an iterative manner. Testing the approach underlined the importance of a collaborative set-up in which knowledge and experience are exchanged, and capacity is built among a wide range of stakeholders. As such, the approach presented in this report should be, when applied on a specific area, supported by an iterative process and discussions with stakeholders. In this regard, the dynamics between NbS enablers and barriers must be looked at in detail. While enablers (e.g., motivation of stakeholders, related to the acceptance of NbS as a valuable solution) are crucial in the uptake of NbS, they are often given lower priority than barriers due to limited knowledge/understanding by stakeholders. It is therefore recommended to consider enablers from the beginning of the project, as highlighted by all EU collaborators through the application of the proposed approach.

The approach developed in this deliverable has great potential to be refined and re-adapted to other areas and with other stakeholders having an interest in developing large-scale NbS for hydro-meteorological risk reduction. Ultimately, the outlined recommendations could play a role in stimulating a new culture of hydro-meteorological risk reduction through nature-based approaches, in Europe and beyond.

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Glossary of Key Terms

Term	Acronym	Explanation
Nature-Based Solution	NbS	Collective term for innovative solutions to solve different types of societal and environmental challenges, based on natural processes and ecosystems.
Hydro-meteorological risk	-	Natural phenomenon related to water and caused by atmospheric pressures and extreme weather conditions which result in floods, erosion, and/or droughts.
Large-scale NbS	-	NbS located either in rural areas or in combination with urban areas, as they adopt a larger regional system approach comprising of river basins and coastal landscapes. What makes an NbS large-scale is its system approach, holistically connecting multiple water features instead of being a standalone, separate solution.
Upscaling	-	Process related to the diffusion of information, knowledge, and experiences from NbS case-studies. It is a scale-related progression to reach greater impact.
Replication	-	Implementation of a similar NbS intervention based on previous project experience, in an area with similar challenges that the NbS can solve.
Barriers	-	Conditions that can hamper the development of NbS.
Enablers	-	Conditions that can facilitate the development of NbS.
Demonstrators	-	Cases of large-scale NbS in Europe that provide proof-of-concept to the knowledge base of NbS developed through RECONECT.
Collaborators	-	Cases where large-scale NbS are to be developed and where proof-of-concepts and methodologies developed within RECONECT are tested.
Spatial allocation analysis	-	Spatial analysis (in ArcGIS) that determines suitable locations based on input maps (e.g., elevation, land-use) and criteria of suitability.
Suitability maps	-	The output of the spatial allocation analysis that provides a preliminary assessment of suitable locations for NbS.
Cross-referencing	-	The process of comparing different cases/situations to abstract deeper learning such as general key lessons.
Co-benefits	-	Additional benefits to the main benefit, which is often related to reducing the flood risk. These bring additional value for nature, people and/or economy.

Business case	-	Document that clearly communicates the benefits of a project, thus providing the arguments for initiating a project. A strong business case is essential in overcoming barriers.
Cost-benefit analysis	CBA	Evaluation method that compares the costs and benefits of a project in monetary terms, and often used as documentation for a business case.
Co-creation		Collaborative approach to engagement which allows stakeholders to collectively design and build more inclusive and sustainable mechanisms for change. RECONECT social innovation approach is underpinned by co-creation processes involving researchers and other stakeholders iteratively throughout the stages of co-assessment and planning; co-design; co-implementation, operations, and maintenance; and co-monitoring and evaluation.
Participatory approach		Approach that involves a diverse group of stakeholders in tasks such as setting research objectives, gathering, and processing data, interpreting results, and implementing solutions with the goal to balance interests, benefits, and responsibilities between the relevant stakeholders, focus attention on user needs, and make the whole process – from planning to implementation and evaluation of its impact – transparent and inclusive.

1 Introduction

RECONECT is an interdisciplinary international project that aims to contribute to the European reference framework on *large-scale Nature-Based Solutions (*called *NbS* in the following), by stimulating a new culture for land use planning that links the reduction of risks with local and regional development objectives in a sustainable way.

Stimulating this new culture of nature-based risk reduction will not only ensure the adaptation of society to climate change, but also create opportunities for enhanced wellbeing of humans and nature. This requires that experience and knowledge from existing NbS are properly captured and utilized to upscale NbS to other locations in Europe and beyond.

This deliverable, framed within Work Package 5 (dealing with the consolidation of the NbS evidence base, exploitation, and standardisation), contributes to assessing the potential for implementation of NbS in Europe by developing and applying a replication methodology combining a quantitative (spatial) analysis and a qualitative assessment of barriers and enablers, altogether considered for successful replication.

The methodology is tested with the five RECONECT EU Collaborators: the river basins of Pilica (Poland), Kamchia (Bulgaria), Bregana (Croatia), Drina (Serbia) and Kolubara (Serbia).

This deliverable aims at going beyond presenting a replication methodology. Key learnings are compiled, and outputs from the assessment of EU Collaborators are cross-referenced with insights from Demonstrators. Drawing upon these lessons learnt, recommendations are provided to assess the potential for NbS implementation and to successfully upscale NbS in Europe and beyond.

These recommendations, together with the proposed methodology, support the RECONECT upscaling strategy and framework as they can be of interest for several target audiences:

- Local, regional, and national policymakers and agencies, civil protection administrations and municipalities interested in NbS will find key insights on how to successfully upscale NbS.
- NbS practitioners and academic experts may be interested in the methodology undertaken, possibly to use it more widely or identify regions with similar contexts and features as their areas of interest.

This deliverable is structured in the following manner:

- Section 2 provides an overview of the key concepts forming the backbone of this deliverable: large-scale NbS, upscaling, replication, barriers, and enablers.
- Section 3 sets the scene by compiling existing knowledge on the potential for upscaling the NbS demonstrated by RECONECT in Europe.
- Section 4 details the replication methodology, which combines a quantitative analysis (spatial allocation) with a qualitative assessment of barriers and enablers.
- Section 5 presents and discusses the outputs of the methodology, assesses replication potential in Collaborators and compiles key lessons.

- Section 6 presents the approach for upscaling NbS in Europe which comprises cross-referencing Collaborators and Demonstrators, mapping inter-dependencies between barriers and leveraging key enablers for NbS including business cases.
- Sections 7 and 8 provide the key conclusions and recommendations for assessing the potential for NbS implementation, and for successfully upscaling NbS.

2 Key concepts

2.1 Large-scale NbS

NbS is a collective term for innovative solutions to solve different types of societal and environmental challenges, based on natural processes and ecosystems[1]. Therefore, it is considered an “umbrella concept” covering a range of different ecosystem-related approaches and linked concepts that provides an integrated way to look at different issues simultaneously (Cohen-Shacham, 2016; Nesshöver, 2017).

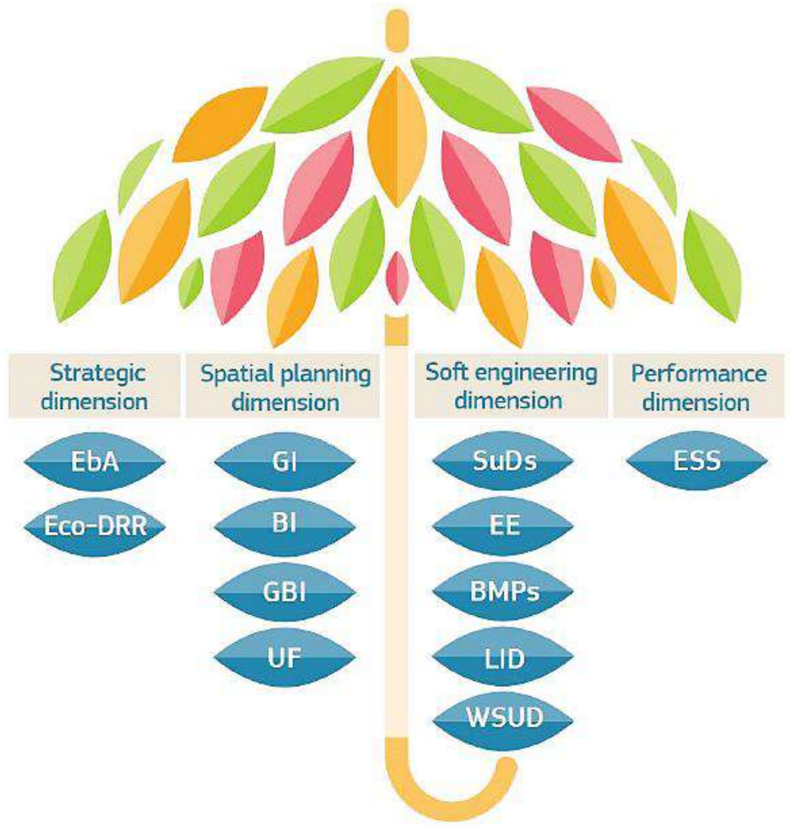


Figure 1 NbS as an umbrella concept and the relation of NbS to key existing concepts.
(Directorate-General for Research and Innovation, European Commission, 2021)

EbA=ecosystem-based adaptation, Eco-DRR=ecosystem-based disaster risk reduction, GI=green infrastructure, BI=blue infrastructure, GBI=green-blue infrastructure, UF=urban forestry, SuDS=sustainable urban drainage systems, EE=ecological engineering, BMPs=best management practices, LID=low-impact design, WSUD=water-sensitive urban design, ESS=ecosystem services.

NbS are envisaged to enhance climate change resilience and mitigation, while being more efficient than traditional measures (Brudler, 2016; Sørup, 2019). The European Environment Agency (2015) emphasizes that NbS address specific demands and challenges in a sustainable manner, while simultaneously generating additional environmental, economic, and social benefits. NbS can prove to be more cost-effective and adaptable, demand less raw material and improve ecosystem functioning, compared to traditional engineering measures (Brudler, 2016; Olsen, 2009; Van der Nat, 2016).

[1] See RECONECT deliverable D1.3

NbS can furthermore be spatially conceptualized as small-scale or large-scale:

- Small-scale NbS are local solutions in urban areas (i.e., buildings, streets, or roofs).
- Large-scale NbS, which are the scope of RECONECT, are either in rural areas or in combination with urban areas, as they adopt a larger regional system approach comprising of river basins and coastal landscapes.

Defining the scope of the "large-scale NbS" concept remains a challenge and it is sometimes hard to determine whether a solution can be categorized as large-scale. Especially, for solutions in urban settings that have a high inter-connectivity of several NbS, those could be considered large-scale due to the larger systemic design and operational dependencies.

There is a large variety of large-scale NbS for hydro-meteorological risk reduction, which are summarized and classified in the RECONECT measures selector (RECONECT, 2021). This online tool allows to screen existing NbS and to filter and select them depending on the type of hazard, location, land use and type of project (new development or improving existing measure).

NbS have the potential to tackle multiple hydro-meteorological challenges such as floods, including fluvial floods, coastal floods, flash floods, groundwater floods and pluvial floods, but also landslides, heat waves and droughts. The function to be fulfilled, and the associated type of NbS to be implemented, depend on multiple factors including the specific risks to be addressed, type of area (urban, rural), landscape type (mountainous, coastal, etc.), as well as land use and scale. NbS can generate direct benefits by reducing hydro-meteorological risks, but also several co-benefits[1].

This deliverable focuses on large-scale NbS for flood risk reduction at river basin scale, and more specifically: floodplain restoration, detention/retention ponds, afforestation, and forest buffers, as these four solutions cover a wide range of functions and co-benefits. Note that the term "NbS" will be used in this deliverable to refer to "large-scale NbS". The four selected NbS are detailed in Table 1, together with their co-benefits and examples of projects in Europe where they have been applied.

[1] "Co-benefits" are additional benefits to the main benefit. These bring additional value for nature (improved air and water quality, ecosystem services, etc.), for people (improved health, social cohesion, recreation, etc.) or for economics (increase in employment, real estate values, etc.).

Table 1 Four NbS for flood risk reduction.
Adapted from the RECONECT measures selector (RECONECT, 2021), IHE-Delft (Balaji Devanand, 2021) and NWRM (NWRM, 2021).

	Description	Co-benefits	Examples in Europe
Floodplain restoration	Floodplain restoration mitigates fluvial, coastal or groundwater floods. Floodplains are natural areas bordering rivers that fulfil the function of storing water during floods. In many places, floodplains have been drained or separated from the main watercourse by grey, traditional infrastructure. Restoring, enlarging, or excavating floodplains contributes to create more space for the water during high flow periods by increasing the discharge capacity and providing upstream detention space.	Creating opportunities for recreational uses Activating filtration by vegetation and soil Enabling recovery of natural erosion and sedimentation processes (reducing sediment transport downstream) Improving biodiversity and natural habitats Reducing carbon dioxide through photosynthesis and organic carbon burial Enhancing landscapes	**RECONECT:** DA1[1]: Dove/Gosse Elbe Estuary **Examples of other EU projects:** • Revitalization of the upper Drau River in Austria • River restoration of the lower Aurino in Italy • Órbigo River ecological status improvement, Spain
Retention ponds / Detention basins[2]	Detention basins and retention ponds are areas that store water during high flow and control the outflow. Detention basins are empty from water during dry periods while retention ponds always contain a baseline volume of water. These NbS are designed to reduce peak runoff and to allow the settling of sediments and associated pollutants.	Improving water quality through intercepting sediments and pollutant removal Improving biodiversity and natural aquatic habitats Contributing to sustainable agriculture Enhancing landscapes	**RECONECT:** DA1: Dove/Gosse Elbe Estuary DB3: Aarhus, Egå Engsø and Lystrup **Examples of other EU projects:** • Restoration of Amalvas and Žuvintas Wetlands, Lithuania • Reconstruction and modernization of existing and construction of new reservoirs and ponds in rural areas of Poland

[1] DA1=Demonstrator Type A, number 1. RECONECT Demonstrators are divided in two categories: Demonstrators Type A – large-scale NbS with the full co-creation and validation process during the project, and Demonstrators Type B - track record in implementing large-scale NbS in natural and rural with high local/national/international visibility.
[2] In this deliverable, retention ponds and detention basins are not differentiated. They are grouped under the name “detention ponds” in the following.

Forest buffers	Forest buffers are of forest that are planted adjacent to streams and other water bodies. They reduce and decelerate runoff, increase infiltration, remove nutrients, and contribute to increase the stability of banks.	Creating opportunities for recreational uses Improving biodiversity and natural habitats and habitat corridors Enhancing landscapes	**Examples of other EU projects:** • Natural bank stabilization and riparian buffer galleries along the Odelouca River, Portugal • Órbigo River ecological status improvement, Spain
Afforestation	Afforestation is the process of planting or growing forests that can mitigate flooding by serving as sponges, trapping water after heavy rains, and releasing it into waterways, reducing flood incidence and maintaining stream flow during dry periods.	Creating opportunities for recreational uses Improving biodiversity and natural habitats and habitat corridors Enhancing landscapes	**RECONECT:** DA4: Portofino Regional Natural ParkDB2: Inn River Basin

2.2 Upscaling and replication

"Upscaling" in RECONECT refers to the process related to the diffusion of information, knowledge, and experiences (Kern, 2019) from NbS case-studies. In this sense, upscaling implies a scale-related progression and involves "a mechanism where information from one scale is transferred to another, thereby reaching a higher level of scale and a greater impact" (Van Doren, 2016).

While "Replication" can sometimes be used interchangeable with upscaling, it refers to the implementation of a similar NbS intervention based on a previous project experience, in an area with similar challenges that the NbS can help alleviating. The "Replication Potential" is then defined as the possibility for implementing NbS subject to local barriers and enablers.

RECONECT developed an upscaling strategy and framework which includes four types of scaling (Moore, 2015) described in Table 2 and illustrated in Figure 2. The upscaling strategy and framework are described in detail in D4.3 (UFZ, 2021).

Table 2 The four types of scaling (scaling out, scaling deep, scaling up, scaling down).
Adapted from RECONECT D4.3 (UFZ, 2021)**.**

	Aims to impact a great number of stakeholders, make them aware of the outcomes of RECONECT, and support capacity-building to implement NbS. Activities include dissemination and knowledge sharing, development of training and capacity building material, assessing the replication potential, and exploitation of RECONECT both commercially and non-commercially.
Scaling deep	Aims to impact and change rules and values and is about a deeper transformative process addressing social interactions and forms of participation. Scaling deep recognizes that culture plays a powerful role in shifting problem domains. Activities include co-creation as well as twinning activities.
Scaling up	Aims to impact laws and policies in such a way that they help to amplify the uptake of NbS. This form of scaling is based on the recognition that the roots of social problems transcend specific contexts, and that innovative approaches must be codified in law, policy, and institutions. Activities include partnering, agenda setting and advocacy.
Scaling down	Takes a predominantly analytical perspective with the setting and enforcement of specific NbS standards which can be, for instance, by the EU, by its Member States or by other international or national entities. It also includes the analysis of enablers and barriers to the realization of NbS.
Cross-cutting scaling	Scaling activities are often based on a mix of the previously outlined elements. This is also the case in RECONECT.

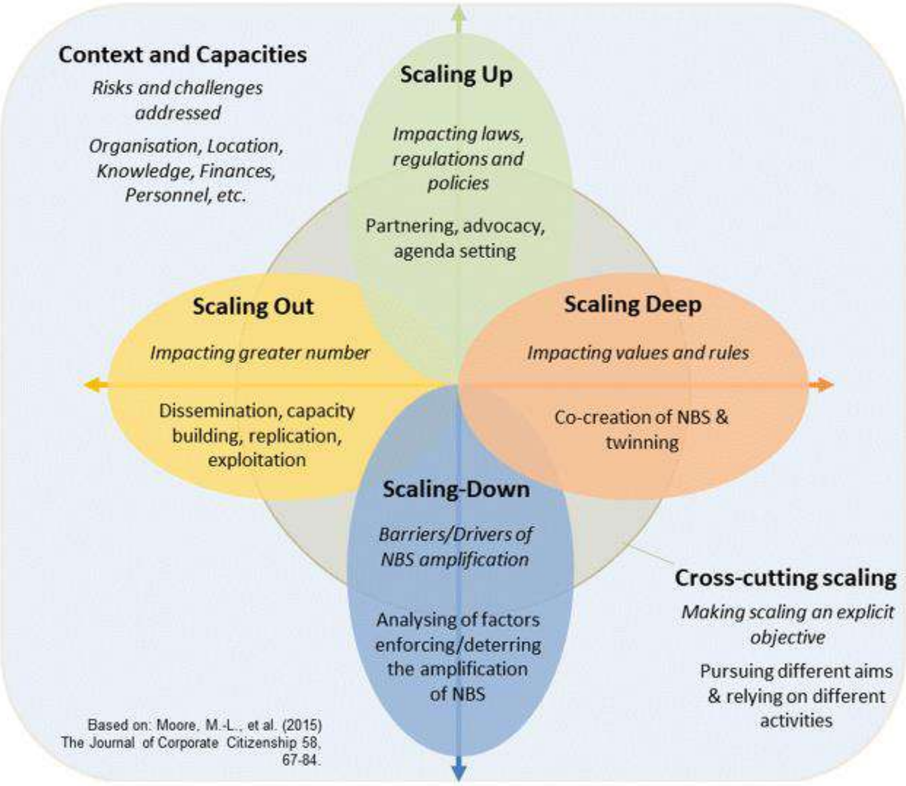


Figure 2 The four types of scaling and related activities.
Adapted from RECONECT D4.3 (UFZ, 2021).

The RECONECT upscaling framework intends to guide a wide range of stakeholders on how to draw on previous experiences to successfully implement NbS projects in other locations or at other scales. This deliverable supports the uptake of the framework in Europe (and beyond) by combining scaling activities within a cross-cutting approach:

- The replication methodology supports the *scaling out* of existing NbS, from existing projects towards new areas with similar contexts and challenges.
- The spatial analysis of barriers and enablers, which is a key part of the methodology, supports the *scaling down* of NbS by locating and discussing concrete enablers and barriers with local stakeholders.
- Beyond the methodology itself, the approach of this deliverable targets a wide range of stakeholders by providing hands-on recommendations for successful upscaling of NbS. This supports scaling NbS *out* to a wide audience through capacity building and knowledge sharing.
- Even though the "scaling deep" and "scaling up" components of the framework are not the focus, they can be impacted by the work presented in this deliverable. By demonstrating that hydro-meteorological risk and the need to overcome barriers for NbS replication transcend specific locations, this deliverable confirms the need for a deep transformative process of our values, regulations, and policies, towards a more nature-based risk reduction approach.

Therefore, although the word "upscaling" is used throughout this deliverable, it is to be understood as a form of cross-cutting scaling, or at least as a combination of different forms of scaling, mostly scaling down and scaling out.

2.3 Barriers and enablers

Assessing barriers and enablers to the realization of NbS is part of the scaling process. Barriers are elements that can hamper the development and implementation of NbS, whereas enablers refer to all the conditions that can facilitate them. In this deliverable, barriers and enablers are sometimes grouped under the generic term of "factors".

There is broad consensus amongst researchers and practitioners that besides technical viability, implementation of NbS critically depends on governance related factors, including legal, institutional, social, political, and financial conditions (Han, 2019) (Thinknature, 2019). This is especially true in parts of the world where NbS only recently has gained attention, where policies are still aimed towards conventional technical solutions and experience and knowledge with NbS is limited (Thinknature, 2019). This section describes barriers and enablers mentioned in literature, including previous RECONECT deliverables.

No comprehensive framework for assessing barriers and enablers of large-scale NbS for hydro-meteorological risk-reduction could be found in literature when the work on this deliverable was started (November 2020). A preliminary assessment was thus conducted, using deliverables D2.2 (UFZ, 2019) and D2.3 (TAUW, BDCA, 2019) as a starting point, drawing from the experience of Demonstrators. These deliverables assessed barriers and enablers through workshops, interviews and online or personal meetings.

A literature review was then carried out to cross-check and complement the barriers and enablers obtained from D2.2 and D2.3, focusing on publications from major research projects related to small- and large-scale NbS (PHUSICOS, ThinkNature, EKLIPSE, OPPERANDUM, CLEVER Cities, Interreg NSR BwN), relevant organizations (World Bank, IWA, UBA) and key scientific publications. Overall, nine relevant factors were identified from literature (Table 3).

Table 3 Barriers and enablers named in RECONECT deliverables and literature.

	PHUSICOS **(Martin, 2019)**	ThinkNature **(Bernardi, 2019)**	OPPERANDUM (**(Debele, 2019)**	EKLIPSE **(Raymond, 2017)**	CLEVER Cities **(Schmalzbauer, 2018)**	Interreg NSR BwN **(Huthoff, 2018)**	**(World Bank, 2017)**	IWA 2018 **(Marinetti, 2020)**	UBA **(Naumann, 2014)**	**(Sarabi, Han, L. Romme, de Vries, & Wendling, 2019)**	**(Sekulova, 2017)**	**(Seddon, 2020)**	D2.2 **(UFZ, 2019)** / D2.3 **(TAUW, BDCA, 2019)**
Ownership of land and competing interests	X	X	X	X	X	X	X		X	X	X	X	X
Accessibility for construction and maintenance									X				X
Risk awareness due to prior events	X												X
Experience with NbS		X	X	X	X					X		X	X
Knowledge of NbS	X	X	X	X	X	X	X	X	X	X	X		X
Resistance from stakeholders	X		X	X	X		X	X	X		X	X	X
Motivation and co-benefits	X	X	X	X	X	X	X	X	X	X	X	X	X
Financing & incentives	X	X	X	X	X		X		X	X	X	X	X
Legislation & policy	X	X		X	X		X		X	X	X	X	X

While the concept of upscaling has become more prominent in recent years, there is still a considerable lack of empirical insights on how such strategies are set-up, how effective they are or to what kind of needs upscaling activities respond. The scientific discussion is currently dominated by conceptual papers or single case studies contributions. In order to advance the discussion on upscaling and deeper analyze NbS barriers and enablers, a RECONECT standardized survey on innovative strategies for co-creation, upscaling and amplification of NbS was conducted between April and June 2021 among more than 220 stakeholders from across Europe and beyond (details can be found in Annex 2, Section 10.2 of this deliverable as well as D4.3 (UFZ, 2021). The survey itself is based on the RECONECT conceptual framework and addresses two different groups of actors:

- Actors with an interest in realizing NbS but no first-hand experience and expertise. The survey predominantly focused on their current capacities, needs and perceptions of potential barriers for realizing NbS.
- Actors with experience in realizing NbS who shared their lessons learned (e.g., the upscaling activities they developed and/or participated in as well as on the perception of potential barriers to NbS implementation and uptake).

3 Setting the scene: upscaling potential of RECONECT NbS

This deliverable was prepared bearing in mind that, at the core of RECONECT, is the idea of building on lessons learnt and insights from previous cases to stimulate the uptake of NbS across Europe and beyond. Hence, the ground of this deliverable's methodology and approach is to be found among previous initiatives of NbS for hydro-meteorological risk reduction in Europe, including the Room for the River project in the Netherlands and the RECONECT Demonstrators.

RECONECT demonstrates a range of different NbS types which are located along rivers (see Figure 3), as well as in coastal and mountainous regions.

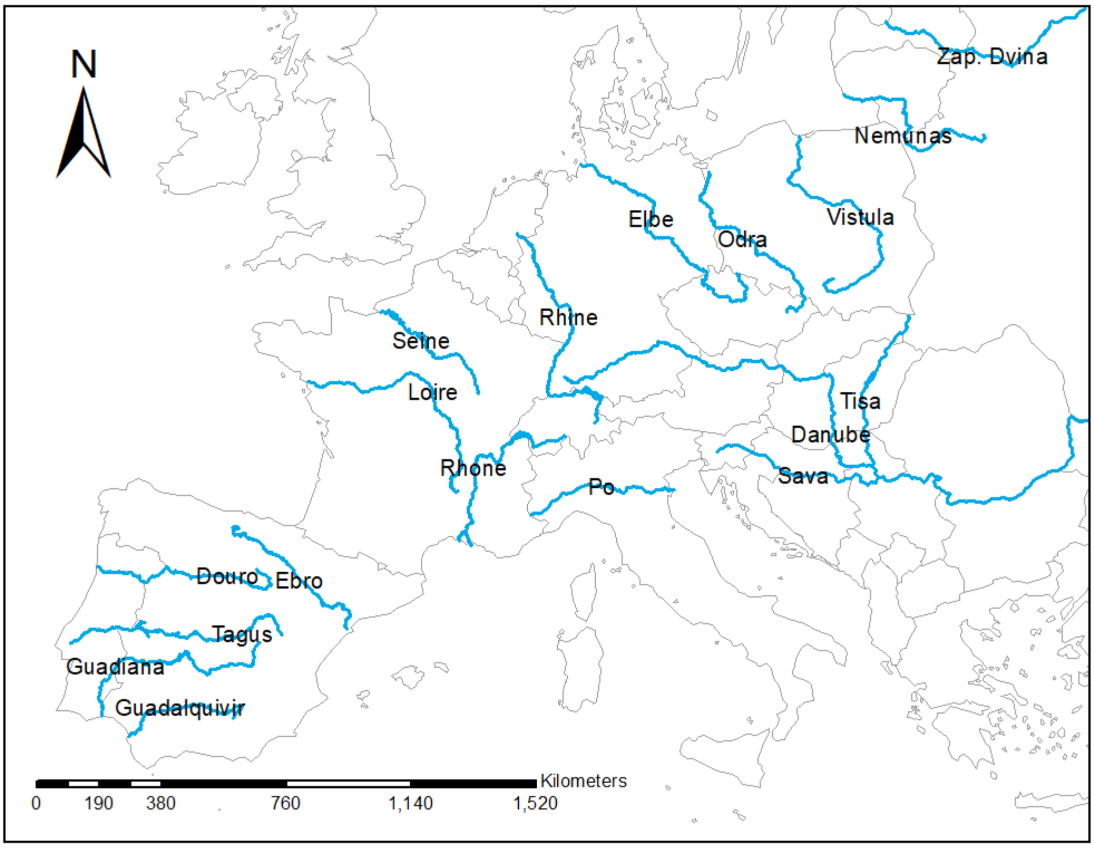


Figure 3 Overview of some large rivers in Europe.

Analyzing the replication potential of RECONECT NbS is the foundation for the successful upscaling of NbS across Europe and beyond.

3.1 Overview of Demonstrators

Demonstrators have been described within RECONECT deliverables D2.2 and D2.3. Table 4, Figure 7 and Figure 8 sum-up their key characteristics.

Table 4 Overview of Demonstrators.

	Scale	Main Hazard	Key Issues	Main Land Use	Planned/Implemented NbS
DA1: Dove/Gosse Elbe Estuary	Catchment (175 km^2)	Flash floods, droughts	• Lack of retention volume during floods: increased risk • Lack of stable water levels during droughts	Agriculture	• Retention ponds/Detention basins • Floodplain excavation/enlargement
DA2: Odense Coastal Area	Local (around 10-15 km^2)	Coastal floods	• Increased coastal flood risk due to climate change and rising sea levels • Urban/residential and agricultural settlements located in flood-prone low-lying areas	Urban	• Afforestation, forests, and naturally vegetated land • Retention ponds/Detention basins • Dike relocation • Re-meandering • Removing obstacles
DA3: Tordera River Basin	River Basin (900 km^2)	Fluvial floods, flash floods	• Vulnerable activities are found in flood prone areas as the middle part of the basin is highly industrialized and the delta is a popular tourist spot where different camp sites are located	Forestry	• Floodplain excavation/enlargement • Wetland • Retention ponds/Detention basins
DA4: Portofino Regional Natural Park	3 catchments	Fluvial floods, landslides, flash floods	• Very specific landscapes with steep slopes and accumulated loose coarse soil: risk of disastrous debris and mud flows in case of floods	Forestry	• Afforestation, forests, and naturally vegetated land • Retention ponds/Detention basins • Terrace restoration/Stonewalls
DB1: Ijssel River Basin	Catchment (3 km^2)	Flash floods	• Vegetation forming a barrier for water flow which can lead to a raise in water levels and thus increased flood risk	Agriculture	• Re-meandering • Removing obstacles
DB2: Inn River Basin	Catchment (around 10-15 km^2)	Flash floods	• Increasing urban density • Interaction of urban and torrential features in alpine environment	Forestry	• Sustainable Urban Drainage Systems: Green roofs, Infiltration swales, Retention ponds
DB3: Aarhus, Egå Engsø and Lystrup	Local (Egå Engsø wetland, 1.6 km^2)	Pluvial floods	• Nitrogen supply into Aarhus Bay • Degraded natural conditions • Lack of hydrological connectivity between Lystrup and Egå Engsø • Important surface runoff during heavy rainfall, that might exceed the capacity in the sewage system	Urban	• Retention ponds/Detention basins • Dike relocation • Re-meandering • Sustainable Drainage Urban Systems • Wetland restoration/channel
DB4: Thur River Basin	Catchment (2.5 km^2)	Flash floods	• Prone to flooding catchment with very sensitive areas, e.g., urbanized areas with industries and camping sites	Agriculture	• Afforestation, forests, and naturally vegetated land • Reconnection to floodplain • Re-meandering
DB5: Var Éco-Vallée	Catchment/Local (lower Var River, length of 22 km)	Flash floods, landslides	• Alpine environment with torrential runoff • River was canalized in the 19th century and loss significant width	Urban	• Retention ponds/Detention basins
DB6: Les Boucholeurs	Local, urban district (7 km^2)	Coastal floods	• Coastal flood risk affecting people, goods and activities in an urban context, lack of surveillance tool and protective structures	Urban, Agriculture	• Retention ponds/Detention basins • Wetland restoration/Wetland channel

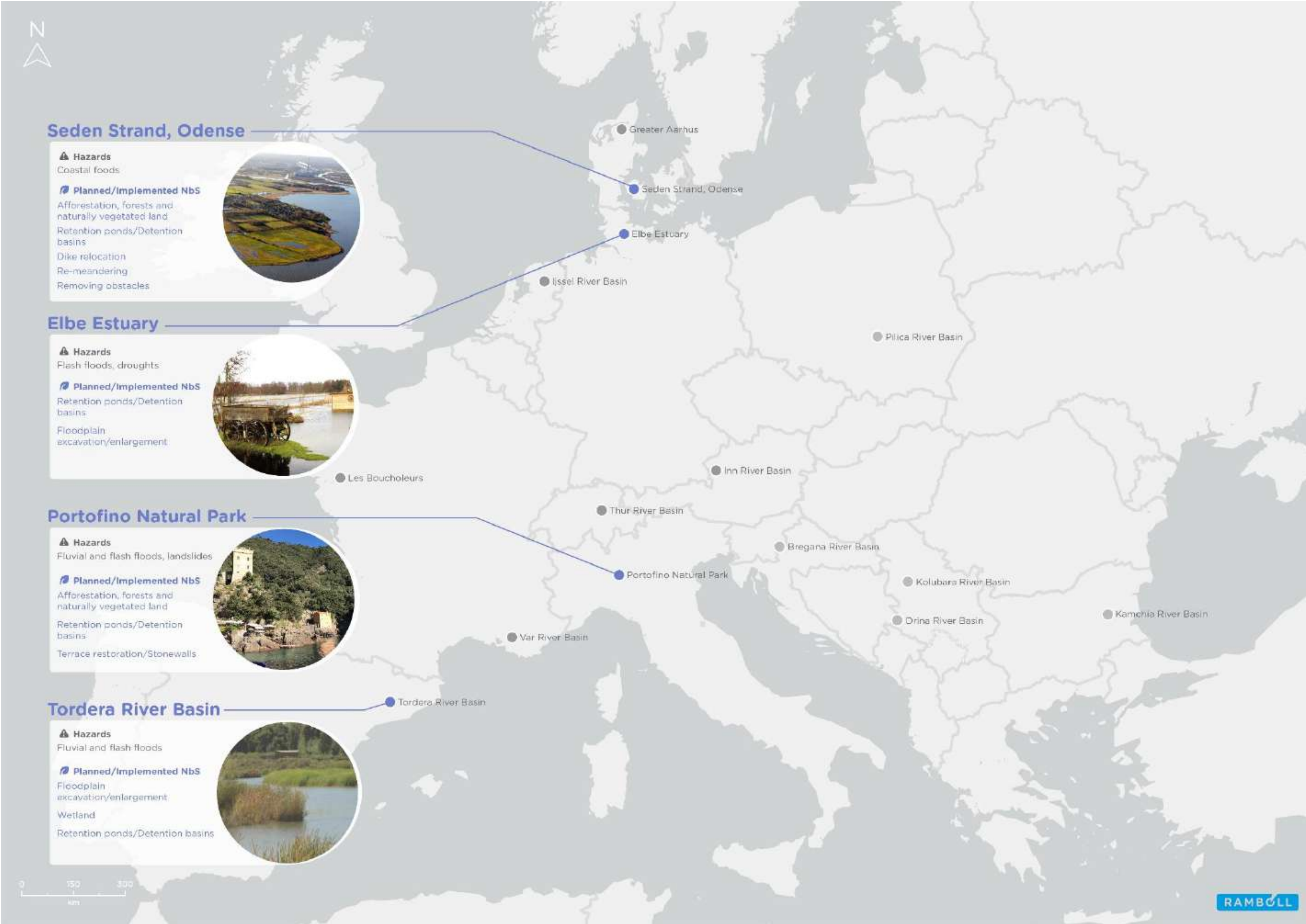


Figure 4 Overview map of Demonstrators A.

Figure 5 Overview map of Demonstrators B.

3.2 Spatial analysis of replication potential

To assess the potential for replicating the NbS demonstrated in RECONECT across Europe, a spatial replication methodology was developed. Details are given in Section 4 of this report. This methodology generates high-level maps of the potential for replication. Figure 6 shows the potential for NbS for selected NbS (afforestation, river restoration, retention ponds and floodplain restoration) across Europe. Figure 7 shows the potential for afforestation and slope stabilization measures, and Figure 8 shows the potential for all retention measures (e.g., detention and retention ponds, lakes, wetlands, etc.).

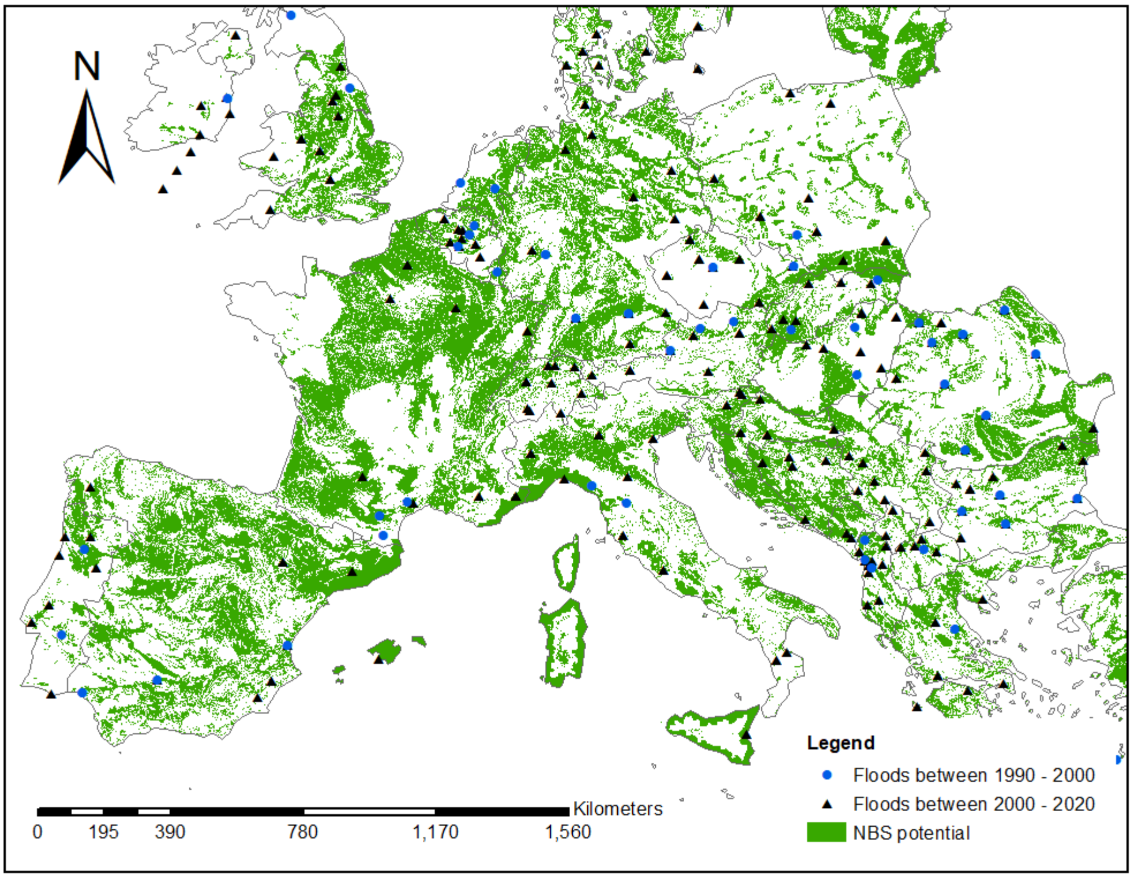


Figure 6 Areas with high potential for implementation of RECONECT types of NbS.

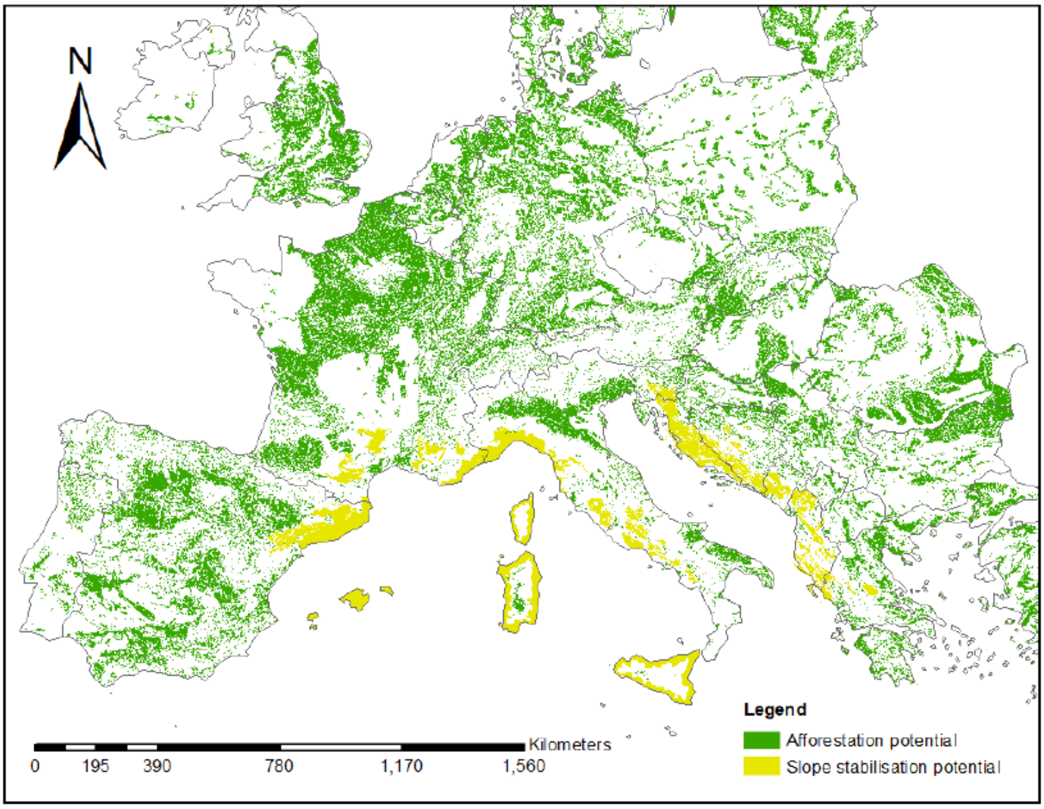


Figure 7 Areas with high potential for implementation of afforestation and slope stabilization NbS.

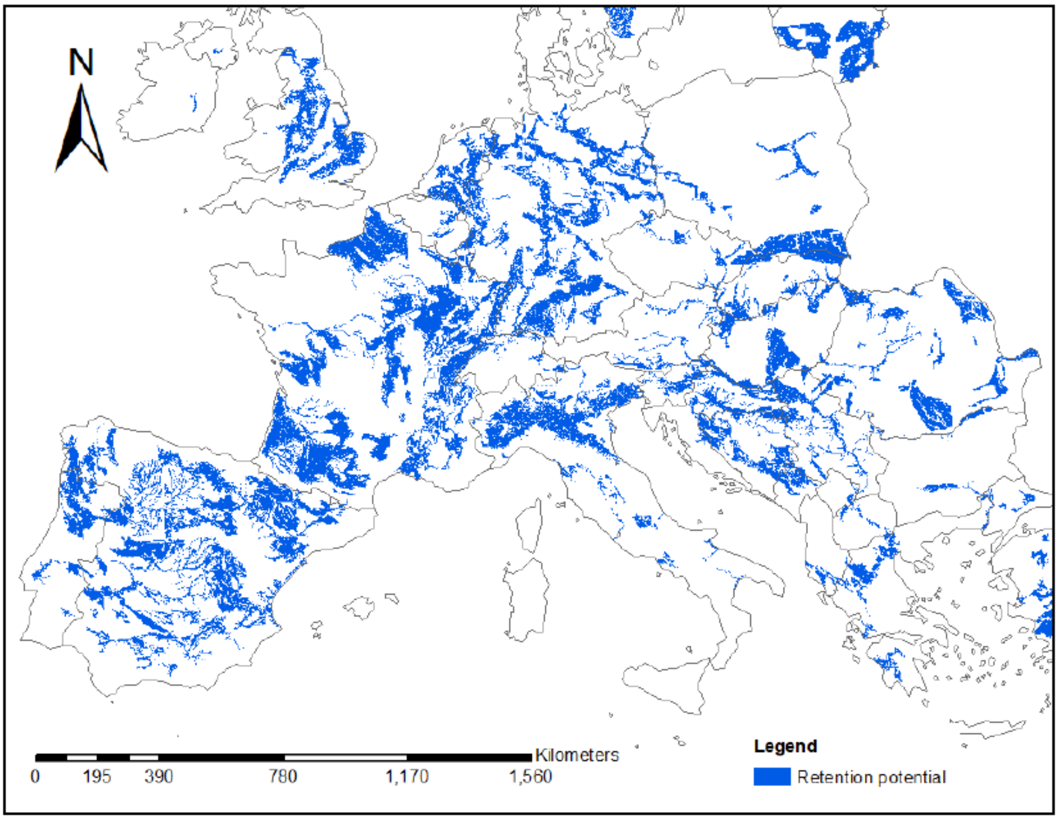


Figure 8 Areas with high potential for implementation of NbS based on retention (e.g., detention and retention ponds, lakes, wetlands, etc.).

This high-level spatial analysis shows that RECONECT NbS have the potential to be replicated in many areas across Europe, at least when looking at environmental and geographic factors. Consultation with RECONECT experts can cross-check those results by bringing more detailed insights on the potential for replication of Demonstrator cases.

3.3 Experts' knowledge on replication potential

A key aspect of understanding the replication potential of RECONECT NbS is to collect expert knowledge and lessons learnt for each Demonstrator. This section provides an overview of RECONECT NbS replication potential for European rivers, mountainous and coastal areas based on the opinion of experts within the project.

Assessment of applicability of NbS from the "Room for the River" programme (Demonstrator B1):

The key of the Room for the River approach is the restoration of the river's natural floodplain in areas that need flood protection.

The Dutch Room for the River Programme was implemented in the period:

- Planning and design phase: 2006 – 2010,
- Construction phase: 2010 - 2017

The programme consisted of 39 local projects which combine different types of measures/solutions such as floodplain lowering, dike relocation, groin lowering, summer bed deepening, water storage/detention, bypasses and floodways, high-water channels, removal of hydraulic obstacles, and dike strengthening (Klijn, 2013).

The benefits of this programme are not only flood-related, but they also offer opportunities for recreation, habitat, and biodiversity enhancement (Klijn, 2013). However, these measures may not be applicable for coastal and mountainous areas as they are designed for areas along rivers with relatively flat slopes in downstream and upstream sections.

Several rivers have been addressed within the EC INTEREG Flood Resilient Cities project and the "Room for the River" type of measures/solutions were implemented in:

- France: Loire and Seine,
- Germany: Rhine between Basel and Mainz,
- Belgium: Dijle at Leuven,
- UK: Aire river at Bradford and Eden river at Appleby
- Netherlands: Meuse (Maastricht)

The new potential candidates for these measures are areas along the following rivers:

- Germany: Weser (Bremen), Ems (Emden), Spree (Berlin), Danube (Regensburg), Emsher
- France: Gironde (Bordeaux), Rhone (Camargue), Marne
- Italy: Arno (Florence), Po, Tiber (Rome)
- Belgium: Schelt (Antwerp),
- Hungary: Tisza,
- Romania (Danube and tributaries),
- Bulgaria (Danube and tributaries, Kamchia River),

- Serbia (Danube, Sava, and tributaries),
- Croatia (Danube, Sava, and tributaries),
- Bosnia and Herzegovina (Danube, Sava, and tributaries),
- Poland (Pilica, Wissla/Vistula, Warta, and Oder),
- Ireland: Shannon, River Barrow
- Spain: River Guadalquivir, River Ebro
- Portugal: Tagus (Tejo)

Upscaling and replication of NbS implemented along Thur River Switzerland (Demonstrator B4):

The solution implemented in the Thur river Demonstrator location (i.e., river restoration / re-naturalization) can be (and has already been) implemented in many locations throughout the European river catchments (and also in locations outside Europe). In Switzerland alone, there is a plan to replicate the Thur river NbS in other Swiss river locations (the planned investment is in the order of 60 million CHF annually for a period of 80 years). Similar medium sized rivers can be found in Alpine type of mountains as well as in lower mountain ranges like the Black Forrest, the Vosges, Massif Central, etc.

Upscaling and replication of NbS implemented in Elbe Estuary Germany (Demonstrator A1):

The NbS implementation in the German/Hamburg Demonstrator includes the use of the existing storage volume of the water body of Dove-Gose Elbe by proactively draining the volume below the usual water level line of Dove-Gose Elbe system, thus using the residual additional storage volume in case of unfavorable meteorological conditions. The system might be interpreted as automated polder volume management system.

The potential of this NbS is not necessarily restricted to tidal regimes, flat areas close to sea level, locks or even precipitation. Such NbS is applicable in all geographical areas where the river catchment area is characterized by small slopes and wider river floodplains (e. g. Pannonian Plain, Danube catchment). It can be also applied in the southeastern areas of France to the Ural as well as in coastal areas of rivers in Bulgaria flowing to the Black Sea.

Upscaling and replication of NbS implemented in Portofino Italy (Demonstrator A2):

Assessment of areas for potential replication of NbS implemented in Portofino requires careful consideration of geo-hydrological hazards. Typically, such hazards are driven by:

- Shallow landslides, whose main source are abandoned/not abandoned agricultural terraces with dry-stone walls, rockfalls and mud-debris flows;
- Flash floods and hyper-concentrated flows;
- Possible reactivation of relict large-scale landslides.

The appropriate NbS should be focused on reducing multiple hazards that may threaten vulnerable elements in the lower parts of the catchments which are usually urban areas. Hence, the potential for upscaling of such NbS is quite high in the Mediterranean region and the criteria that can be applied for identifying potential locations should include the following:

- Small catchments;

- High slope gradients;
- Urbanization in the lower part;
- Stream stretches which are either culverted or contain highly impervious surface;
- Short time of concentration;
- High geo-hydrological risk due to heavy and concentrated rainfall events and historical settlements with constant presence of people;

Similar features can be found in other Mediterranean areas such as:

- The Alpine region, the Apennine, and South Italy regions,
- Balearic Islands in Spain,
- Côte D'Azur in France,
- Greek Islands,
- Montenegro Coastal areas.

3.4 Lessons learnt on key influencing factors

As shown in the two previous sections, the NbS demonstrated in RECONECT can be, and for some of them are already, implemented in other areas in Europe with similar contexts. To enable this replication, it is critical that knowledge is transferred from one place to the other, especially regarding the key factors that can either enable or hamper the implementation of NbS.

Deliverables D2.2 and D2.3 summarized such factors in nine categories (Table 3). To get the views of Demonstrators on this, a standardized survey was developed to assess if each of the factors acted as a barrier or enabler for each Demonstrator (Annex 2). The survey did not include "Financing & Incentives" and "Legislation & Policy". The survey scheme and response from Demonstrators can be found in Annex 2 (Section 10.2). Closed questions were chosen whenever possible, to facilitate a structured analysis. The survey was set up online using KoBo Toolbox and filled out by all Demonstrators. The survey was shared with Demonstrators in July 2020. The results are summarized in Table 5.

Table 5: Overview of factors identified as barriers (-), enablers (+), or neither (0) in the surveys conducted under D5.5.

	Ownership	Accessibility	Risk awareness	Experience	Knowledge	Resistance	Motivation
DA1: Dove/Gosse Elbe Estuary	0	0	+	+	0	-	+
DA2: Odense Coastal Area	-	0	+	-	-	-	+
DA3: Tordera River Basin	-	0	-	-	+	-	+
DA4: Portofino Regional Natural Park	+	-	+	+	-	0	+
DB1: Ijssel River Basin	-	0	+	+	+	-	+
DB2: Inn River Basin	0	-	+	+	+	0	+
DB3: Aarhus, Egå Engsø and Lystrup	+	0	+	+	0	-	+
DB4: Thur River Basin	+	0	+	+	+	0	+
DB5: Var Éco-Vallée	0	0	+	+	-	-	+
DB6: Les Boucholeurs	+	0	+	+	+	-	+

“Resistance” of stakeholders was pointed out by most Demonstrators as the main barrier for successful NbS development and implementation. This includes for example, the resistance of decision-makers and financiers to promote and fund NbS because they do not necessarily offer as immediate and high visibility impacts as traditional grey infrastructure. But this also includes resistance from landowners or resistance to change from civil society, and many other forms of resistance from various types of stakeholders.

On the other hand, “Motivation” of stakeholders is perceived as an enabler by all Demonstrators. “Motivation” relates, for example, to the acceptance of NbS as a valuable solution, but also to the willingness to engage in the process of planning and implementing the NbS.

The experience and collected insights from Demonstrators in relation to each of the seven factors is summarized as:

- **Motivation and co-benefits.** Expected financial, environmental, and social benefits were identified as a driver for NbS implementation by all Demonstrators and analyzed publications. Most Demonstrators benefitted from motivated responsible organizations, and half of the cases, private stakeholders and elected politicians were motivated by NbS projects. In only three cases, the general public was motivated for NbS implementation.

- **Risk awareness due to prior events.** The risk awareness of individuals and authorities is often influenced by the previous experience of extreme events. Nine Demonstrators confirmed that the occurrence of recent extreme events in the region where the NbS was implemented acted as an enabling factor. For only one Demonstrator (DA3 Tordera), occurrence of recent extreme event acts as a barrier as “some key stakeholders who suffered recent floods demanded higher levees and dredging of the riverbed and were not ready to lose part of their agriculture land to provide space for the river”. While this factor is rarely named in literature, its importance has been recognized by e.g., Madsen et al. (2019) and could be confirmed in this survey.

- **Prior experience with NbS.** Eight Demonstrators identified experience with NbS as enablers. In five of these cases, main authorities and stakeholders had experience which constituted an enabling factor for NbS implementation. This is also frequently named in literature: Experience can potentially create knowledge, but also e.g., lead to improved policy frameworks or partnerships. On the other hand, a lack of prior experience can act as a barrier, as identified by two Demonstrators (DA2 Odense, DB5 Var Éco-Vallée).

- **Knowledge of NbS.** Knowledge within the stakeholder group can act as an enabling factor (identified by five Demonstrators), while a lack thereof can pose a barrier for NbS implementation (identified by three Demonstrators). Surprisingly, two Demonstrators (DA1 Dove/Gosse, DB3 Aarhus) stated that knowledge of NbS was not a relevant factor in their case.

- **Ownership of land.** Especially for large-scale NbS, land ownership is complex and can affect NbS projects in multiple ways. This barrier is one of the most frequently named in existing literature, often also in connection with conflicting interests and unclear responsibilities regarding NbS maintenance. The Demonstrators that identified ownership as a barrier specified that the land was exclusively or partly owned by private parties. For DA2 (Odense), agricultural landowners required extensive negotiations. In the case of DB1 (Ijssel), the ownership structure with a mix of private, commercial, and public owners with resistance from only part of this group acted as a barrier. There also are different possibilities to tackle this barrier: In one case (DA3, Tordera), public authorities bought land from private owners. In the case of DB3 (Aarhus), privately owned land was consolidated, i.e., the ownership did not change, but public authorities may use the land for a limited time. Four Demonstrators (DA4 Portofino, DB3 Aarhus, DB4 Thur, DB6 Var Éco-Vallée) indicated that land ownership was an enabler, with all these Demonstrators specifying that the land was at least partly publicly owned.

- **Resistance from stakeholders.** Seven Demonstrators identified resistance from stakeholders as a barrier for NbS implementation. Six of them indicated that there was resistance from the private stakeholders and only one (DB5 Var Éco-Vallée) stated that the general public was against NbS implementation. Only three Demonstrators did not meet resistance from stakeholders (neutral). Demonstrators often connected resistance to land ownership and skepticism towards the effectiveness of NbS, and numerous other reasons have been identified in literature. Resistance can be offered in several ways, from refusal to provide land to denied political and financial support.

- **Accessibility for construction and maintenance.** Only two Demonstrators (DA4 Portofino, DB2 Inn) named limited accessibility as a barrier, where access was only possible on foot and not by road, rail, or air. This factor is often already considered in technical feasibility assessments but can also be related to policies (e.g., limited access to protection areas). Most cases stated that accessibility was not an important factor in their NbS projects.

Overall, lessons learnt and insights from previous cases suggest that there is potential to replicate NbS demonstrated in RECONECT across Europe and beyond. This deliverable intends to provide a sound, hands-on approach, as well as recommendations, to support this replication process and further enhance upscaling of NbS.

4 Replication methodology

The methodology proposed is a replication methodology, and more specifically a methodology to assess the replication potential of selected NbS. It aims to support the implementation of a similar NbS intervention based on a previous project experience, in areas with similar challenges that the NbS can help alleviating. The methodology combines a quantitative assessment and a qualitative assessment, with a focus on barriers and enablers for NbS replication. This methodology is based on work conducted by IHE (Balaji Devanand, 2021) (Hernandez, 2021) (Mubeen, 2021).

The methodology was tested with EU Collaborators as they are at the earliest stage of the NbS development. It is at this stage that a reflection on enablers and barriers should also be initiated. Moreover, Collaborators would benefit the most from having a preliminary assessment of the replication potential, indicating key locations for implementing NbS in their river basins.

Narrowing down the geographical scope facilitated the dialogue process, especially under COVID-19 circumstances. It simplified coordination by reducing the number of stakeholders involved, which allowed the methodology to be tested entirely, from its first step to the last. However, the outputs from this work can be extended to International Collaborators, or other NbS initiatives, in or outside Europe.

The methodology consists of two parts: a spatial allocation analysis and an assessment of barriers and enablers (Figure 9). Each step is explained in more details in the following sections. The methodology was applied to the four selected NbS (Section 2.1), but it can be expanded to other NbS, including NbS for other types of hydro-meteorological hazards.

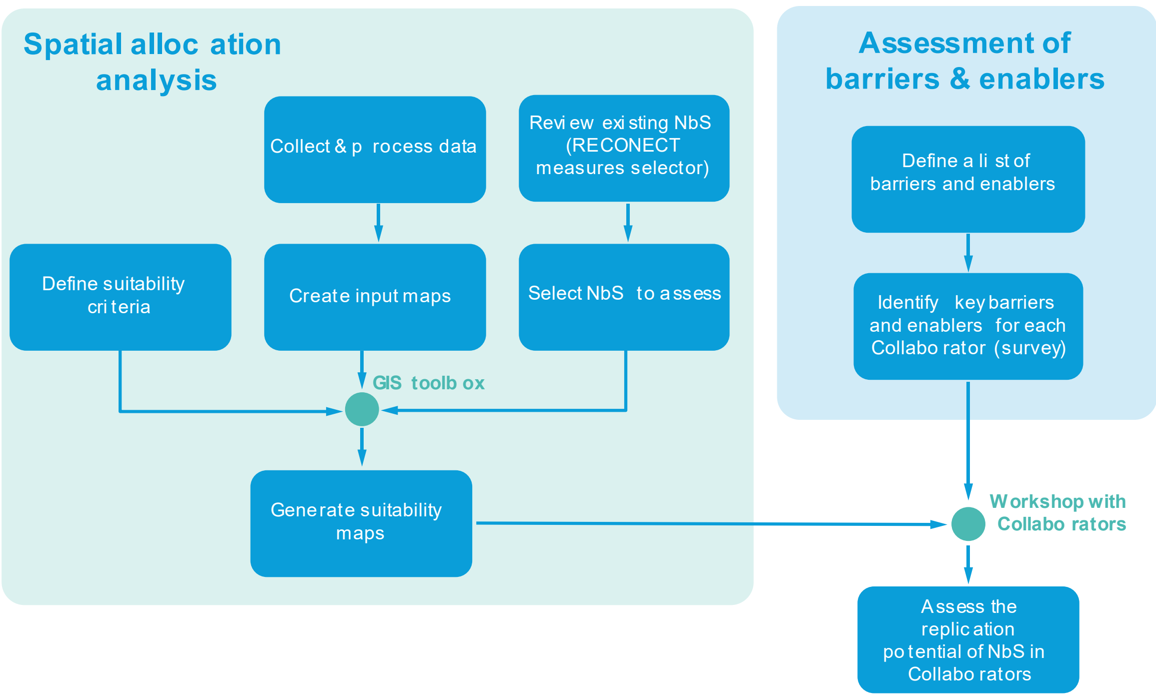


Figure 9 Methodology for assessing the replication potential of large-scale NbS.

4.1 Spatial allocation analysis

The quantitative component of the methodology consists of a spatial allocation analysis which aims to determine the spatial suitability of the four selected NbS. The NbS spatial allocation methodology aims to help decision-makers by acting as the first step in the identification of suitable locations for the implementation of appropriate NbS for hydro-meteorological risk reduction.

The spatial allocation methodology follows these steps:

- Collect and process spatial data to create input maps
- Review existing NbS and discuss with local stakeholders on which set of NbS to assess
- Define suitability criteria, which depend on the type of NbS previously selected
- Develop a GIS toolbox which integrates all the criteria
- Feed the input maps into the GIS toolbox to generate suitability maps for each NbS

As mentioned previously, the focus is on four NbS: forest buffers, afforestation, floodplain restoration, and detention ponds. These four NbS were selected because they cover a wide range of functions and provide a wide range of co-benefits, as detailed in Table 1. They help mitigating flood risk and other hydro-meteorological hazards. Vegetative measures like forest buffers and afforestation can prevent landslides by absorbing water and binding the soil. Both vegetative measures and detention measures can prevent droughts by increasing storage and infiltration of water and controlling its release.

Biophysical characteristics including slope, soil and aquifer type, streams, and planning and governance characteristics; land use or land cover, and existing infrastructure such as roads are used as suitability criteria.

For this specific deliverable, suitable locations for the four selected NbS were assessed by combining this list of criteria:

- Elevation (slope)
- Distance from streams
- Distance from roads
- Land use
- Shallow aquifer type

For each criterium, a quantitative value was defined as a threshold to be fulfilled to guarantee spatial suitability. Table 6 shows the threshold values for the five criteria and each of the four NbS. Note that the use of criteria depends on the scale of NbS: over larger scales, as demonstrated over Europe, smaller features such as road infrastructure, smaller rivers and streams, and flow length cannot be represented on the map as clearly. To map suitability of NbS over larger scales, only the slope, landcover, soil/aquifer type are considered.

Table 6 Example of how criteria and threshold values for spatial allocation of NbS can be set within the GIS toolbox developed to reflect the local conditions
Adapted from IHE-Delft (Balaji Devanand, 2021; Mubeen, 2021).

	Elevation (slope)	Distance from streams	Distance from roads	Land use	Aquifer type
Forest buffers	< 60%	≤ 100 m	≥ 50 m	Suitable	Suitable[1]
Afforestation	≤ 60%	NA	≥ 50 m	Suitable	Suitable
Floodplain restoration	< 5%	≤ 1 km	≥ 50 m	Suitable	Suitable
Retention basins	≤ 5%	≤ 1 km	≥ 50 m	Suitable	Suitable

A "suitable" land use means that the land is barren land, with no or sparse vegetation. The suitability maps were developed with the CORINE Land Cover dataset. Suitability conditions for land use and aquifers are detailed in Annex 6 (Section 10.6) for the case of afforestation.

As illustrated in Figure 10, a given NbS type is suitable when it fulfils ALL the quantitative thresholds for all five criteria listed above. Note that this figure is an example for afforestation since the thresholds are NbS-specific. Besides, the criteria themselves are specific to the four NbS selected for this deliverable. The methodology is flexible and can be adapted to other NbS and with other criteria.

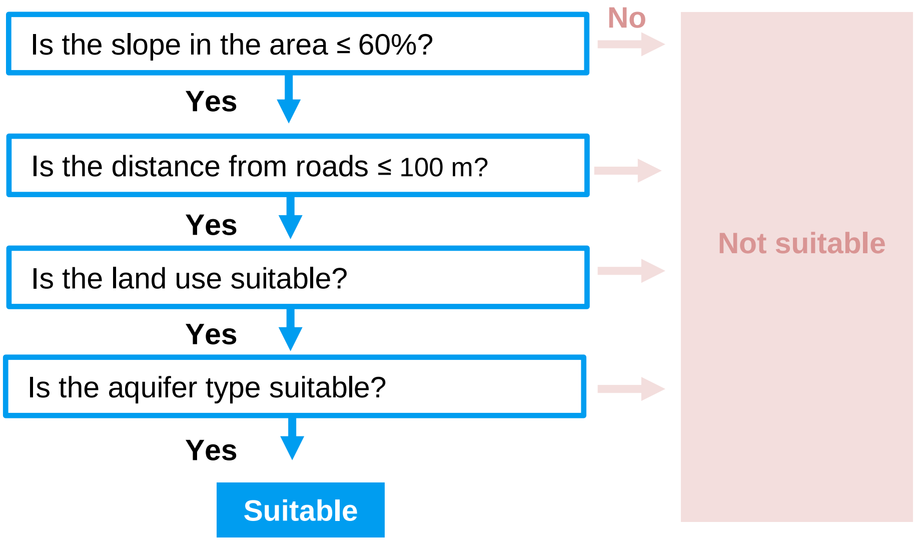


Figure 10 Conceptual flow for assessing spatial suitability of NbS (example for afforestation).

Additionally, to map suitability for floodplain restoration and detention ponds, the flow length of the area was determined. The flow length delineates the areas of the catchment that contribute water flow to upper, middle, and lower course of the river. Detention and retention measures were only allocated suitable in the upper parts of the river basin (upper and middle courses). The floodplain restoration measures are more suitable in the

[1] A suitable aquiferous class should be highly productive and local.

downstream areas (lower course), where they can increase water conveyance. The flow length filter was combined with the suitability criteria (Table 6) to generate final suitability maps for detention ponds and floodplain restoration.

To automate the methodology, the conceptual model illustrated in Figure 10 was implemented into geospatial toolboxes developed using Model-builder plugin by utilizing the available Spatial Analyst tools within the ESRI ArcGIS environment.

The toolboxes were used to generate suitability maps for all RECONECT Collaborators, focusing on the selected NbS. Figure 11 sums-up the process followed to generate suitability maps based on the different suitability criteria.

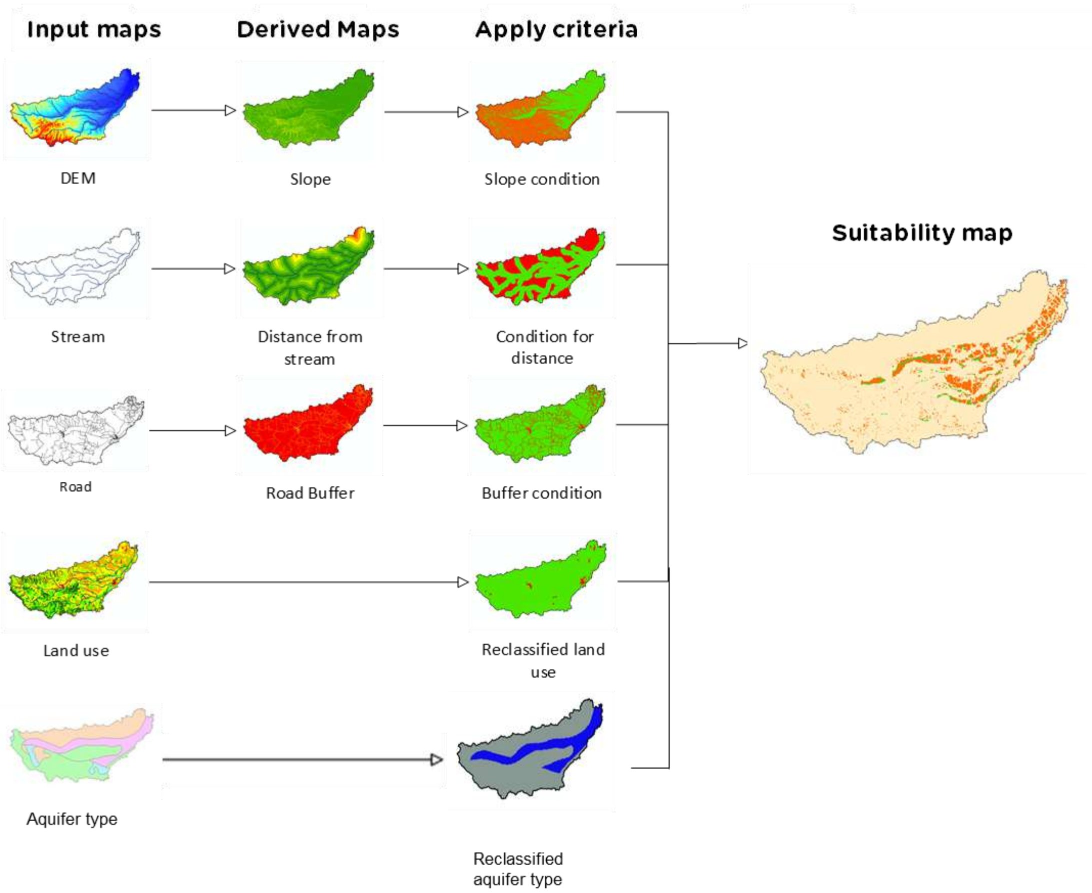


Figure 11 Spatial allocation methodology on GIS.
Adapted from IHE-Delft (Balaji Devanand, 2021).

The spatial allocation methodology gives an overview of appropriate locations for the four selected NbS, at river basin scale. Combined with land use maps, the suitability maps can reveal spatial barriers (or enablers) for NbS replication. Suitability maps can be a useful screening tool, to initiate decision-making and get a first understanding of the NbS potential in the area of interest.

4.2 Assessment of barriers and enablers

Barriers and enablers were assessed for replication of NbS in EU Collaborators following two steps:

- First, a survey was sent to Collaborators in July 2021 focusing on barriers. This survey contained the barriers identified by IHE-Delft (Hernandez, 2021), and detailed in Annex 1 (Section 10.1). Collaborators ranked the relevance of barriers for different project phases: investigation, planning, implementation, and operation & maintenance. Barriers were ranked on a scale from 1 (not relevant) to 5 (highly relevant).

- Then, to validate the barriers identified by Collaborators in the survey, and to investigate options to overcome them (enablers), a workshop was organized, involving all five EU Collaborators. The expected outcomes of this workshop were:

    1. Broader understanding of enablers and barriers
    2. Broader understanding on how enablers and barriers can interact locally
    3. Broader understanding on how enablers can be the building blocks of a business case for a large-scale NbS project

The workshop was held online using a Miro Board (www.miro.com), which is an online tool enabling several users to work collaboratively. A screenshot of the Miro Board is shown in Figure 12. Contrary to the survey, the workshop did not distinguish between the different project phases. The workshop included the two following exercises:

1. A discussion on barriers, based on the answers to the survey that was shared by IHE to all Collaborators in July 2021. This discussion followed a collaborative mapping approach, where each Collaborator was able to locate the barriers that they identified in the survey onto their respective suitability maps. Collaborators considered the following questions:

    a. Are these barriers relevant everywhere?
    b. Are some barriers more local?
    c. What type of information do you need to assess this barrier spatially?
    d. Did this process exclude areas for NbS implementation?

    Collaborators were then inserting post-its with barriers on their suitability maps. They could freely define the barriers and did not have to use the same wording as the barriers listed in the survey. Collaborators worked individually on their maps.

2. A discussion on enablers that can potentially overcome the barriers mapped in the first session. Participants considered the following questions:

    a. Which of the barriers can potentially be overcome by enablers?
    b. Are some enablers local/general?
    c. What type of information do you need to assess these enablers spatially?
    d. Did this process exclude/include areas for NbS implementation?

This exercise was performed in plenum, taken one Collaborator at a time. The purpose of doing this exercise in plenum was for Collaborators to better discuss and inspire each other.

More details on the workshop are provided in Annex 4 (Section 10.4).

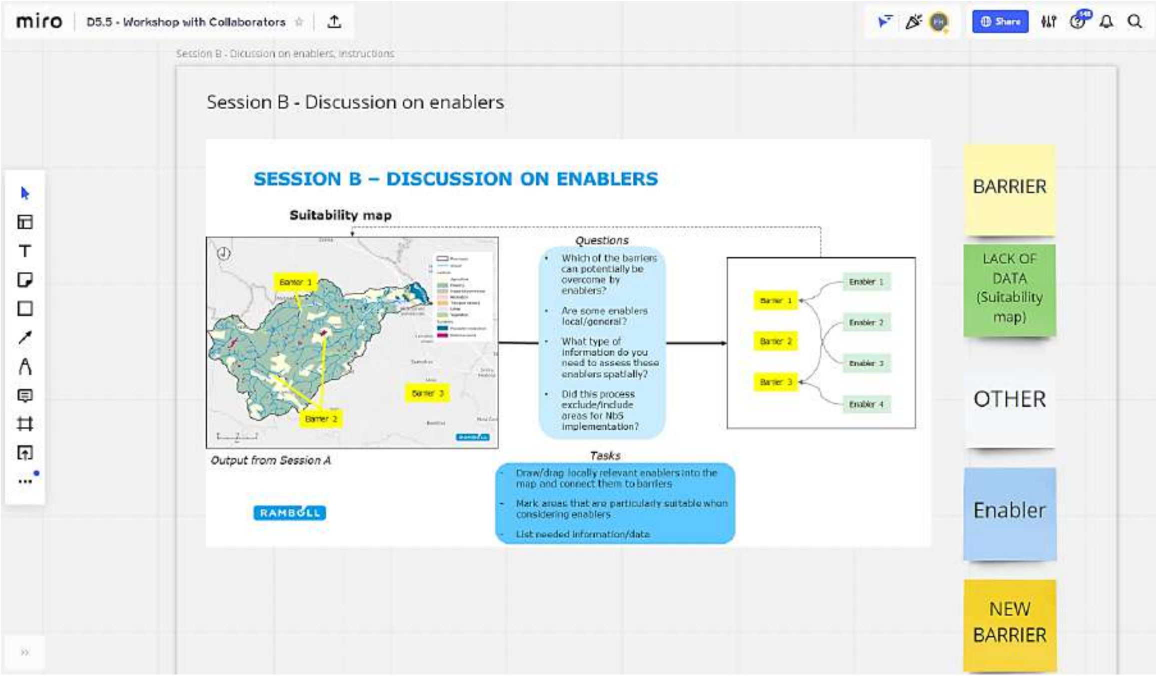


Figure 12: Screenshot of the Miro Board used during the workshop with EU Collaborators on NbS enablers and barriers.

5 Assessment of replication potential in Collaborators

5.1 Overview of European Collaborators

As previously explained, the methodology was tested on RECONECT EU Collaborators. An overview of Collaborators is provided in D4.2, with a focus on hazards and vulnerabilities and potential NbS to be selected to overcome these. D4.2 also provides individual deliverables for each Collaborator. Table 7 and Figure 13 show the overview of EU Collaborators, focused on features that will serve to interpret the results from the replication methodology.

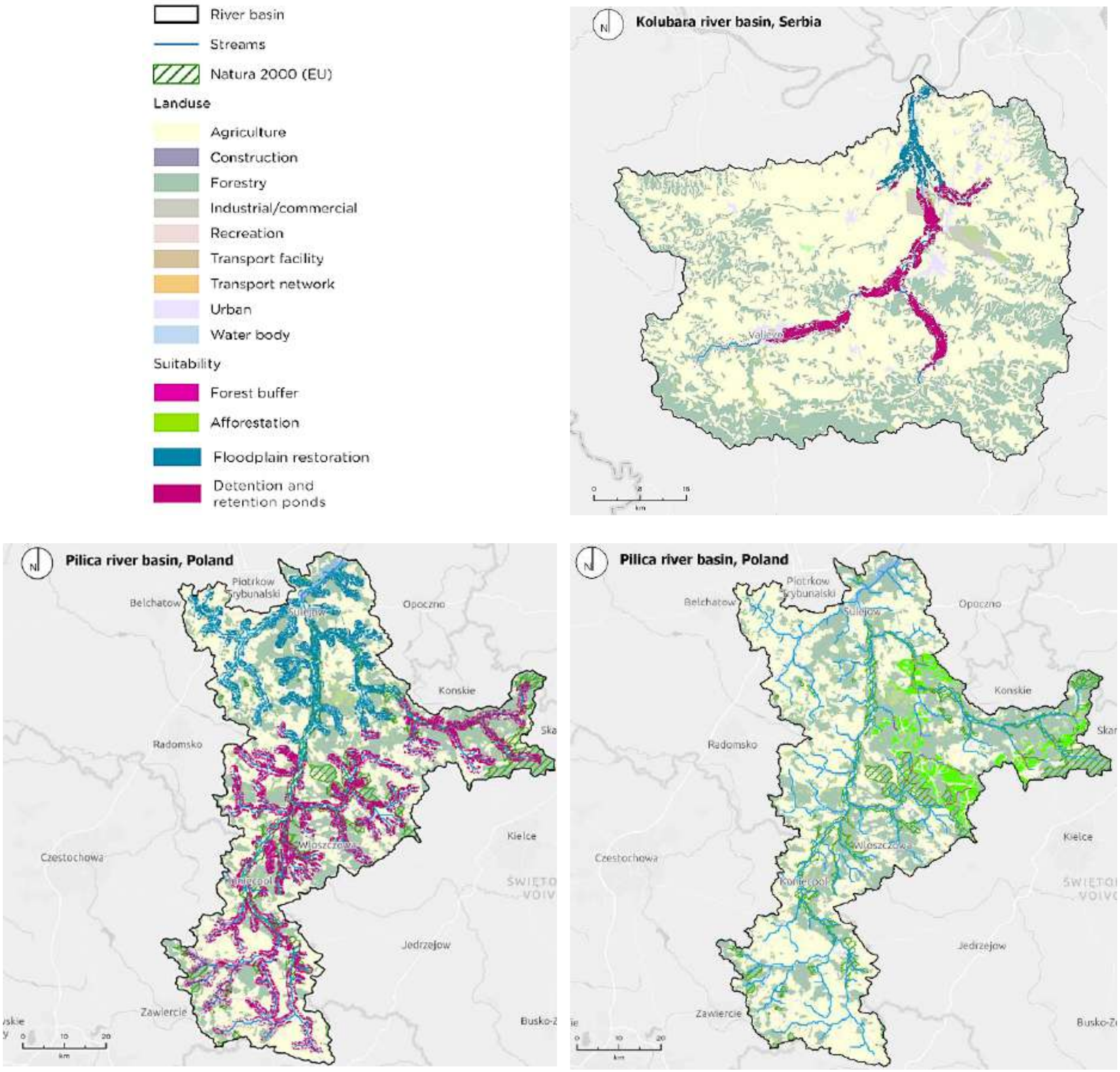
Table 7 Overview of European Collaborators.

	Scale	Hazard	Key issues	Main land use	Selected NbS
Kolubara River Basin	Tamnava river basin (730 km^2)	Fluvial floods, landslides	Frequent flooding threatening key assets in the Tamnava basin and also downstream municipalities. It is estimated that an area of 8,100 ha and population of 9,200 in the Tamnava basin are vulnerable to floods.	Agriculture (72%), forestry (26%), urban (1.3%)	1) Reforestation and forest conservation 2) Afforestation, forests, and naturally vegetated land 3) Floodplain excavation/enlargements/restoration 4) Retention ponds and detention basins
Pilica River Basin	Sub-basin (Luciąża River Basin including Bogdanówka River Basin NbS area) (approx. 400 km^2)	Fluvial floods, droughts	Fast runoff, erosion and transport of sediments, ice blockages. Agricultural activities threatened.	Agriculture (79%), residential & transport (5%), recreational (16%)	1) Wetland restoration/enhancement 2) Wetland channel (Wet swale) 3) Restoration of nature infiltration to groundwater 4) Sand dam
Bregana River Basin	River basin (92 km^2)	Fluvial floods	Torrential character of the river leading to fluvial floods and erosion.	Forestry (77%), agriculture (19%), residential / industrial / transport (2%)	1) Retention ponds 2) Upper watershed restoration
Kamchia River Basin	Surroundings of Kamchia river in the upstream part of the basin (approx. 600 km^2)	Pluvial, fluvial, and flash floods (emergency discharge of local dams), landslides, droughts	High intensity rains during winter leading to sediment transport towards the Black Sea.	Mainly agriculture and Natura 2000 areas (>50%)	1) Deepening water bodies 2) Floodplain enlargement with retention and detention areas 3) Widening of water bodies 4) Removing obstacles
Drina River Basin	Jadar river basin (approx. 900 km^2)	Fluvial and flash floods	Flash floods and landslides in the upper watershed and fluvial floods in the Jadar river valley.	Agriculture (58%), forestry (38%), urbanized areas (1.7%)	1) Reforestation and forest conservation 2) Afforestation 3) Retention ponds and detention basins 4) Bypass/diversion channels

Figure 13 Overview map of EU Collaborators.

5.2 Replication potential in Collaborators

This section presents the first assessment of the replication potential in Collaborators based on the spatial allocation analysis and assessment of barriers and enablers. Figure 14 shows the suitability maps for each of the five EU Collaborators. Larger and higher quality pictures of the maps can be found in Annex 4 (Section 10.4). Additionally, the barriers that Collaborators identified in the survey can be seen in Figure 15 and the detailed workshop results are summarized in Annex 4. Overall results for each Collaborator are explained in the following sections. Enablers were identified in the workshops. Unlike barriers, these were discussed in plenum. Thus, enablers are not presented for each Collaborator, but jointly as common means to overcome some of the identified barriers in the Collaborators.



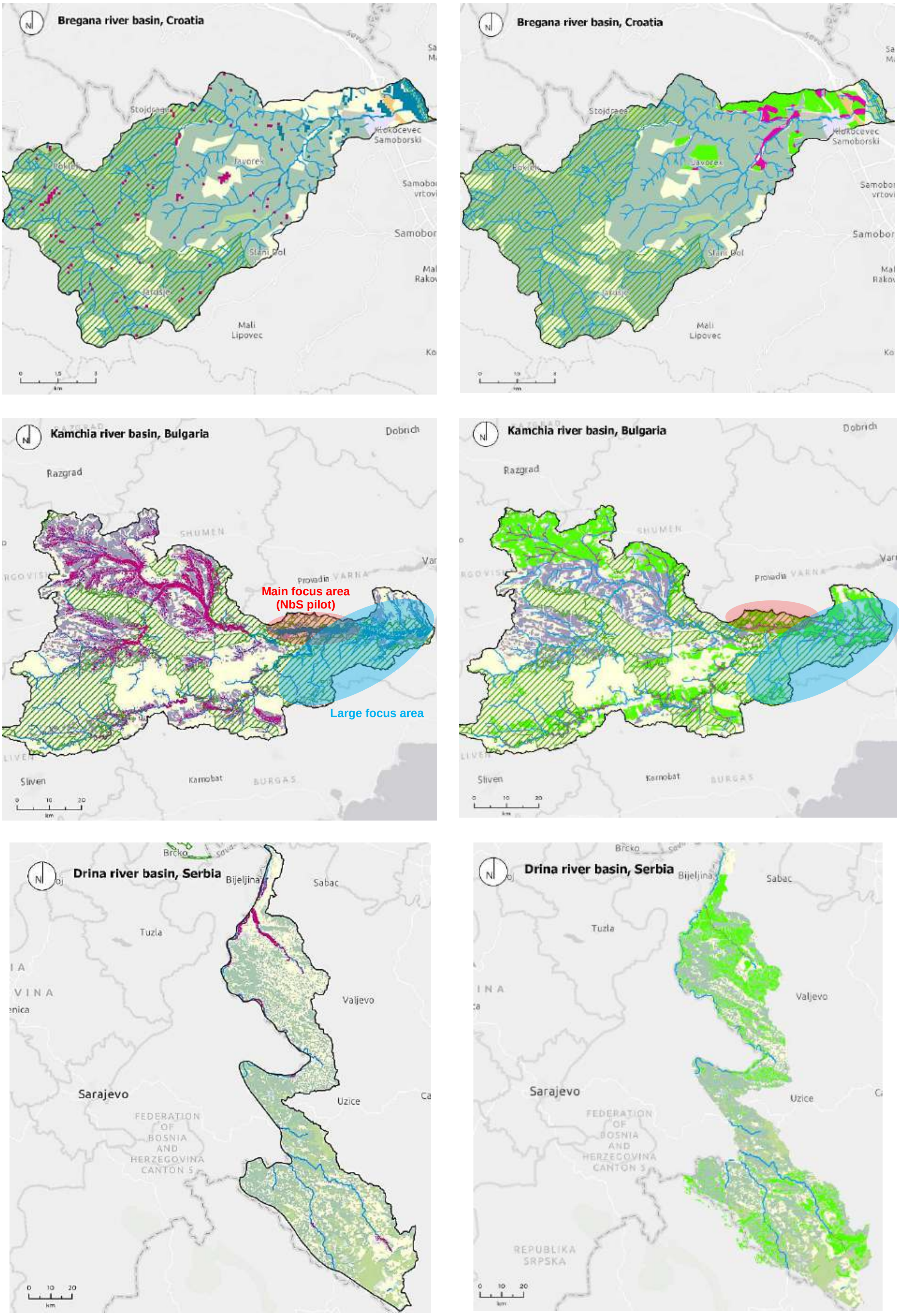


Figure 14 Suitability maps for the five EU Collaborators.

Source: maps from Ramboll, adapted from data from IHE-Delft (Balaji Devanand, 2021).

Note: the map for the Drina River basin shows only the Serbian part of the river basin which is shared by Bosnia& Herzegovina and Serbia & Montenegro.

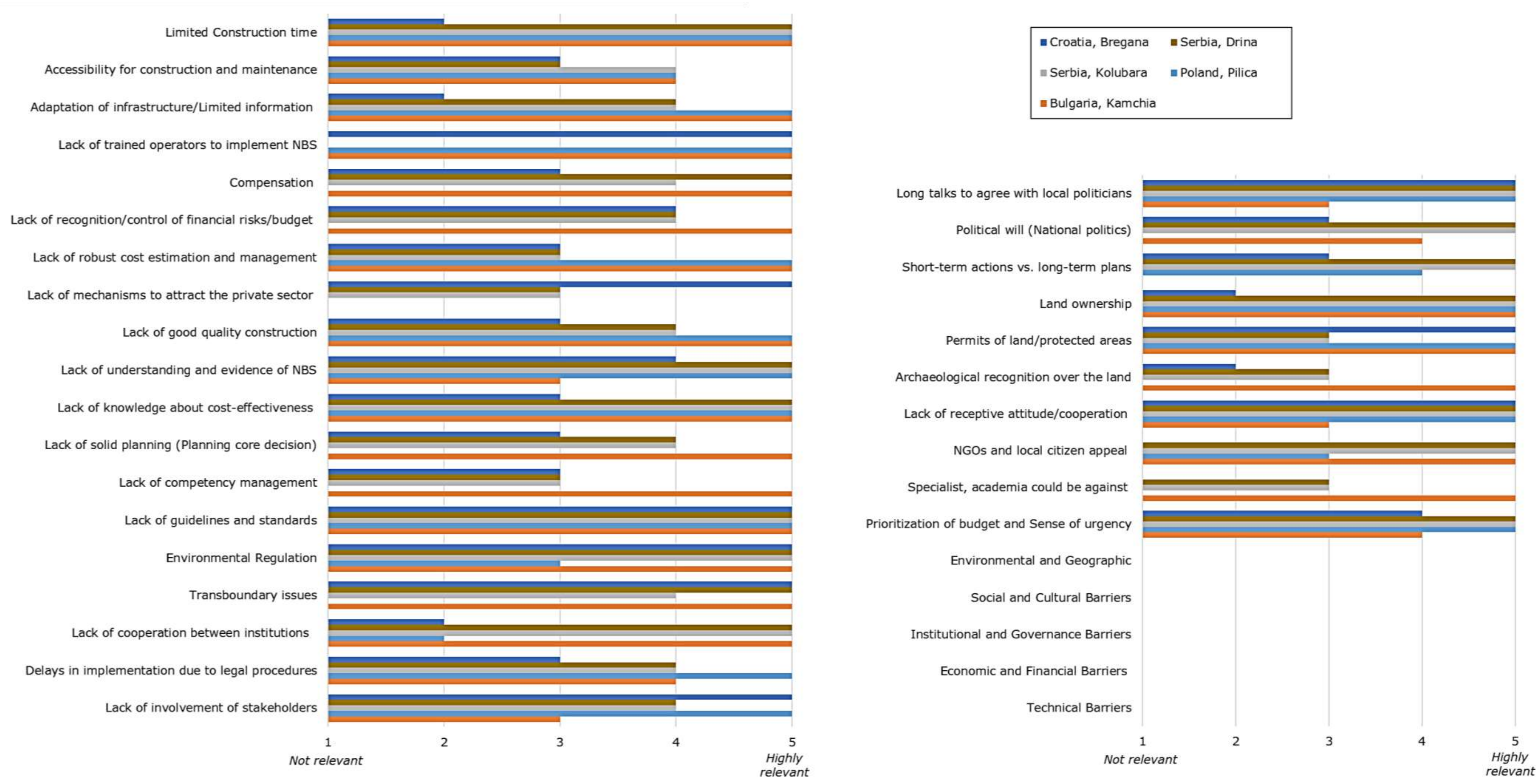


Figure 15 Survey results for all EU Collaborators.

5.2.1 Kolubara river basin

According to the suitability map, floodplain restoration is highly suitable along the river in the lower parts of the basin, and detention ponds are highly suitable in the upper parts. Yet the resolution of the suitability maps hinders local-scale decision support on where to implement NbS. The decision-making process needs to be supported by other considerations, such as enablers and barriers due to institutional, governance, economic, financial, social, or cultural conditions.

In the survey, the Collaborator identified 13 barriers as highly relevant for the Kolubara river basin (Figure 15). These were barriers like lack of guidelines and standards, political will, and lack of receptive attitude/cooperation. The suitability map shows that the basin is dominated by agriculture and forestry/nature. Land ownership and environmental regulation are therefore also highly relevant barriers. These barriers were also mentioned during the workshop as they can be assessed spatially. Land ownership is a barrier throughout the entire Kolubara basin, whereas environmental regulation is related to specific protected species.

5.2.2 Pilica river basin

Floodplain restoration is highly suitable along the streams in the lower parts of the basin, and detention ponds are highly suitable in the upper parts (Figure 14). Therefore, the suitability map does not inform local-scale decisions on where to implement these NbS. The decision-making process needs to be supported by other considerations, such as enablers and barriers due to institutional, governance, economic, financial, social, or cultural barriers and enablers. Afforestation is suitable in the North-East part of the basin. Suitable areas for forest buffers are scarce, mainly located in the central parts of the river basin.

In the survey, the Collaborator identified 15 barriers as highly relevant (Figure 15). These were barriers like lack of trained operators to implement NbS, lack of good quality construction, land ownership, and lack of guidelines and standards. The suitability maps show that the biggest part of the Pilica river basin is covered with agricultural land. Additionally, there are several Natura 2000 areas, the main ones being in the central part of the basin. In the workshop (and survey), barriers related to permits/protected land were highlighted by the Collaborator as there are several restrictions related to land use. For example, it is not allowed to convert good agricultural soil to forest and to convert wet areas (e.g., wetland) to forest. There are several places in the suitability maps, where suitable locations overlap with these barriers. These types of data are thus essential to include in the spatial allocation analysis. However, this information was brought forward by the Collaborator, thus underlining the need for an iterative approach.

The abundance of suitable locations for the assessed NbS types made it very difficult to assess the suitability map. The discussion of barriers in relation to the suitability map did exclude some areas for the replication of NbS, but the outcome of the discussion was more focusing on basin-wide barriers such as lack of guidelines and standards, lack of involvement of stakeholders, and lack of knowledge about cost-effectiveness. An additional output was a list of data that can improve the suitability map, such as hydrological data, data on heavily modified streams, and the location and extent of flooding. This section presents the first assessment of the replication potential in Collaborators based on the spatial allocation analysis and assessment of barriers and enablers. Figure 14 shows the suitability maps for each of the five EU Collaborators. Larger and higher quality pictures of the maps can be found in Annex 4 (Section 10.4). Additionally, the barriers that Collaborators identified in the survey can be seen in Figure 15 and the detailed workshop results are summarized in Annex 4. Overall results for each Collaborator are explained in the following sections. Enablers were identified in the workshops. Unlike barriers, these were discussed in plenum. Thus, enablers are not presented for each Collaborator, but jointly as common means to overcome some of the identified barriers in the Collaborators.

5.2.3 Bregana river basin

Bregana is in the North-West part of Sava River basin, and according to the analyses in D4.2, the most suitable measure identified was upper watershed restoration, followed immediately by retention ponds/detention basins. Floodplain restoration is not suitable since the few small possible areas are very close to the settlements. The only larger area of the floodplain along the Sava River itself will not contribute to the reduction of flooding on the Bregana River, because that floodplain is located too downstream.

In the survey, the Collaborator identified nine barriers as highly relevant (Figure 15). These were barriers like lack of mechanisms to attract the private sector, lack of involvement of stakeholders and long talks to agree with stakeholders. As mentioned above, the suitability maps show that a large part of the basin is covered by Natura 2000, forest, and agriculture. In the workshop, several barriers related to these types of land use were brought forward, such as environmental regulation and permits of land/protected areas. As there is an abundancy of forest compared to agriculture, the Collaborator speculates that there might be a pushback from farmers to convert agricultural land, and from citizens (as they don't need new recreational areas). Thus, lack of receptive attitude was highlighted in the survey and workshop as highly relevant. In the survey, land ownership was not deemed a relevant barrier. However, in the workshop, land ownership was highlighted as a potential (relevant) barrier in the basin as there is many small private landowners.

Compared to some of the other Collaborators, the discussion of barriers was more strongly linked to the type of NbS. Several suitable locations of the different NbS types were questioned according to their physical limitations. For example, the abundance of forest in the basin, makes the relative effect of afforestation and forest buffers smaller. Similarly, the Collaborator identified several areas where detention ponds were unfit due to already planned detention ponds or due to the very upstream location (no effect). The reason for the more NbS specific assessment might be due to the more approachable suitability map, with more specific locations. The discussion of barriers in relation to the suitability map therefore efficiently reduced the number of suitable NbS locations.

5.2.4 Kamchia river basin

The focus area of the Collaborator is highlighted on Figure 14. This area is in the downstream part of the river basin, which makes floodplain restoration very suitable. Afforestation is also suitable in a significant part of the area, and forest buffers are suitable along some of the riverbanks. In a discussion held in August 2022, the Kamchia Collaborator explained that an extended area of interest ("large focus") has been defined, including lower parts of the river basin and the Black Sea estuary, as shown on Figure 14.

In the survey, the Bulgarian Collaborator identified 19 barriers as highly relevant (Figure 15). These were barriers like lack of competency management, lack of good quality construction, lack of knowledge about cost-effectiveness, and limited construction time. The land use is mostly agricultural, also including some urban areas and construction zones, while the whole area overlaps with Natura 2000 zones. Particularly the latter, results in barriers related to environmental regulation and permits of land/protected areas (both in workshop and survey) and requires an extensive environmental impact assessment. In addition, approximately 200 landowners are present in the focus areas, making land ownership a highly relevant barrier.

Complexity is further increased by having four responsible authorities: three municipalities and a regional administration, suggesting that barriers related to lack of cooperation between institutions is something to be aware of.

The discussion of barriers in relation to the suitability maps was slightly challenged as the scale of the suitability map did not match the scale of the focus area. However, the suitability of different NbS types were still discussed. For example, historically the area used to be a very large floodplain, thus increasing the incentive for this NbS type. This type still needs to be approved by the local authorities, whereas afforestation and forest buffers already have been approved.

5.2.5 Drina river basin

Detention ponds are the only NbS in the Drina River basin where the replication potential has been investigated. This NbS type has the highest suitability in the most northern part of the basin, and the most southern part. These two parts of the basin are dominated by agriculture and areas with vegetation and forestry (Figure 14).

In the survey, the Serbian Collaborator identified 15 barriers as highly relevant (Figure 15). These were barriers like lack of guidelines and standards, prioritization of budget/sense of urgency, and short-term actions vs. long-term plans. In the workshop, barriers related to transboundary issues and lack of cooperation between institutions were raised as major barriers, as transboundary issues (and thus also cooperation issues) occur on two levels; 1) The basin is shared by three countries (Serbia, Montenegro, and Bosnia and Herzegovina), 2) two authorities in Bosnia and Herzegovina that do not cooperate well. In addition, barriers related to political will and lack of receptive attitude/cooperation were discussed. These barriers were related to the hydropower plants in the basin. Some are already built and provide protection from floods, and more are being planned. The Collaborator expects that environmentalists may favor NbS, whereas politicians favor hydropower maximization.

The discussion of barriers in relation to the suitability maps provided a clearer representation of the replication potential of detention ponds. The hydropower plants in the basin (and the plan to develop more) mean that the potential for detention ponds is mainly relevant on the smaller tributaries of the Drina River. The assessment of barriers thus highly reduced the number of suitable sites in the Drina River basin.

5.3 Enablers to overcome barriers

During the workshop, a discussion was conducted in plenary session to exchange views on potential enablers that could overcome identified barriers and/or turn them into opportunities.

Although enablers have been defined in Section 2.3 as conditions that can facilitate the development of NbS, from the discussions with Collaborators, it appeared that they also consider that enablers could refer to any action that can be taken to tackle some of the existing barriers for NbS development. Enablers are not only the opposite concept of barriers. They are leverages that can be acted upon and influenced to overcome barriers. All five EU Collaborators participated in the identification of such leverages. They collectively identified a series of enablers, mostly focused on improving dialogue and knowledge sharing among stakeholders (Table 8).

Table 8: Enablers identified in the workshop and examples of barriers they can potentially overcome.

Identified enabler	Example of relevant barrier(s)
Improved data collection/digitalization and knowledge sharing to ensure better understanding of local conditions and existing solutions	• Lack of knowledge about cost-effectiveness • Adaptation of infrastructure/ Limited information
Evidence-based knowledge on NbS multiple benefits	• Lack of understanding and evidence of NbS • Lack of knowledge about cost-effectiveness • Short-term actions vs. long-term plans
Early warning systems and monitoring to enrich the evidence base	• Lack of understanding and evidence of NbS
Training material for both non-technical and technical stakeholders	• Lack of guidelines and standards • Lack of trained operators to implement NbS • Lack of good quality construction
Local needs assessments	• Land ownership • Lack of receptive attitudes/cooperation • NGOs and local citizen appeal • Lack of involvement of stakeholders
Compensation mechanisms	• Land ownership • Lack of involvement of stakeholders
Political leverages (e.g., from European Commission)	• Lack of receptive attitudes/cooperation
Involvement of multiple stakeholders	• Lack of receptive attitudes/cooperation
Land-ownership issues considered early in the planning phase	• Land ownership • Lack of receptive attitudes/cooperation • Lack of involvement of stakeholders

Many of these enablers will continue being assessed in other deliverables in RECONECT, increasing the evidence base on NbS multiple benefits, as well as in the development of standards and guidelines to support the planning and implementation of NbS.

5.4 Challenges in assessing barriers and enablers

During the workshop, several challenges became evident when assessing barriers and enablers. Some of these were related to the survey, and other related to the spatial assessment. These challenges provide a foundation for improving the assessment of barriers and enablers, and their combination with the spatial allocation analysis. These challenges were:

- Some participants felt they had too little experience to fill out the survey. Several mentioned it would be useful to include more stakeholders in the assessment, e.g., local authority. This would also reduce the subjectivity of the assessment, a concern also mentioned by participants.

- Some participants said the barriers were too specific and thus difficult to assess on river basin scale. For example, the barrier “Accessibility for construction and maintenance” was not deemed relevant on river basin scale. One Collaborator stated that it is very difficult to make the list exhaustive, providing an additional argument for more broadly defined barriers.
- The suitability maps proved difficult to interpret, which might be due to the very large scale of the assessment (Low resolution). Abundance of suitable areas for the respective NbS makes the maps very difficult to use for planning (e.g., Pilica river basin in Figure 14). This is due to land use information not being considered to a sufficient extent in the spatial allocation analysis. One way for improvement is to consider regional/local specific thresholds for land use suitability criteria (See Section 4.1). Another way is to consider more land use and land ownership information/data in the spatial allocation analysis, if available.
- Compared to identifying barriers, it was more challenging for Collaborators to identify enablers. Some Collaborators pointed to the planning process often focusing solely on “problem-solving”, and that they are too involved in the project to take a step back and look at enablers. Most Collaborators said they lacked the experience and knowledge to assess enablers, co-benefits and develop preliminary business cases.

5.5 Key lessons

This proposed methodology combined a quantitative assessment with a qualitative assessment to estimate the replication potential of NbS. This exercise revealed some challenges, but also opportunities and ways forward. The following key lessons were obtained:

- Multiple stakeholders from the same focus area should participate in identification and discussion on barriers and enablers. Optimally these stakeholders should come from different organizations/institutional settings and have different professional backgrounds.
- There was a mismatch between the defined barriers in the survey and assessing these on river basin scale, i.e., many of these barriers were too specific to be assessed on river basin scale. More broadly defined barriers must be properly identified when working on river basin scale.
- Developing standards, guidelines and training materials is critical to successful replication of NbS. Collaborators stressed that these should be easy to read so all professionals and local authorities can understand them.
- Additional sessions/workshops focusing more on enablers, business cases and benefits should be conducted.

Overall, the approach underlined the value of discussing quantitative results in a qualitative manner, and not only once, but several times including stakeholders with different background and responsibilities.

6 Approach on upscaling NbS in Europe

The replication approach applied with Collaborators proved to be a powerful tool to understand the potential for NbS replicability, through different types of engagement (survey, workshop) and different tools/methods (suitability mapping, assessment of barriers and enablers). Suitability maps revealed to be strong outputs with a high potential for being used to perform a first screening of NbS suitability, but also to engage with stakeholders to refine the analysis, considering local contexts.

The methodology and its application to EU Collaborators provided valuable knowledge on NbS barriers and enablers and their interaction with spatial features. Bringing together this knowledge with lessons learnt from previous projects provides a strong ground for recommendations to support practitioners, academia and research centers, decision-makers, policy makers, politicians and other NbS stakeholders.

6.1 Cross-referencing Demonstrators and Collaborators

As detailed in Section 3.3, a survey was previously shared with Demonstrators to identify barriers and enablers for NbS implementation (July 2020). To combine the outputs of this deliverable with previous experiences, the results from the other survey shared with EU Collaborators (Section 4.2) were cross-referenced with the results from the Demonstrators' survey.

Demonstrators and Collaborators answered two distinct surveys: Demonstrators were asked about the nine factors identified in Table 3 whereas Collaborators were asked about a more detailed list of barriers. Thus, to enable cross-referencing, these detailed barriers were grouped under the above-mentioned nine bigger categories. The idea of grouping factors (barriers and enablers) within broader categories was supported by Collaborators themselves during the workshop. As seen in Section 5.4, several Collaborators suggested to have more broadly defined barriers and enablers to better fit the river basin scale of the suitability maps.

Cross-referencing barriers between Demonstrators and Collaborators allowed for a better understanding of the relation between their characteristics (e.g., land use types, hazards, etc.) and the barriers that they consider relevant for their respective NbS.

Moreover, combining the big picture provided by Demonstrators and the discussions with Collaborators on more specific barriers revealed similarities and interdependencies between barriers, which allowed a deeper understanding on how to tackle them (e.g., which enablers to act on). Interdependencies across Demonstrators and Collaborators in their mapping and tackling of barriers for NbS implementation are displayed on Figure 16, assessed through five overall categories: i) EG – Environmental and Geographic; ii) T – Technical; iii) SC – Social & Cultural; iv) IG – Institutional & Governance; and v) EF – Economics & Finance.

The assessment of interdependencies has great potential to support the successful upscaling of NbS. Mapping interdependencies in a specific context can provide a holistic view of the different factors that influence the potential for implementation of NbS. This practice should be further adopted as a preliminary assessment to NbS planning.

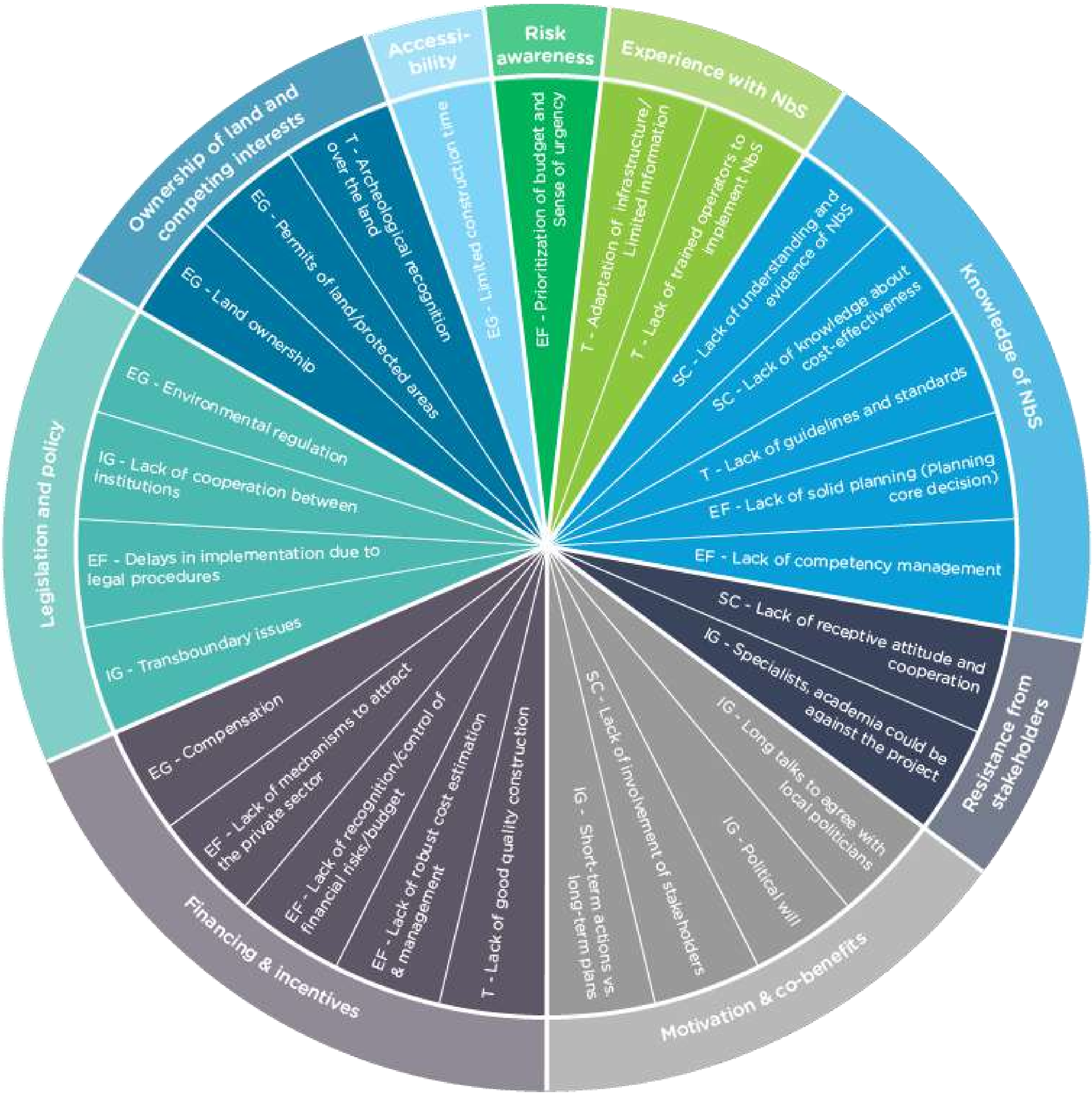


Figure 16: Assessment of interdependencies between different groups of barriers.

EG: Environmental & Geographic barriers, T: Technical barriers, SC: Social & Cultural barriers, IG: Institutional & Governance barriers, EF: Economics & Finance barriers.

Drawing upon the interdependencies between barriers, the results from the survey shared to Collaborators (Table 9) could be cross-referenced with insights on barriers from Demonstrators.

Note that in the survey, Collaborators were asked to rank barriers from 1 (not relevant) to 5 (highly relevant). The number presented in the Table are the averages of the grades for all the specific barriers within each broader category.

Table 9 Results from the survey on barriers shared with Collaborators.
Collaborators ranked barriers from 1 (not relevant) to 5 (highly relevant).

	Ownership	Accessibility	Risk awareness	Experience	Knowledge	Resistance	Motivation	Legislation & Policy	Financing & Incentives
EC1: Kamchia River Basin	4	3	3	3	3	3	2	3	3
EC2: Pilica River Basin	3	4	5	4	4	2	3	3	5
EC3a: Bregana River Basin	2	1	4	3	3	2	3	3	3
EC3b: Drina Riber Basin	3	3	4	2	3	4	4	4	3
EC3c: Kolubara River Basin	3	3	4	3	3	4	4	3	3

Results from Collaborators, and their cross-referencing with Demonstrators, reveal the following key points:

- The most important barrier, identified as such by seven out of ten Demonstrators (Table 5), and ranked as a 4 by two out of 5 Collaborators, is the **Resistance from Stakeholders**.

- **Land ownership** was either considered as an enabler or ranked as a neutral/low priority barrier by most Demonstrators and Collaborators. However, it was ranked as a 4 by the Kamchia river basin and considered as a barrier by three Demonstrators: DA2 (Elbe Estuary), DA3 (Tordera River Basin) and DB1 (Ijssel River Basin). Land ownership can be a barrier when there are a lot of landowners, which is the case in the area of interest for Kamchia (more than 200 different owners), as well as for Ijssel (400 direct stakeholders involved: managers, land renters, residents, and users). Land ownership can also hamper NbS implementation when the land is privately owned since it requires agreements with landowners. Additionally, land ownership can be a barrier if the capabilities of the landowner to operate or maintain NbS are low. For example, in the case of Tordera, the landowners are responsible for maintenance while the municipality is responsible for operation, which can be a barrier, as small municipalities might not have the will and/or capability to carry out the operation of the NbS. In DB3 Aarhus and DB4 Thur, there was a change of ownership from a mixed private-public to purely public ownership. In the case of DB6 (Les Boucholeurs), there was a change from purely publicly owned to a public-private ownership as a result from the significant flooding that occurred in 2010 which motivated private investors to join the NbS implementation through land ownership.

- **Legislation and Policy** also includes permits of land and protected areas. In Kamchia, this is of high relevance since there are eight Natura 2000 zones in the area of interest, and the biosphere reserve area of Longoz is located nearby. In Odense, part of the land is also protected under the Natura 2000 framework. Overcoming land ownership barriers requires agreements and compensation mechanisms that are cost-effective enough to guarantee the active cooperation of landowners.

- **Accessibility i**s a barrier in DA4 (Portofino) and DB2 (Inn). It is also ranked as a high priority barrier for the Pilica river basin. However, this ranking of the accessibility does not have the same causes for the three cases. Portofino and Inn are located in areas with steep slopes and a high risk of sediment/mud transport through runoff. Pilica does not have the same type of landscape, but still faces accessibility issues which could be due to a number of land use factors (a big portion of the land use is forestry). Pilica could benefit from knowledge exchange with the Inn River basin which has similar conditions: a big forestry part in its land use, and important runoff (Pilica is called "the most mountain river among lowland rivers").

- **Risk awareness** is an important factor for all Demonstrators, either as a barrier or as an enabler and for all Collaborators (ranked above 3). Note that Collaborators were not asked to consider enablers in the survey, but only barriers. The way the results of the cross-referencing could be understood is that the lack of risk awareness is an important barrier, but that raising awareness on hydro-meteorological risk can act as a strong enabler to strengthen motivation. Risk awareness contains only one barrier from IHE-Delft, which is called "Prioritization of budget and sense of urgency". There is, however, not a one-to-one correlation between risk awareness and "Prioritization of budget and sense urgency".

- Both Serbian River basins identified **Resistance and Motivation** as high priority barriers. These two barriers can include resistance or lack of receptive attitude from different groups of stakeholders, the lack of political support or will, the lack of involvement of stakeholders or the adoption of a "short-term" mindset which overlooks long-term benefits and co-benefits of NbS. In the case of Serbia, according to the workshop, this lack of motivation is the direct result of a lack of understanding/knowledge of the effectiveness of NbS. Both cases would benefit from knowledge exchange with the Ijssel River basin which had to overcome resistance from stakeholders, through regular consultations with various groups of stakeholders (citizens, environmental agencies, landowners, etc.).

Overall, the cross-referencing of Demonstrators and Collaborators revealed similarities between different cases on how they assess and rank barriers for NbS implementation. These similarities can be explained by similar land use, land ownership and landscapes conditions. However, there are several other factors that could explain such similar priorities and it is important to not "over-interpret" the results.

From the methodology which focused on replication, the cross-referencing contributed to a broader understanding on upscaling, by revealing similarities and key points of knowledge exchange between Collaborators and Demonstrators. It also enabled a deeper understanding of interdependencies between the different groups of barriers identified from various sources.

6.2 Assessing interdependencies between barriers and enablers

Barriers are not independent. They interact with other barriers and with enablers throughout the different phases of NbS development. Successful upscaling requires an understanding of such interactions. Mapping interdependencies can help targeting factors to act on (either enablers or barriers) by identifying those who have a high degree of connectivity to other factors.

This exercise was done for the nine factor categories identified in Table 3, which draws from interdependencies based on insights from previous European projects, Demonstrators and Collaborators.

Factors are connected by asking “what other factors are affected by the presence/absence of this factor?”. “Legislation & Policy” directly or indirectly affects all factors by setting the boundary conditions (Figure 17). Within these boundary conditions, most factors affect at least two others. For example, if “Motivation & Co-benefits” are not present, it might result in barriers related to “Resistance from stakeholders”, “Ownership of land & competing interests”, and “Financing & Incentives”. Similarly, “Knowledge of NbS” comprising both development of guidelines and standards, as well as lack of evidence, impacts “Resistance from stakeholders”, “Financing & Incentives”, “Experience with NbS”, and “Motivation & Co-benefits”. If the relevant knowledge is available, it contributes to overcome the mentioned barrier groups. “Resistance from stakeholders” and “Accessibility for construction and maintenance” do not necessarily have an impact on the other factors (No output arrow, Figure 17). This suggests that these are always seen as barriers, and not enablers. Note that the links shown on Figure 17 would differ depending on the context.

Adapting this exercise to the local context can help identify intertwined barriers and enablers. This should be a key step in assessing the potential for implementing NbS.

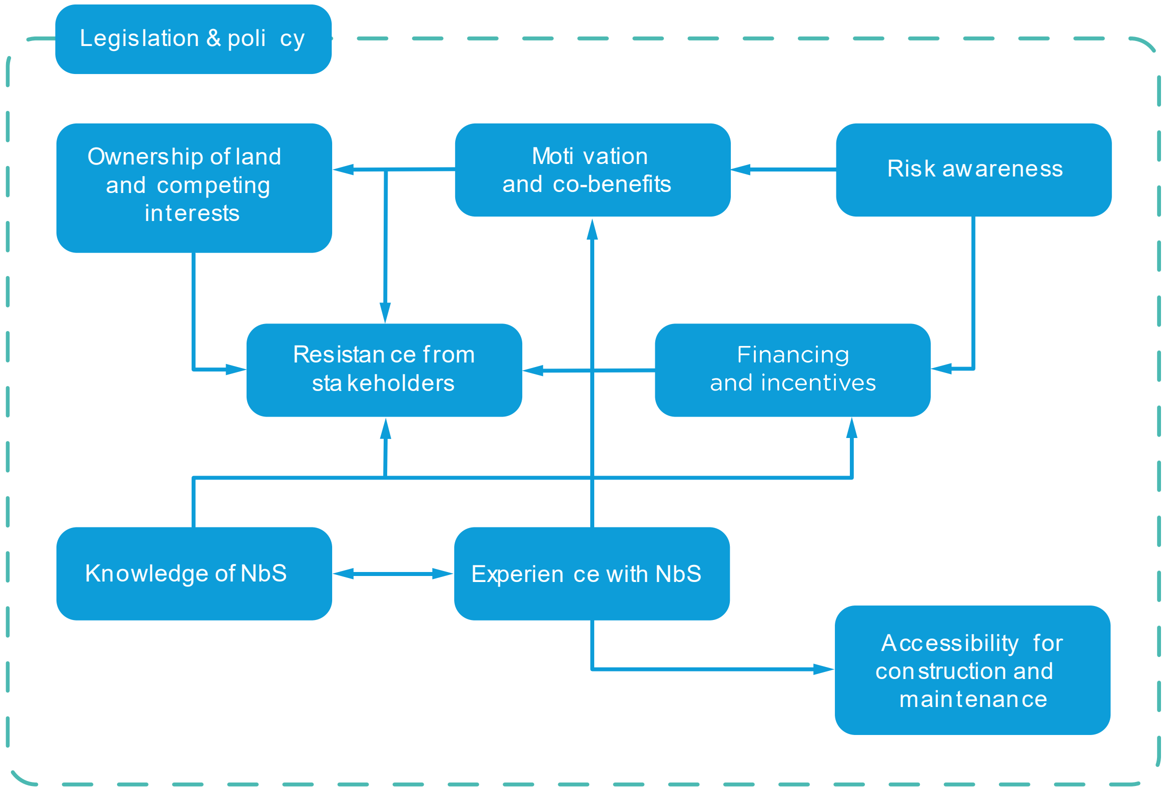


Figure 17: Links between barrier/enabler categories estimated by asking “what other categories are affected by the presence/absence of this group?”. The absence of an arrow out of a category (a box) suggests that it is solely seen as a barrier and not as an enabler (e.g., Resistance from stakeholders).

As shown on Figure 17 and as explained in Section 6.1, stakeholder motivation is a key enabler for successful development and implementation of NbS. Stakeholder motivation is typically conditioned by how valuable they think the project is for society, or, in other words, which benefits and co-benefits it brings. This must be demonstrated through a solid business case which will also be critical to get financiers on board.

6.3 Building strong business cases for NbS

The assessment of enablers and barriers for NbS implementation in Europe from various EU stakeholders, Demonstrators and Collaborators highlighted the importance of stakeholder motivation.

When it comes to NbS, motivation is very much related to the demonstration of how the NbS can yield positive impacts on society, including long-term benefits and co-benefits. This can be achieved through a solid business case which should be prepared at the early stages of any NbS project. Business cases will show stakeholders, including financiers, that the project is truly valuable and worth to invest in.

The NAIAD handbook for the Implementation of NbS for Water Security (Altamirano, 2021) identifies business cases as the missing link for attracting financiers. It recommends the use of the Five Case Model[1] to ensure that programmes and projects meet their intended goals and deliver their intended benefits and co-benefits.

The Five Case Model (Figure 18) is based on ensuring that the investments proposed:

- Make a robust case for change – the strategic case
- Optimize Value for Money in terms of benefits and co-benefits – the economic case
- Are commercially viable – the commercial case
- Are financially viable – the financial case
- Are achievable – the management case

[1] The Five Case Model is the approach for developing business cases recommended by HM Treasury, the Welsh Government and the UK Office of Government Commerce. It has been widely used across central government departments and public sector organisations over the last 10 years (Altamirano, 2021).

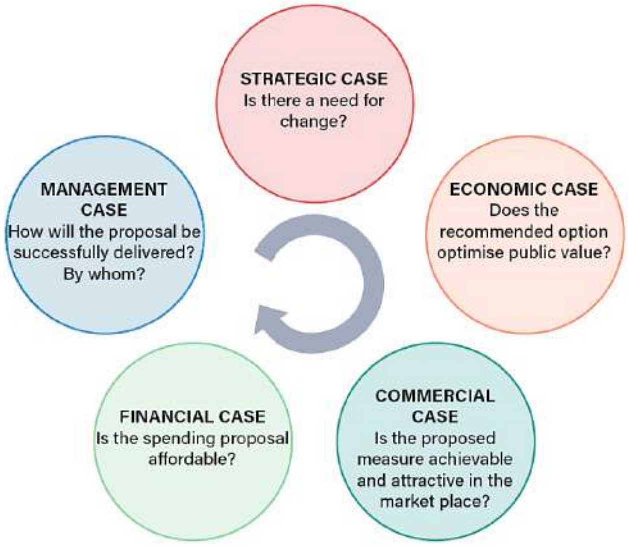


Figure 18 The Five Case Model
Source: NAIAD (Altamirano, 2021)

To support the Five Case Model, understanding enablers and barriers is critical. More specifically, to overcome the key barrier of stakeholder resistance, the economic case should be supported by a valuation of not only benefits but also co-benefits of NbS. The ability of NbS to fulfil multiple functions increases their cost-effectiveness and could ideally lead to multiple sources of funding.

Cost Benefit Analyses (CBAs) provide an ideal analytical tool for evaluating and comparing projects against each other or a baseline in their planning phase. They are a strong tool for communicating and comparing the project specific economic and wider social impacts to stakeholders. Their calculation methods allow for a clear comparison of co-benefits among strategy choices and the baseline. A CBA takes all relevant costs and benefits associated with a project into account and comprises monetization of marketable and non-marketable goods and services (Figure 19).

Figure 19 Cost Benefit Analysis and added value (co-benefits) of NbS.
Source: Ramboll.

When developing a CBA to support the business case of a given NbS and its associated decision-making process, it is important to strike the balance between the values (market and non-market) to be captured by the NbS, the level of protection the NbS offers (against e.g., hydro-meteorological hazard) and the overall costs, benefits, and co-benefits which, altogether, come together into finding an “optimum protection level”. This is illustrated by Figure 20.

The figure conceptually illustrates the optimum level of protection in a given stormwater flooding scenario. Applying this method allows for a comparison between different scenarios, comparing costs and benefits for each scenario and determining the optimum scenario. The optimum is reached when total costs fall below investment and maintenance costs, or in other words, when the monetary value of co-benefits exceeds the costs. This conceptual representation of the optimum protection level has been developed through numerous NbS implementation projects in Denmark, by Ramboll.

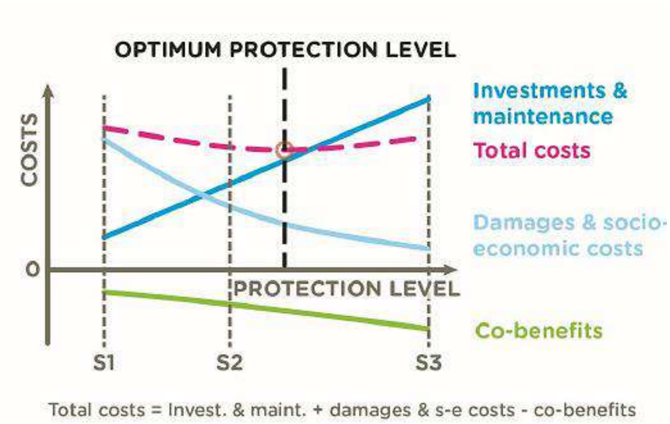


Figure 20 The optimum protection level approach for CBAs.
Source: Ramboll.

S1, S2 and S3 are three scenarios corresponding to three different levels of protection. Each scenario requires different levels of investment and implies different levels of damages and associated socio-economic costs, as well as different levels of co-benefits. The total costs result from the difference between investment and maintenance costs added to socio-economic costs of damages, minus the added value brought by co-benefits. The optimum protection level is reached when total benefits exceed costs.

The optimum protection level approach could be adapted to large-scale NbS projects for hydro-meteorological risk reduction. This would allow the development and comparison of different scenarios with different levels of risk reduction. Results could be discussed with stakeholders, who would receive valuable information on what is the optimum level of protection for the area of interest, therefore unlocking and optimizing financial resources. The optimum protection level approach can create strong incentives to implement NbS and therefore support RECONECT’s outcomes.

There are also specific tools to undertake a CBA. One of such tools is the Microsoft Excel® based CBA model (Figure 21) built on FEMA[1] guidelines for CBAs and the standard CBA practice. The model is designed to be flexible in its use, and to be used at different stages in the planning process. The model monetizes both costs and benefits of resiliency strategies, including socio-economic effects. The CBA model is designed as a user-friendly tool aimed at non-economists and thereby designed to evaluate resiliency strategies thoroughly, effectively, and easily.

[1] The Federal Emergency Management Agency (FEMA) supports citizens and emergency personnel to build, sustain, and improve the nation's capability to prepare for, protect against, respond to, recover from, and mitigate all hazards.

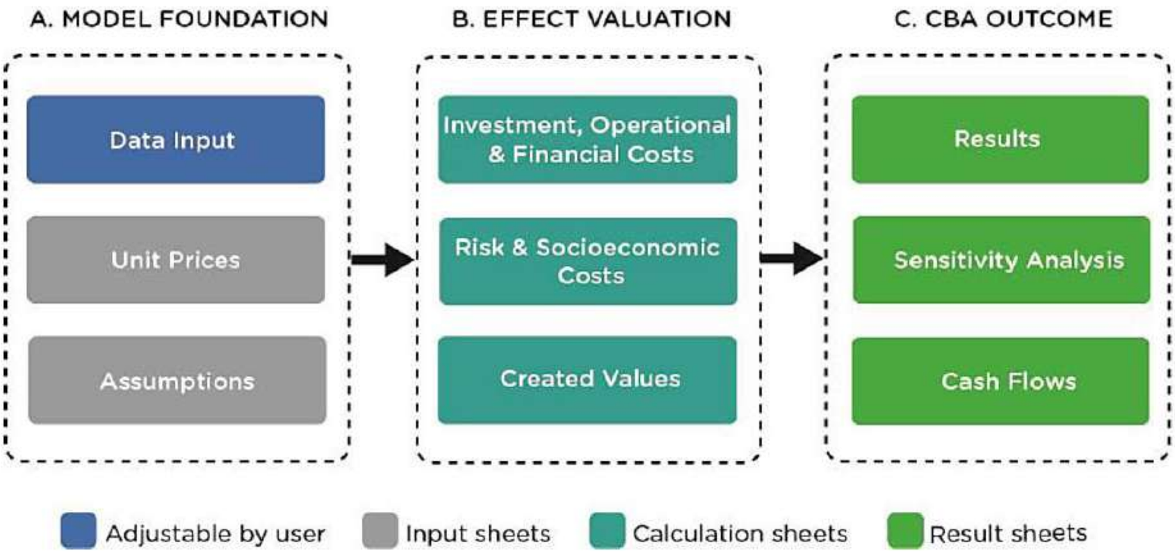


Figure 21 Excel model for CBA, developed by Ramboll.

The model comprises three main modules:

1. **Model Foundation:** it contains data inputs, unit prices and assumptions. Together, these elements contain all the data used in the calculations of the effects and are thus the foundation of the model.
2. **Effect Evaluation:** it performs the main calculations of the effects and contains Investment, Operational & Financial Costs, Risk & Socioeconomic Costs, and Created Values.
3. **CBA Outcome:** it contains Results, Sensitivity Analysis of Strategy and Cash flows[1]. The 'Results' sheet provides the user with a general overview of the results of the model, based on the cash flows presented in the 'Cash flows' sheets. This allows for ease of comparison on key project parameters, such as total project cost and created values, the Net Present value and cost-benefit ratio. The 'Sensitivity' sheets contain the sensitivity analysis which assesses the impact of the different parameters on the results. Variation to these key parameters is performed to evaluate the robustness of the model result. The 'Cash flows' sheets gives an overview of the development in the costs and benefits over time and thus facilitates analysis of the liquidity of the project.

This user-friendly, comprehensive tool is a very powerful support for NbS upscaling. Increased understanding of the long-term economic efficiency of NbS can support decision-making towards a wider uptake of NbS.

As highlighted by Collaborators during the workshop, assessing enablers for NbS implementation can prove more difficult than assessing barriers, because barriers are given whereas enablers must be found and investigated. Therefore, business cases should be recommended to stakeholders as a strong enabler that should be considered from the earliest stages of a project. Moreover, adopting the "business case" perspective will also reveal additional key enablers.

[1] The cash flows show the costs and benefit of each year over the reference period. The cash flows are used to analyze the costs and benefits over time, for example to investigate when large costs or benefits accrue during the period. Cash flows also allow for the calculation of the net present value (NPV); the value of the future cash flows of the costs and benefits in today's value.

7 Conclusions

NbS have been widely recognized as an innovative way to address societal challenges in relation to hydro-meteorological hazards. High-level efforts and initiatives have advocated for the use of NbS in the past few years, with RECONECT being just one of the many projects and/or initiatives launched at EU level. In The Netherlands, the Room for the River project stands as a key example of successful implementation of large-scale NbS for flood risk reduction and, together with other cases in Europe, reveals some key factors that can either hamper (barriers) or facilitate (enablers) NbS implementation.

Drawing from the international and European knowledge base in NbS, as well as from the wealth of data and information available through the project cases in RECONECT, this deliverable develops and applies a replication methodology focusing on the potential for implementation of large-scale NbS. The deliverable combines a quantitative (spatial) analysis and a qualitative assessment of barriers and enablers, altogether considered for successful replication.

In doing so, this deliverable applies RECONECT's upscaling strategy and framework, supported by a replication methodology addressing a wide range of technical elements, qualitative criteria and stakeholders taking part in the implementation of NbS. Testing this methodology on the five EU Collaborators revealed key barriers for successful NbS implementation, but also key enablers, considered by Collaborators as leverages that can help overcoming barriers and turn them into opportunities. The following enablers were identified:

- Improved data collection/digitalization and knowledge sharing to ensure better understanding of local conditions and existing solutions
- Evidence-based knowledge on NbS multiple benefits
- Early warning systems and monitoring to enrich the evidence base
- Training material for both non-technical and technical stakeholders
- Local needs assessments
- Compensation mechanisms
- Political leverages (e.g., from European Commission)
- Involvement of multiple stakeholders
- Land-ownership issues considered early in the planning phase

Overall, the approach underlined the value of discussing quantitative results in a qualitative manner, and not only once, but several times including stakeholders with different background and responsibilities.

The replication approach applied with Collaborators proved to be a powerful tool to understand the potential for NbS replicability, through different types of engagement (survey, workshop) and different tools/methods (suitability mapping, assessment of barriers and enablers). Suitability maps revealed to be a powerful tool to perform a first screening of NbS potential, but also to engage with stakeholders to refine the analysis, considering local conditions, opportunities, and constraints.

Anchoring the approach followed in this deliverable within the core of RECONECT, this deliverable also presents a cross-referencing of results with experiences from Demonstrators. This exercise allowed an assessment of interdependencies across barriers and enablers, supporting the overall upscaling of NbS in Europe and beyond. In this way, this deliverable offers both a relatively standardized and hands-on methodology, but also flexible and adaptable to other contexts and larger groups of stakeholders. It also allows outlining recommendations for assessing the potential for implementation of large-scale NbS and successfully upscaling NbS in Europe and beyond.

Moreover, the suitability maps and experts' assessments collected in this deliverable provide a strong basis for knowing *where* in Europe there is potential to replicate the different NbS tested in RECONECT and other EU projects. It has been identified that the NbS from the Room for the River program could be implemented in Germany, France, Italy, Belgium, Hungary, Romania, Bulgaria, Serbia, Croatia, Bosnia and Herzegovina, Poland, Ireland, Spain, and Portugal. The NbS implemented in the Thur River Demonstrator could be applied in similar mountainous contexts such as the Black Forrest, the Vosges or the Massif Central. The NbS implemented in the Elbe Estuary Demonstrator could be applied to other areas with small slopes and wide river floodplains (South-East of France, Ural, coastal areas of Bulgarian rivers). The NbS implemented in the Portofino Demonstrator could be applied in locations with the same features and challenges (small catchments, high slope gradients, etc.). This includes, for example, the Alpine region, the Balearic Islands in Spain, the Côte d'Azur in France, the Greek islands, or Montenegro coastal areas.

Overall, there is clear potential for the NbS demonstrated in RECONECT and previous EU projects to be replicated across Europe. To confirm this replication potential, an approach like the one presented in this deliverable is a true added value.

8 Recommendations: potential for NbS & successful upscaling

The following recommendations apply to stakeholders willing to assess the replicability of NbS in their respective sites, and to practitioners or academics who have an interest in the replication methodology:

1. To assess replicability of NbS, spatial allocation analysis and assessment of enablers and barriers are equally important. Performing these in parallel and in iterative steps is essential. Iterative steps are important because the ability of stakeholders to identify barriers and enablers highly depends on which stage of the project they are in (planning, design, implementation, monitoring, etc.) Barriers and enablers are not static concepts. They can be overlooked during the planning phase but revealed during implementation. To ensure the iterative process, the following recommendations apply:
    a. As a minimum, meetings/workshops with stakeholders should be conducted to determine relevant data and thresholds for the suitability criteria in the spatial allocation analysis. The use of multi-stakeholders' workshops is an essential element of the co-creation pathway defined in RECONECT.
    b. Optimally, a dialogue with stakeholders should be facilitated on different scales (e.g., a first screening at river basin scale followed by a more local analysis). Collaborative mapping could be a valuable approach for combining the quantitative and qualitative assessments. For inspiration, refer to section 10.4, as well as D3.5 which provides a manual for practitioners on participatory approach to co-creating NbS.

2. The scale of the suitability maps should fit the resolution of enablers and barriers. As a rule of thumb:
    a. Local/catchment scale suitability maps and/or detailed information → detailed enablers and barriers (inner circle, Figure 16)
    b. Regional/river basin scale suitability maps and/or little information → overall enablers and barriers (outer circle, Figure 16)
    c. It's also important to keep in mind that the scale of the assessment also depends on the stage of the project. If a larger-scale analysis would fit to the planning phase, a more local scale may be needed for implementation.

3. Assessment of enablers and barriers should always be based on discussions with all relevant stakeholders, e.g., through workshops as illustrated in this deliverable. Multiple stakeholders covering different professional backgrounds and responsibilities should be present to provide deeper insights into the barriers and enablers of the replication area.

4. Discussions on enablers should be held from the beginning of the analysis. Each meeting/workshop with stakeholders is an opportunity to identify enablers.

5. Many of the enablers and barriers mentioned in this deliverable are connected to stakeholder engagement of varying forms (e.g., land ownership, lack of receptive attitude/cooperation, compensation, etc.). Including stakeholders early to understand what barriers and enablers they foresee, and their preferences in relation to NbS, is an enabler in itself and a good practice for successful upscaling. This is much in line with the overall recommendation of undertaking quantitative and qualitative assessments in parallel, and not allow one or the other to be dominant at the outset.

More generally, for local, regional, and national policymakers and agencies, civil protection administrations and municipalities interested in NbS, the following recommendations apply to get a deeper understanding of the potential for NbS implementation and on how to successfully upscale NbS:

6. Mapping independencies between barriers and enablers facilitates a deeper level of understanding of how to act to facilitate NbS development. Mapping interdependencies should be done based on cross-referencing various sources of information, and through discussions with stakeholders. Preferably, interdependencies should be discussed using participatory approaches, e.g., through workshops and other communication techniques (UFZ, 2021). Understanding how factors interact together is highly valuable because it can highlight cascade effects and good leverages (e.g., if an enabler is connected to multiple barriers, it may be a very relevant leverage to focus on).

7. Involve stakeholders with different professional backgrounds, experience, and areas of responsibility as early as possible.

8. Consider enablers from the earliest stage of discussions and planning. Enablers help avoiding short-term thinking that focuses solely on barriers and day-to-day challenges, which is typically what dominates the list of concerns on project owners or beneficiaries.

Finally, to get even more stakeholders on board and enable a “scaling out” of NbS to a wide range of entities, stakeholders with an interest in developing NbS should unlock financial resources by demonstrating the cost-effectiveness of NbS. This can be done first and foremost by building a strong business case for NbS. Business cases are themselves enablers that can tackle multiple barriers, especially the resistance from potential financiers, by clearly explaining the interest of NbS projects through their multiple benefits and co-benefits.

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10 Annexes

10.1 Annex 1: Description of key barriers

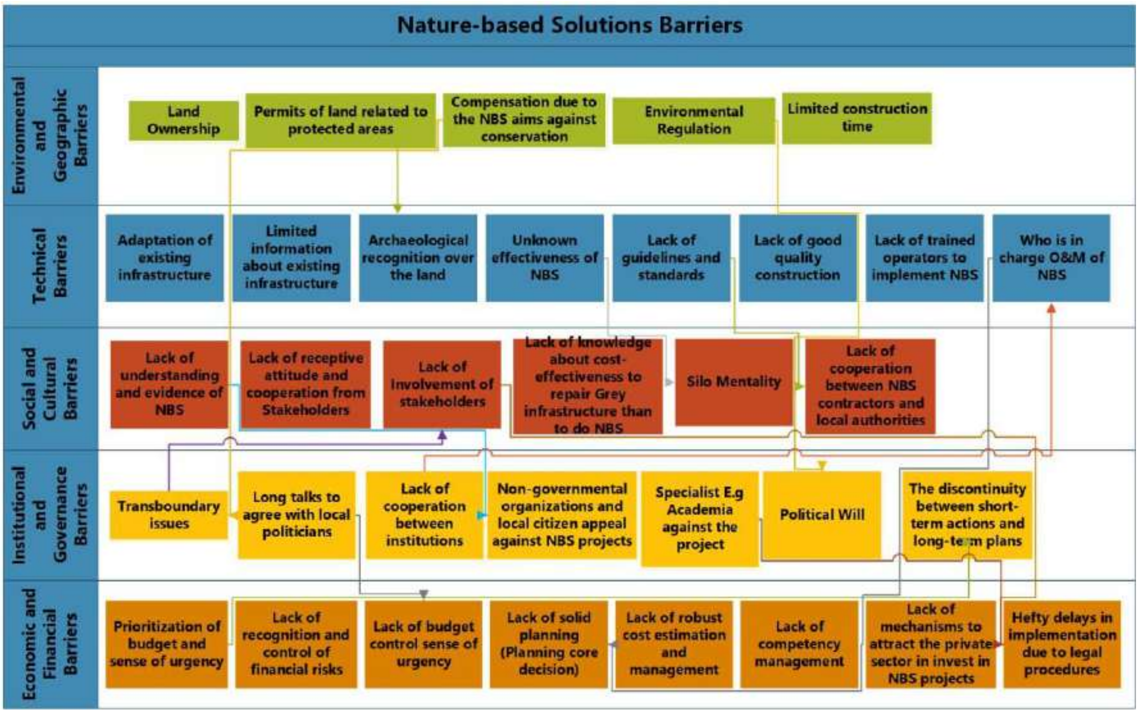

Figure 22 Mapping of barriers as identified by IHE-Delft (Hernandez, 2021).

Table 10 Definition of barriers as identified by IHE-Delft (Hernandez, 2021).

	Definition
Environmental and Geographic barriers	
Land ownership	Private or public ownership.
Permits of land/protected areas	Legislation might go against modifying or altering areas, e.g., for conservation purposes such as Natura 2000.
Compensation	Has a direct effect on implementation cost if monetary compensation is necessary, ultimately making the project more expensive?
Environmental regulation	National and international regulation are not aligned to facilitate the change from grey infrastructure to green infrastructure and/or more oriented towards legislation than practical solutions.
Limited Construction time (E.g., Season)	Implementing NbS projects can be crucial depending on the project's location, which can limit construction time due to, e.g., flooding issues in winter (Seasonal variation).
Social and Cultural barriers	
Lack of understanding and evidence of NbS	The government at various levels do not have clarity about legal and administrative procedures to implement NbS; questions related to legal instruments and requirements are often present in the project's investigation and planning phases. On the other hand, the knowledge about effectiveness, side effects, benefits and co-benefits is hardly known by the parts involved in the project phases.

	Definition
Lack of receptive attitude/cooperation	There are always challenges depending on who is interested and involved. This could be related to culture perception. For example, communities feel better protected by grey infrastructure.
Lack of involvement of stakeholders	The stakeholder's participatory involvement in addressing the societal challenges for the particular project location is crucial for successfully implementing NbS.
Lack of knowledge about cost-effectiveness	Comparison between grey infrastructure and NbS is complex due to the difficulty in monetizing the benefits and the cost reduction in comparison with the grey infrastructure.
Institutional and Governmental barriers	
Transboundary issues	More than one government involved.
Long talks to agree with local politicians	The long talks between local politicians and project managers can be an exhausting and long process until an agreement is reached.
Lack of cooperation between institutions	No clear boundaries of duties between institutions, hindering and/or complicates cooperation.
NGOs and local citizens appeal	Conservation organizations, or similar, could be against the project and thus appealing against its execution.
Specialist, academia could be against	Professors with expertise in the field could be against the project.
Political will	Considering the high cost of investment in the implementation of NbS, political decision-makers are more interested in less expensive measures with short-term outcomes that can be shown during their governmental mandate.
Short-term actions vs. long-term plans	The discontinuity between short-term plans and long-term goals is a critical barrier in the uptake of NbS, considering that the planning, implementation, and maintenance of NbS requires an extensive period; this goes against the short-termism of many municipal, regional, and national administrations culture.
Economic and Financial barriers	
Prioritization of budget and Sense of urgency	The low sense of urgency among political decision-makers is commonly found as a barrier. The perceived high cost of NbS is found in politicians worldwide; the common perception is that the implementation and especially the operation and maintenance phase of NbS is more expensive than grey infrastructure.
Lack of recognition/control of financial risks/budget	The lack of recognition and control of financial risks in NbS projects makes them a risky proposition for investors. It decreases the performance of structuring the NbS measures as a bankable opportunity
Lack of solid planning (Planning core decision)	The planning decision must include everything to make a project feasible, such as good governance, identification of barriers, fundraising and partnership, the actor involved, technical aspects etc.
Lack of robust cost estimation and management	The lack of robust cost estimation and management is directly linked to the previous financial barrier, commonly NbS project has three main costs: cost of planning, capital investment (implementation) and operational cost. If these costs are not analyzed and covered as part of the planning, this could affect the project's performance and life-cycle.
Lack of competency management	Lack of employees with knowledge and skills within management.
Lack of mechanisms to attract the private sector	There are different formats for financing NbS project, these various approaches including public and private owners, quasi-public, agencies developers, constructors, financiers, bankers, investment bankers, and fund managers, included: complex combinations of the public and private sector, debt and equity, sovereign obligations, commitments, statutes, and regulations. and incentives to guarantee the private sector. However, there is evidence that in NbS, the lack of mechanisms to attract the private sector is also connected with the lack of potential

	Definition
	investors involved in the planning process and the governance capacity.
Delays in implementation due to legal procedures	Delays in the implementation due to legal procedures linked with obstacles regarding actors against the NbS project, e.g., farmer communities refuse to move from their lands and go to court to appeal against the project. This influence negatively the financial and economic aspects of the NbS project considering the costs of these procedures.
Technical barriers	
Adaption of infrastructure/limited information	Adaption of infrastructure (grey) to NbS can be difficult as data or technical details on existing infrastructure is limited.
Archaeological recognition over the land	Archaeological value of land potentially delays or hinders the implementation of NbS.
Lack of guidelines and standards	Guidelines and standards are essential in all project phases to provide the best conditions for planning and implementing NbS.
Lack of good quality construction	The lack of high-quality materials increases the need for more frequent maintenance, ultimately increasing the cost.
Accessibility for construction and maintenance	Some potential NbS locations may be difficult to reach, and thus hinders the accessibility for construction and maintenance. Ultimately this increases the costs.
Lack of trained operators to implement NbS	Professionals and operators do not have the experience and knowledge required, which increases the cost of the project, e.g., by hiring externally or training/educating operators.

10.2 Annex 2: Results of RECONECT survey on co-creation

Results from the D4.3 RECONECT survey on innovative strategies for co-creation, upscaling and amplification are presented on Figure 23. In this survey, barriers were grouped into categories that RECONECT can influence, i.e., awareness and knowledge, finances, and lack of standards and capacities. The “Other barriers” are more difficult to influence, as they are institutionally decided (e.g., environmental regulation) or related to practical working environments (e.g., construction time).

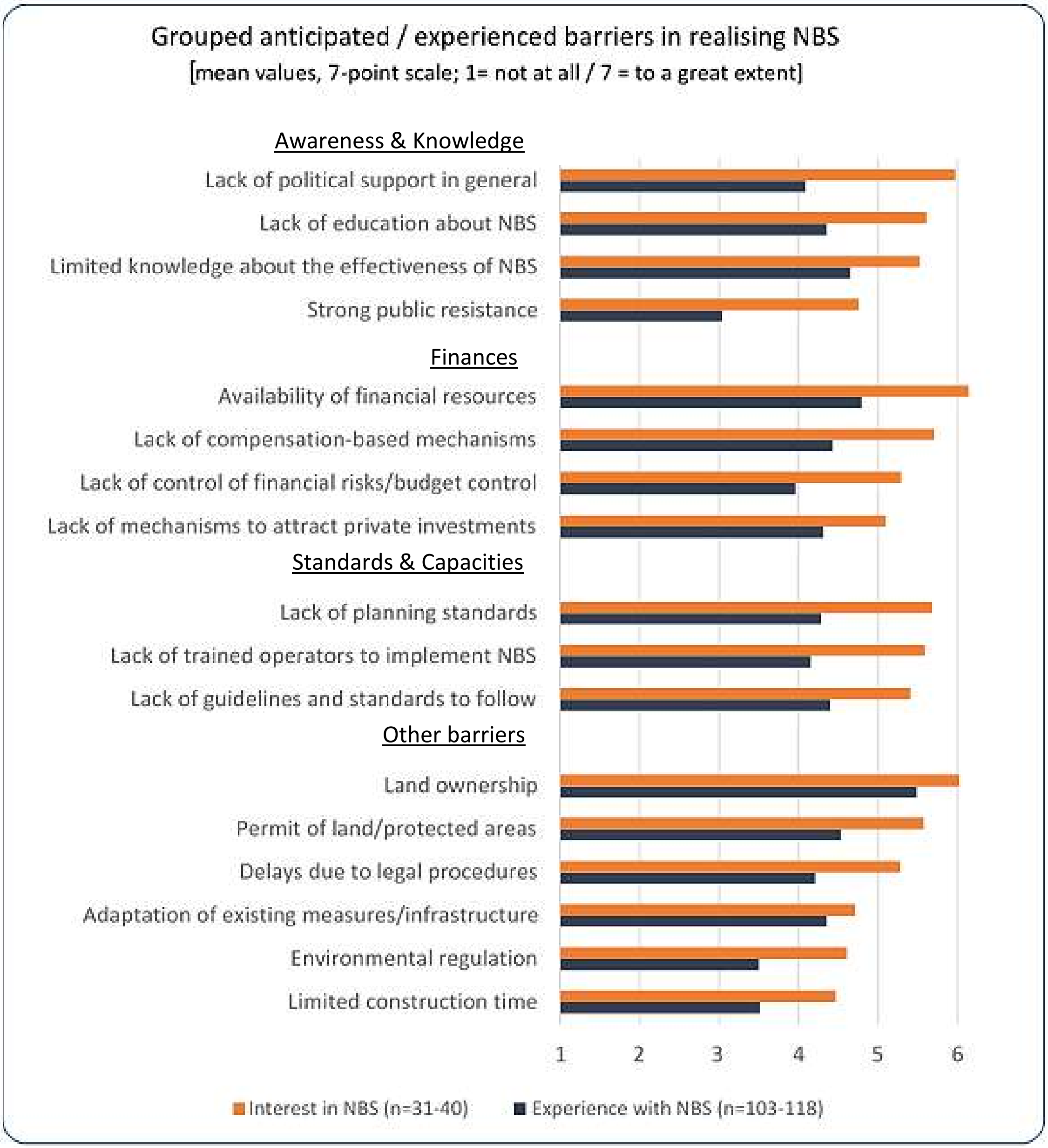

Figure 23: Results of RECONECT survey on innovative strategies for co-creation, upscaling and amplification presenting the identified barriers for NbS implementation.
(UFZ, 2021)

Overall, results indicate that stakeholders with an interest in NbS (but no experience) perceive barriers as more severe than stakeholders with experience in realizing NbS. It also appears that both types of stakeholders (e.g., with and without experience) identified land ownership and availability of finances as one of the main barriers. Although stakeholders with no previous experience identified political support as an important barrier, stakeholders with experience identified limited knowledge on NbS as a more relevant barrier.

To set the ground for the present deliverable, and to facilitate knowledge and experience dissemination within the RECONECT network of cases, Ramboll surveyed Demonstrators on barriers and enablers. This allowed to cross-check and compare results from the Room for the River and UFZ RECONECT Survey with insights from Demonstrators.

10.3 Annex 3: Survey to assess enablers/barriers with Demonstrators

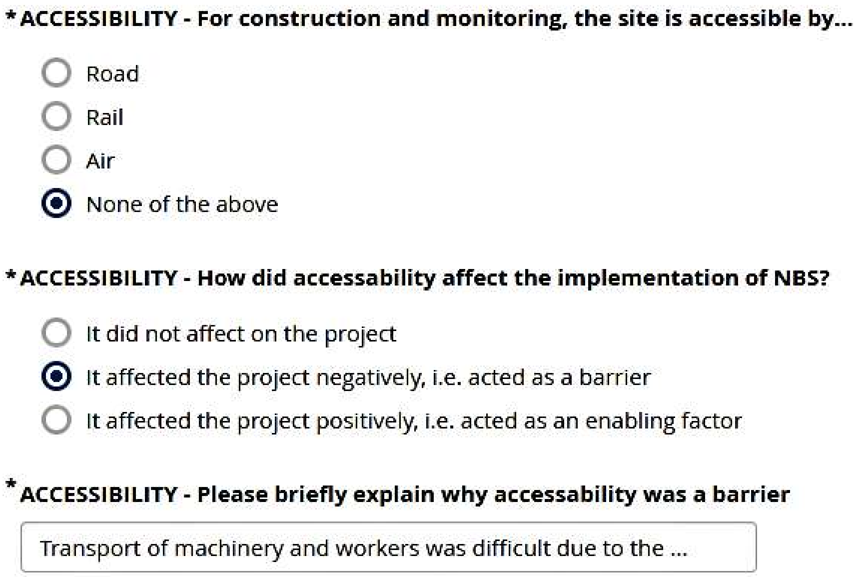

Figure 24: Screenshot of online survey to assess enablers and barriers with RECONECT Demonstrators.
Exemplary questions related to accessibility are shown.

Table 11: Detailed questions of survey to assess enablers and barriers with RECONECT Demonstrators.

Question	Answer 1	Sub-question	Answer 2
OWNERSHIP			
Who owned the land before NbS implementation? (Multiple choices possible)	Private landowners (residential) Private landowners (commercial) Private landowners (agricultural) Public authority (local) Public authority (regional) Other: …		
Who owns the land after NbS implementation? (Multiple choices possible)	Private landowners (residential) Private landowners (commercial) Private landowners (agricultural) Public authority (local) Public authority (regional) Other: …		
How did land ownership affect the implementation of NbS?	It did not influence the implementation It affected the project negatively, i.e., acted as a barrier It affected the project positively, i.e., acted as an enabling factor	Please briefly explain why ownership was a barrier: … Please briefly explain why ownership was an enabling factor: …	
ACCESSIBILITY			
For construction and monitoring, the site is accessible by…	Road Rail Air None of the above		
How did accessibility affect the implementation of NbS?	It did not affect the project It affected the project negatively, i.e., acted as a barrier It affected the project positively, i.e., acted as an enabling factor	Please briefly explain why accessibility was a barrier: … Please briefly explain why accessibility was an enabling factor: …	
RISK AWARENESS			
If there was any, do you recall when was the last extreme hydro-meteorological (e.g., flood or drought that affected local stakeholders) event in the region?	Yes No, there weren't any No, I don't recall	In which year did it take place? …..	
Where was the last extreme hydro- meteorological (e.g., flood or drought that affected local stakeholders) event in the region?	In the location of the NbS In the same region as the NbS In the same country as the NbS I don't know		
Did the previous experience of extreme events (such as flooding, drought etc. that affected local stakeholders significantly) increase or decrease acceptance of NbS amongst stakeholders?	It decreased acceptance of NbS It increased acceptance of NbS	Please briefly explain why previous extreme events decreased acceptance: … Please briefly explain why previous extreme events increased acceptance: …	

Question	Answer 1	Sub-question	Answer 2
EXPERIENCE			
Prior to the NbS project, were there other NbS implemented in the region or country?	No	Did lack of experience hinder the implementation of NbS, i.e., did it act as a barrier?	Yes/No
	Yes, in the same region	At what scale? (multiple answers possible)	Small-scale NbS (e.g., urban level) Large-scale NbS
		Has the main authority involved in this NbS project been involved in the previous project?	Yes No
		Has the previously implemented NbS facilitated this project, e.g., through knowledge transfer?	Yes No
	Yes, in the same country	At what scale? (multiple answers possible)	Small-scale NbS (e.g., urban level) Large-scale NbS
		Has the main authority involved in this NbS project been involved in the previous project?	Yes No
		Has the previously implemented NbS facilitated this project, e.g., through knowledge transfer?	Yes No
KNOWLEDGE			
Did the involved stakeholders have prior knowledge of NbS?	No	Did lack of knowledge hinder the implementation of NbS, i.e., did it act as a barrier?	Yes No
	Yes	Did the main authority involved in the project have prior knowledge of NbS?	Yes, to a high degree Yes, partly No
		Did the other involved authorities / stakeholders have prior knowledge of NbS?	Yes, to a high degree Yes, partly
RESISTANCE			
Was there resistance from stakeholders? (multiple answers possible)	No		
	Yes, from responsible organizations	Please specify the reason for resistance from the different stakeholders: (multiple answers possible)	Conflict of interests Skepticism regarding the effectiveness of NbS to reduce hydro-meteorological risks Skepticism regarding societal co-benefits of NbS Skepticism regarding environmental co-benefits of NbS Other: …
	Yes, from the public/ local population	Please specify the reason for resistance from the different stakeholders: (multiple answers possible)	Conflict of interests Skepticism regarding the effectiveness of NbS to reduce hydro-meteorological risks Skepticism regarding societal co-benefits of NbS Skepticism regarding environmental co-benefits of NbS Other: …
	Yes, from private stakeholders	Please specify the reason for resistance from the different stakeholders: (multiple answers possible)	Conflict of interests Skepticism regarding the effectiveness of NbS to reduce hydro-meteorological risks Skepticism regarding societal co-benefits of NbS Skepticism regarding environmental co-benefits of NbS Other: …
	Yes, from elected politicians	Please specify the reason for resistance from the different stakeholders: (multiple answers possible)	Conflict of interests Skepticism regarding the effectiveness of NbS to reduce hydro-meteorological risks Skepticism regarding societal co-benefits of NbS Skepticism regarding environmental co-benefits of NbS Other: …

Question	Answer 1	Sub-question	Answer 2
MOTIVATION			
Which stakeholders were motivated to realize NbS? (multiple answers possible)	None Responsible organizations	Please specify the reasons for support from the different stakeholders: (multiple answers possible)	Financial incentives Expectation of job creation Expectation of increased tourism Expectation of environmental co-benefits, e.g., increased biodiversity Expectation of societal co-benefits, e.g., increased recreational value Other: …
	Private stakeholders	Please specify the reasons for support from the different stakeholders: (multiple answers possible)	Financial incentives Expectation of job creation Expectation of increased tourism Expectation of environmental benefits, e.g., increased biodiversity Expectation of societal benefits, e.g., increased recreational value Other: …
	General public / local population	Please specify the reasons for support from the different stakeholders: (multiple answers possible)	Financial incentives Expectation of job creation Expectation of increased tourism Expectation of environmental benefits, e.g., increased biodiversity Expectation of societal benefits, e.g., increased recreational value Other: …
	Elected politicians	Please specify the reasons for support from the different stakeholders: (multiple answers possible)	Financial incentives Expectation of job creation Expectation of increased tourism Expectation of environmental benefits, e.g., increased biodiversity Expectation of societal benefits, e.g., increased recreational value Other: …
INCENTIVES			
Were there financial incentives for implementing NBS in place?	No Yes, on local / regional / national level	What kind of financial incentives were in place?	Policy frameworks (public or private investments) Public-private partnerships Business case (NbS was cheaper than a grey solution) Tax incentives Other: …

Table 12: Information regarding enablers and barriers for each Demonstrator.
All colored text is information that was gathered in the survey. All other text (in black) stems from the previous deliverables D2.2 and D2.3.

	Barriers	Enablers	Incentives	Neutral effect	Land ownership	Inconsistencies
DA1: Dove/Gosse Elbe Estuary	Conflicts with existing land uses (recreation and agriculture) Resistance from private stakeholders due to conflict of interest	High motivation on personal, organizational, and political level (confirmed) Expectation of increased tourism Expectation of environmental benefits, e.g., increased biodiversity Expectation of societal benefits, e.g., increased recreational value Sound knowledge of NbS with focus on water-related aspects (not confirmed - see inconsistency) Risk awareness Experience with NbS	YES: Incentives: Policy Frameworks (public or private investments)	Land ownership Accessibility Knowledge	Private landowners (residential) Private landowners (commercial) Private landowners (agricultural) Public Authority (regional) No change of ownership prior and after NbS	Knowledge: survey results revealed that stakeholders had no prior knowledge of NbS and that Knowledge of lack of it did not affect the implementation while this was mentioned as an enabling factor in D2.2 and D2.3. results
DA2: Odense Coastal Area	(no barriers identified so far) Land ownership: All actions to be done are dependent on negotiations with the private landowners. Resistance from private stakeholders due to conflict of interests, skepticism regarding societal co-benefits of NbS Lack of experience Lack of Knowledge	Strong cooperation approach and citizen involvement High motivation on personal, organizational, and political level Responsible organization: Expectation of environmental benefits, e.g., increased biodiversity Expectation of societal benefits, e.g. increased recreational value Private Stakeholders: financial incentives Elected politicians: Financial incentives Expectation of environmental benefits, e.g., increased biodiversity Expectation of societal benefits, e.g. increased recreational value General public: Expectation of environmental benefits, e.g., increased biodiversity Expectation of societal benefits, e.g. increased recreational value Sound knowledge of NbS on general level (not confirmed - see inconsistency) Risk awareness - prior extreme event in 2013 increased acceptance toward NbS	YES Policy Frameworks (public or private investments) Public-Private Partnerships Others: The implementation of the NbS would also help implementation of other plans in relation to the habitat and the bird directive	Accessibility	Private land ownership (agricultural) No change of ownership	Knowledge: survey results revealed that stakeholders had no prior knowledge of NbS, and that lack of knowledge hindered the implementation while this was mentioned as an enabling factor in D2.2 and D2.3. results
DA3: Tordera River Basin	Skepticism from stakeholders regarding the effectiveness of NbS for flood protection Land ownership: change of land ownership to implement NbS from private (commercial and agricultural) to Public (Public Authority regional) --> Farmers and campsite owners, whose land will have to be expropriated to build the NbS, will, most likely, be against its implementation. In this sense, a thorough negotiation process with key stakeholders will be required. Risk awareness: After being affected by extreme flooding in January and April 2020, some key stakeholders (farmers) demand to public agencies higher levees and the dredging of the riverbed. They are not opened to lose part of its agricultural land, to provide more space to the river. Lack of experience with NbS Resistance from private stakeholders due to conflict of interests	High motivation on personal and organizational level (not political), i.e., from responsible organizations Expectation of environmental benefits, e.g., increased biodiversity from responsible organizations Sound knowledge of NbS with focus on water-related aspects (CONFIRMED)	NO	Accessibility	Prior to NbS: private (commercial and agricultural) For NbS implementation: Public (Public Authority regional) Change of ownership	
DA4: Portofino Regional Natural Park	Low interest in NbS of relevant stakeholder Fear that open communication of hydrometeorological risks will negatively affect tourism Complex structure of private and public land ownership (not confirmed), with resistance from private landowners (confirmed) Low financial capacity Accessibility: due to the spread nature of the NbS accessibility mainly by footpath, depending on the kind of intervention it acted as a barrier Lack of prior Knowledge of NbS acted as a barrier	High motivation on personal and organizational level (not political) Motivation from private stakeholders: Expectation of environmental benefits, e.g., increased biodiversity Expectation of societal benefits, e.g., increased recreational value Sound knowledge of NbS on project level Increased public acceptance due to recent experience of extreme weather events - Risk Awareness Land ownership affected the project positively due to the collaborative attitude of the different owners (contrasting with barriers mentioned in D2.3.) Prior experience with NbS	NO	Resistance	Due to the spread nature of NbS multiple type of land ownership: private-association, private-cultural heritage foundation, public No change of ownership	Land ownership was mentioned as a barrier in D2.2 and D2.3. while it was mentioned as an enabling factor in the surveys conducted in D5.5.

	Barriers	Enablers	Incentives	Neutral effect	Land ownership	Inconsistencies
DB1: Ijssel River Basin	Coordination of large stakeholder group	(no information)	NO	Accessibility	Private landowners (residential) Private landowners (commercial) Private landowners (agricultural) Public Authority (local) Public Authority (regional) No change of ownership	In the survey it was mentioned that the accessibility did not affect the project while in the results from D2.2 and D2.3 poor accessibility was mentioned as a barrier
	Resistance from private landowners (Confirmed - Some private owners receive tax for the trees, so they didn't agree with removing the trees)	- Risk awareness due to prior extreme events in the region in 2018				
	Land ownership issues: Some owners did not agree with removing trees because of some tax benefits	- Prior Experience with NbS				
	Poor accessibility (road, it did not affect the project)	Motivation from responsible organizations: Expectation of increased tourism Expectation of environmental benefits, e.g., increased biodiversity Expectation of societal benefits, e.g., increased recreational value				
	Financing is unclear, also for maintenance					
DB2: Inn River Basin	Low level of resistance, due to skepticism from stakeholders regarding the effectiveness of NbS for flood protection	NbS largely accepted as state of the art and extensive experience (confirmed)	YES Policy Frameworks (public or private investments) Others: the afforestation is a complementary implementation to the construction of a retention wall/basin	Ownership Resistance	Private landowners (agricultural) Public Authority (local) No change of ownership	
	Accessibility to site: The area being located in a mountainous torrential catchment was by nature difficult to access. Still, the WLV (stakeholder and implementing party) is used and trained to especially work in such an environment	High motivation on personal, organizational, and political level (confirmed)				
		Sound knowledge of NbS (Confirmed)				
		Sound financial capacities				
		Risk awareness: increased public acceptance due to experience of extreme weather events				
		No resistance from stakeholders				
DB3: Aarhus, Egå Engsø and Lystrup	Resistance from private landowners (land was consolidated to overcome voluntary agreements)	Strong cooperation approach and citizen involvement	YES Business Case (NbS was cheaper than a grey solution)	Accessibility Knowledge	Prior to NbS: Private landowners (residential) Public Authority (local) After NbS: Public Authority (local) change of ownership: Public authority bought part of the private land	Knowledge was mentioned as an enabler in D2.2 and D2.3. while in the survey's prior knowledge of NbS was mentioned as a neutral factor towards NbS implementation
	Low financial capacities	High motivation on personal, organizational, and political level				
	Political resistance due to conflicting interests	Sound knowledge of NbS (not confirmed/ seen as neutral in survey)				
	Coordination and cooperation of different municipal departments	Sound financial capacities				
		Land ownership: Areas in Lystrup where primarily owned by Aarhus Municipality both before and after implementation. This made the implementation process easier that it probably would have been if the areas have been owned by private landowners. One of the planned project areas in Lystrup was never realized because the private owner did not want the project. In Lake Egå the majority of the area was owned by private landowners before the project. But because of a large land-exchange project initiated because a new highway was to be built, the private ownership was not a problem. Land-exchange was made rather easily between private landowners and public landowners. Now the area is owned by Aarhus Municipality.				
		Experience in working with NbS				
DB4: Thur River Basin	Skepticism from some stakeholders regarding the effectiveness of NbS for flood protection (resistance mentioned as a neutral factor in surveys)	NbS widely accepted	YES Policy Frameworks (public or private investments)	Accessibility Resistance	Prior to NbS: Private landowners (agricultural) Public Authority (local) Public Authority (regional) After NbS: Public Authority (regional) Change of ownership	None of the factors included in the survey were mentioned as barriers, these were seen as enablers or as having neutral impacts. Inconsistency with results of D2.2 and D2.3 where skepticism from stakeholders was mentioned as a barrier while resistance in the survey was mentioned as not having an impact on NbS implementation.
		High motivation on scientific, organizational, and political level (responsible organization, elected politicians, general public/local population)				
		Scientific expertise regarding monitoring, evaluation, and communication				
		Land ownership: the two involved cantons bought and/or exchanged the required land from private owners and communities to be able to implement the NbS without risking liability issues.				
		Increased public acceptance due to experience of extreme weather events (flooding affected agriculture negatively and caused property loss for communities.)				

	Barriers	Enablers	Incentives	Neutral effect	Land ownership	Inconsistencies
DB5: Var Éco-Vallée	(no information)	Relatively high motivation on political and institutional level (responsible organizations)	YES Business Case (NbS was cheaper than a grey solution)	Ownership Accessibility	Prior to NbS: Private landowners (agricultural) Public Authority (regional) After NbS: Public Authority (local) Public Authority (regional) Change of ownership	
	Lack of prior knowledge of NbS	Expectation of job creation				
	Resistance from public / local population due to: conflict of interests Skepticism regarding the effectiveness of NbS to reduce hydro-meteorological risks Skepticism regarding societal co-benefits of NbS Skepticism regarding environmental co-benefits of NbS	Expectation of increased tourism				
		Expectation of environmental benefits, e.g., increased biodiversity				
		Increased public acceptance due to experience of extreme weather events (1994, 2011)				
DB6: Les Boucholeurs	(no information)	Relatively high motivation on political and institutional level and from private stakeholders Elected officials motivations: Financial incentives Expectation of job creation Expectation of increased tourism Expectation of environmental benefits, e.g., increased biodiversity Expectation of societal benefits, e.g. increased recreational value Private stakeholders motivations: Expectation of increased tourism Expectation of environmental benefits, e.g., increased biodiversity Expectation of societal benefits, e.g. increased recreational value	YES Business Case (NbS was cheaper than a grey solution)	Accessibility	Prior to NbS: Public Authority (regional) After NbS implementation: Private landowners (agricultural) Public Authority (local) Public Authority (regional) Change of ownership	
	Resistance from private stakeholders due to conflict of interest	Land ownership: Significant flooding that occurred in 2010 brought a clear picture that natural solution for reduction of flood risk is essential.				
		Increased public acceptance due to experience of extreme weather events (2010)				

Explanatory text and comments on Table 12:

Cross-checking survey results with deliverables D2.2 and D2.3 allows to complement and discuss further relevant key barriers and enablers during implementation of NbS in Demonstrators.

This assessment confirms and/or complements the previous investigations with the following conclusions:

- **Motivation** from stakeholders was a strong enabler for all respondents (this had not been tracked before for DA2 and DB1);
- **Risk awareness** developing as a result of prior extreme events in the region acted as an enabling factor for 9 of the cases (this had only been tracked for DA4);
- **Prior experience with NbS** acted an enabling factor in 8 of the cases (this had only been tracked under DB2 and DB3),
- **Lack of prior experience with NbS** acted as a barrier in 2 cases (this had been tracked neither for DA2 nor DA3)
- **Resistance from stakeholders** acted a barrier in 7 cases (this had not been tracked for DA2, DB5 and DB6)

Some inconsistencies were also noted as follows:

- ***DA1: Dove/Gosse Elbe Estuar****y:* survey results revealed that stakeholders had no prior knowledge of NbS, and that lack of knowledge did not affect the implementation while sound knowledge of NbS was mentioned as an enabling factor in D2.2 and D2.3 results
- ***DA2: Odense Coastal Area:*** survey results revealed that stakeholders had no prior knowledge of NbS, and that lack of knowledge hindered the NbS implementation while Knowledge was mentioned as an enabling factor in D2.2 and D2.3 results
- ***DA4: Portofino Regional Natural Park****:* Land ownership was mentioned as a barrier in D2.2 and D2.3 while it was mentioned as an enabling factor in the surveys conducted in D5.5. In the survey it was mentioned that: "*land ownership affected the project positively due to the collaborative attitude of the different owners"* while in the previous deliverables *"the Complex structure of private and public land ownership" was identified as a key barrier.* Therefore, it seems that land ownership acted simultaneously as a barrier and enabling factor in this demo case.
- **DB1: Ijssel River Basin**: In the survey it was mentioned that the accessibility did not affect the project while in the results from D2.2 and D2.3 poor accessibility was mentioned as a barrier.
- ***DB3: Aarhus, Egå Engsø and Lystrup***: Knowledge was mentioned as an enabler in D2.2 and D2.3. while in the survey prior knowledge of NbS was mentioned as a neutral factor towards NbS implementation
- ***DB4: Thur River Basin***: None of the factors included in the survey were mentioned as barriers, these were seen as enablers or as having neutral impacts. Inconsistency with results of D2.2 and D2.3 where skepticism from stakeholders was mentioned as a barrier while resistance in the survey was mentioned as not having an impact on NbS implementation.

10.4 Annex 4: Suitability maps

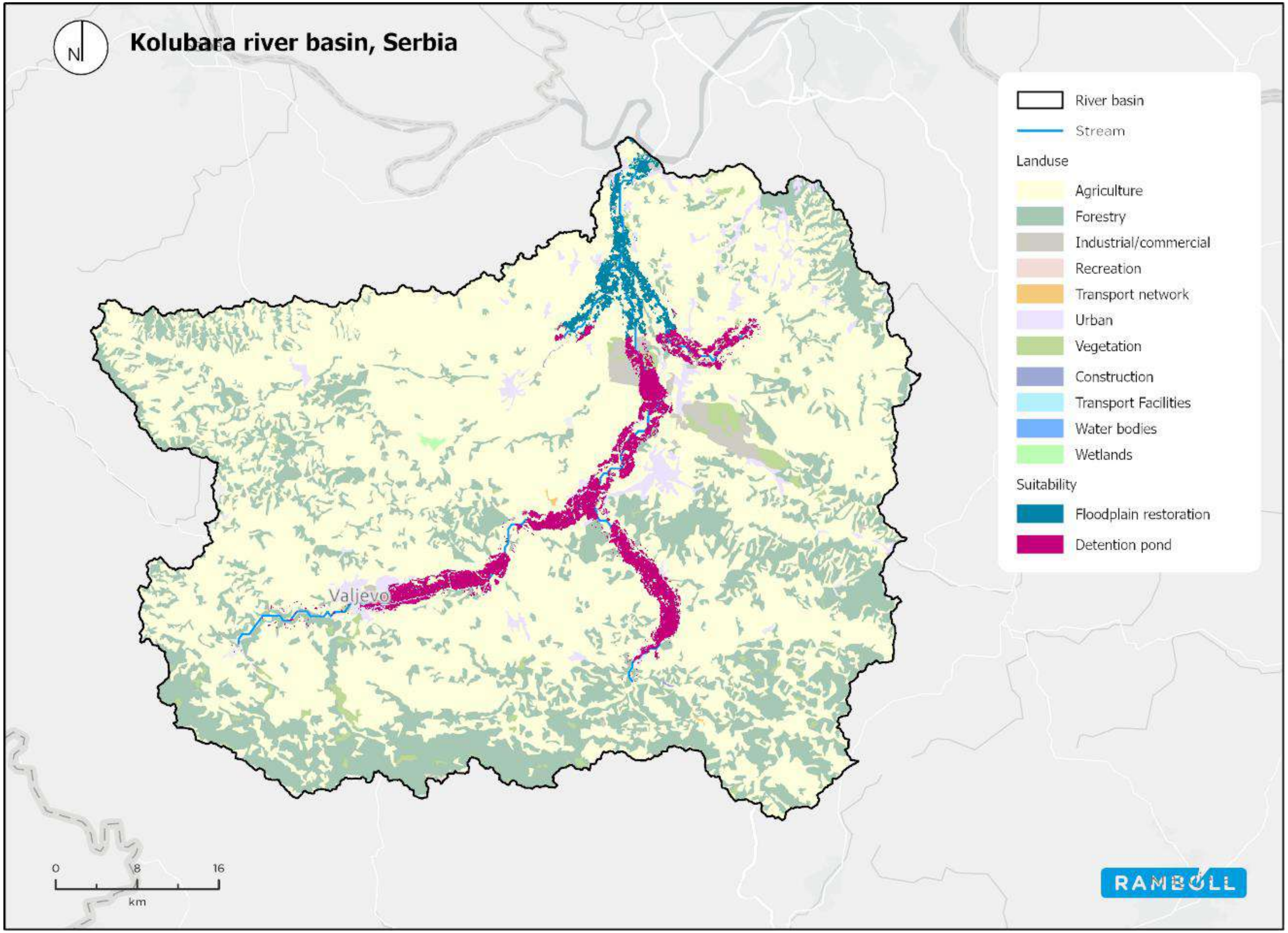

Figure 25 Suitability map of floodplain restoration and detention ponds for Kolubara River Basin.

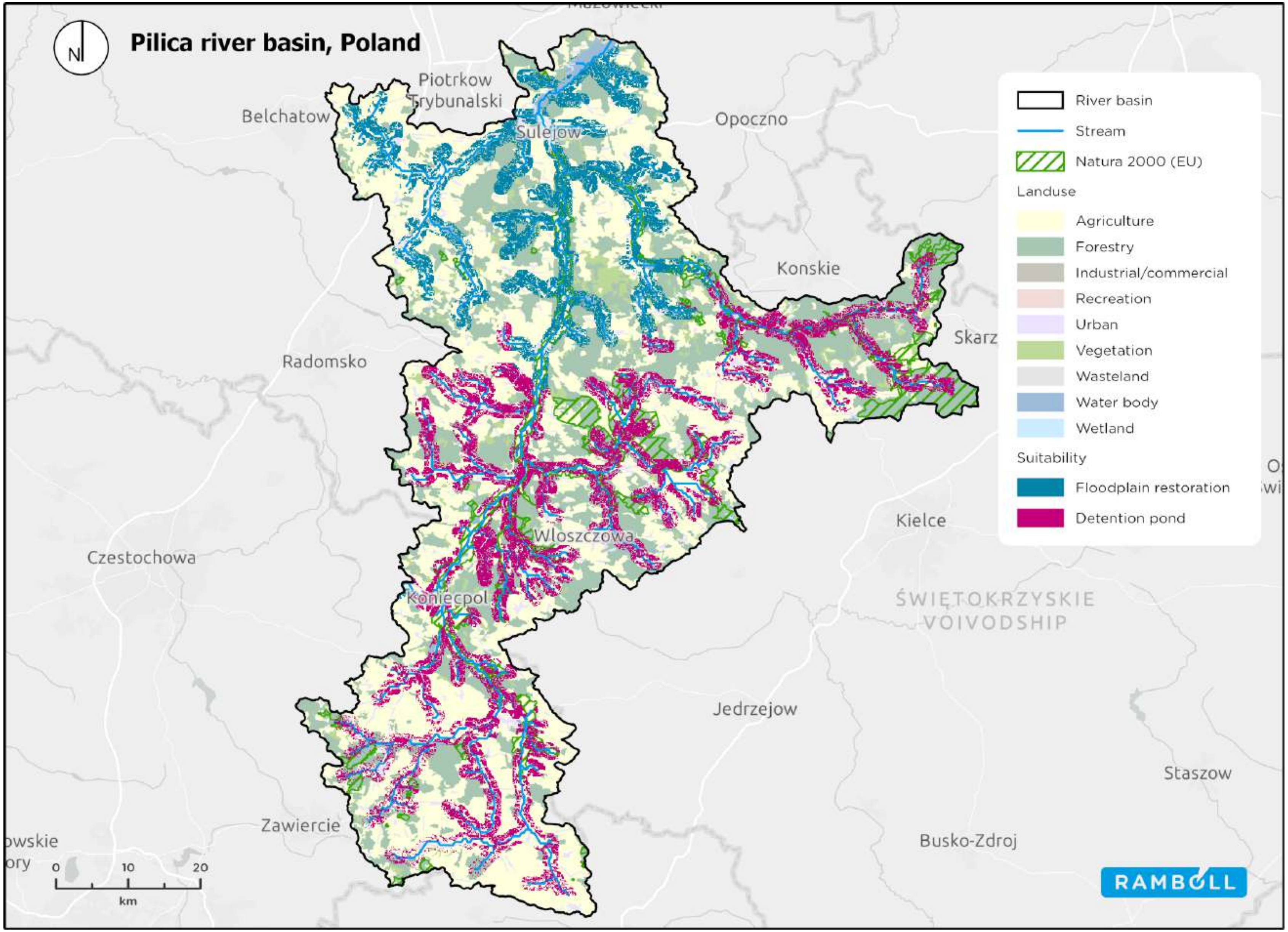

Figure 26 Suitability map of floodplain restoration and detention ponds for Pilica River Basin.

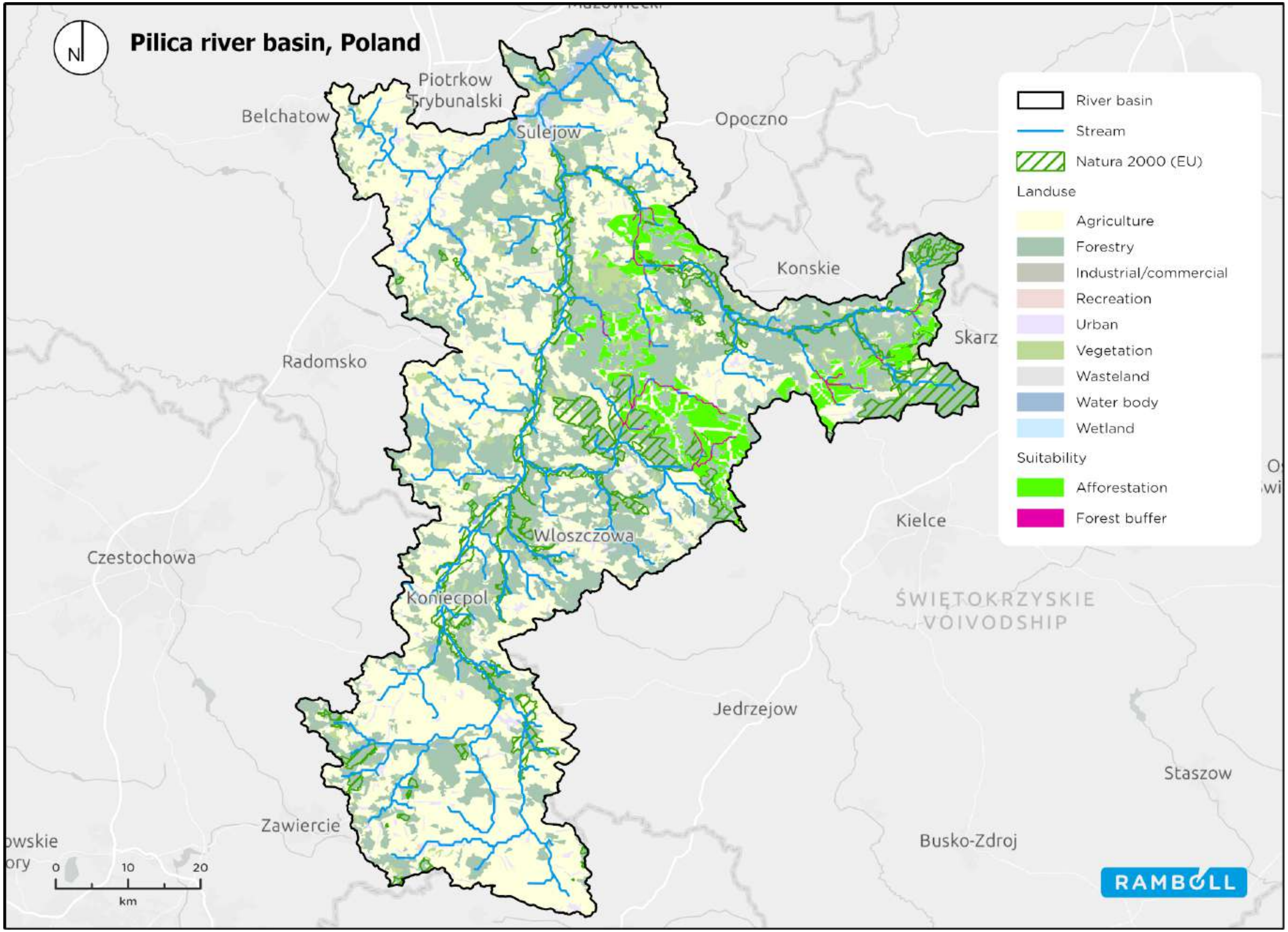

Figure 27 Suitability map of forest buffers and afforestation for Pilica River Basin.

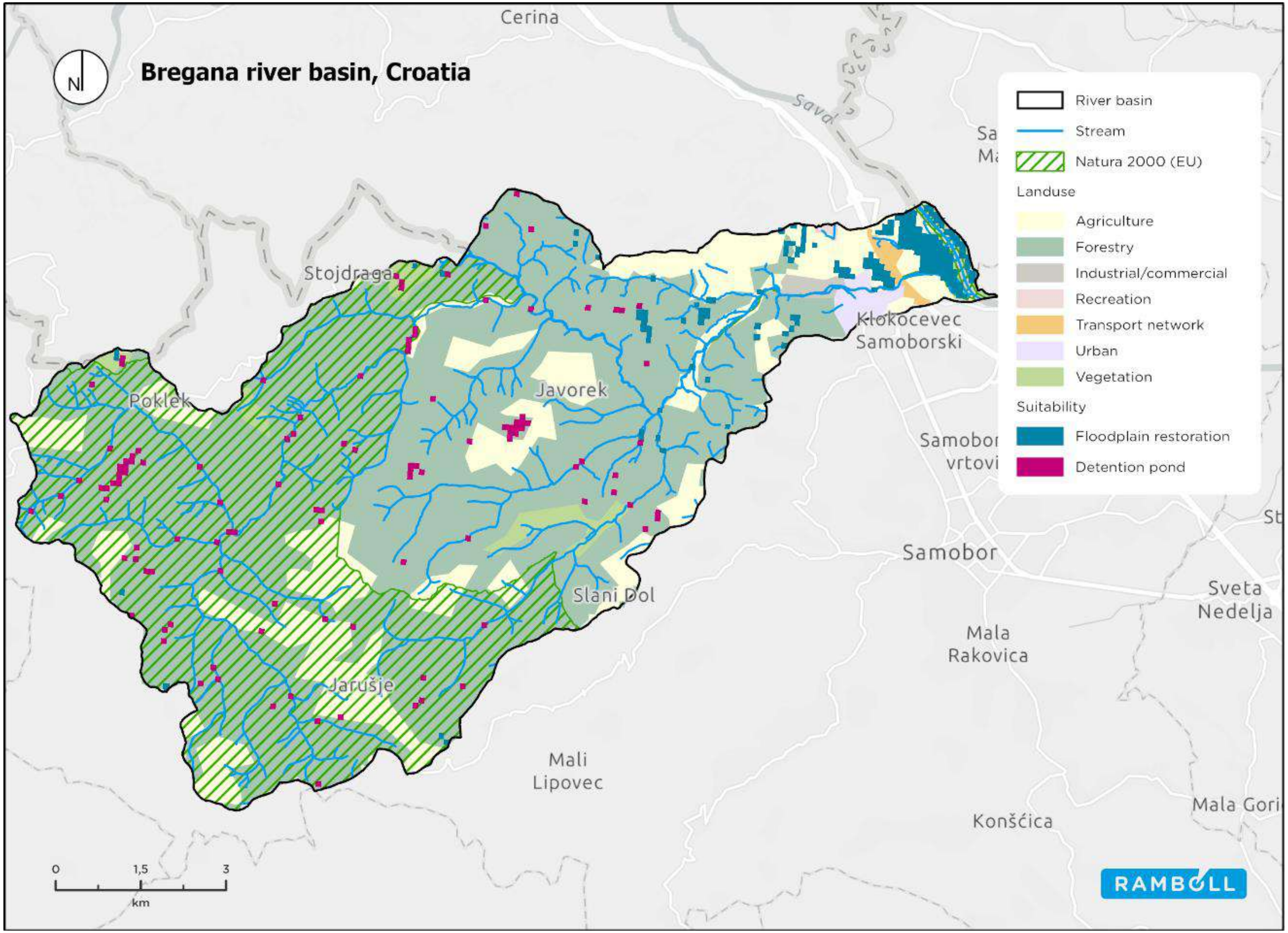

Figure 28 Suitability map of floodplain restoration and detention ponds for Bregana River Basin.

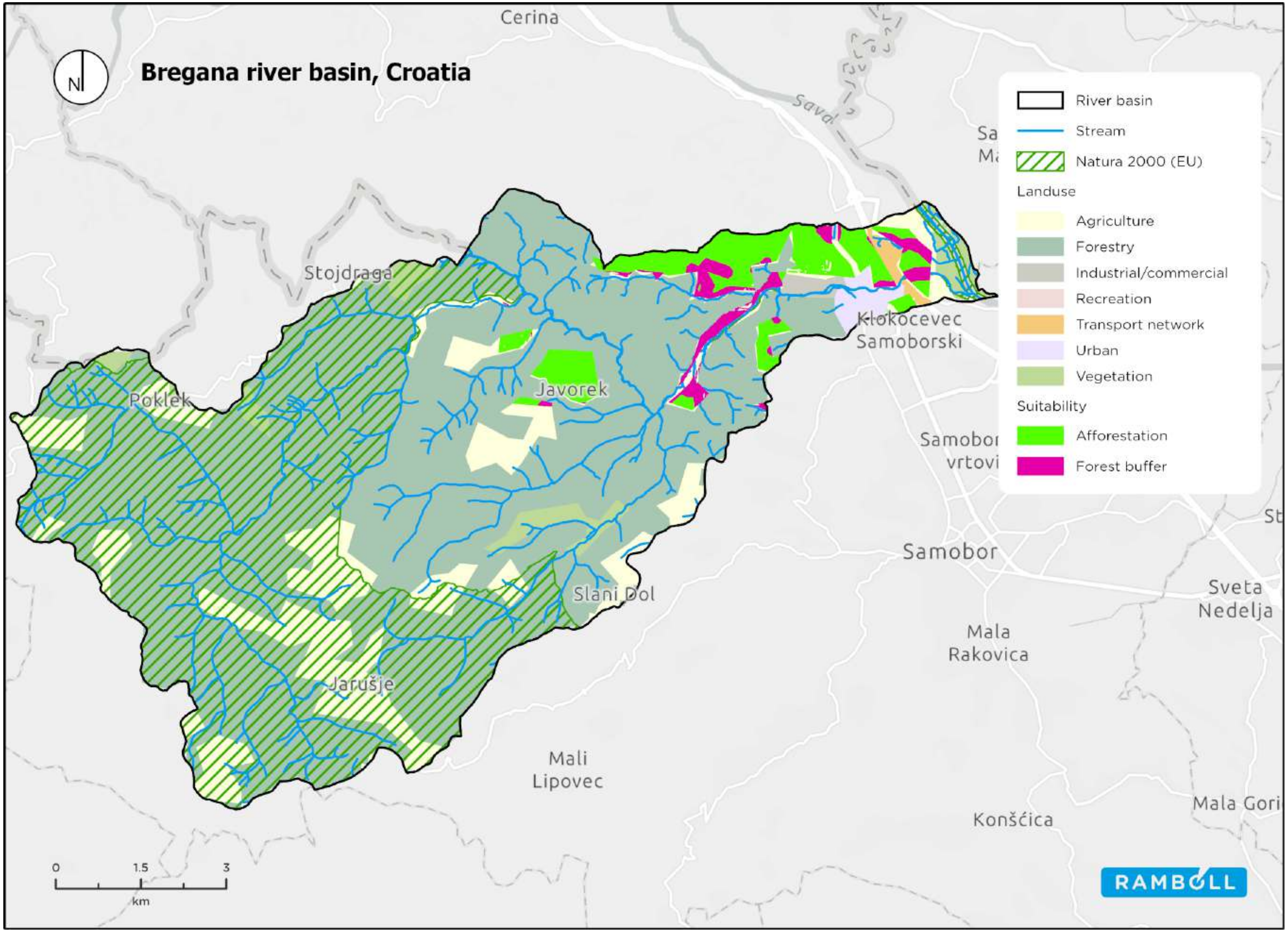

Figure 29 Suitability map of forest buffers and afforestation for Bregana River Basin.

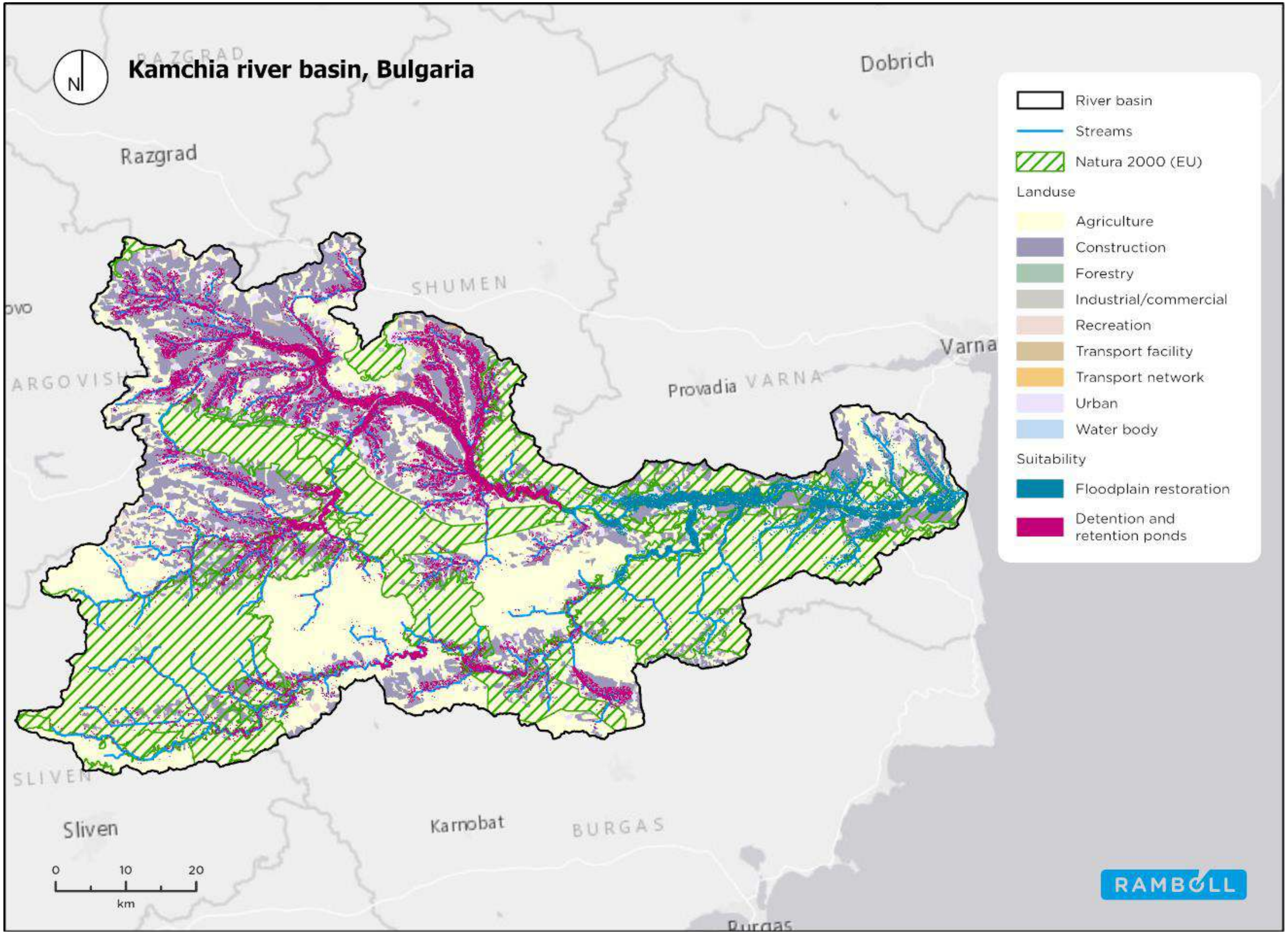

Figure 30 Suitability map of floodplain restoration and detention ponds for Kamchia River Basin.

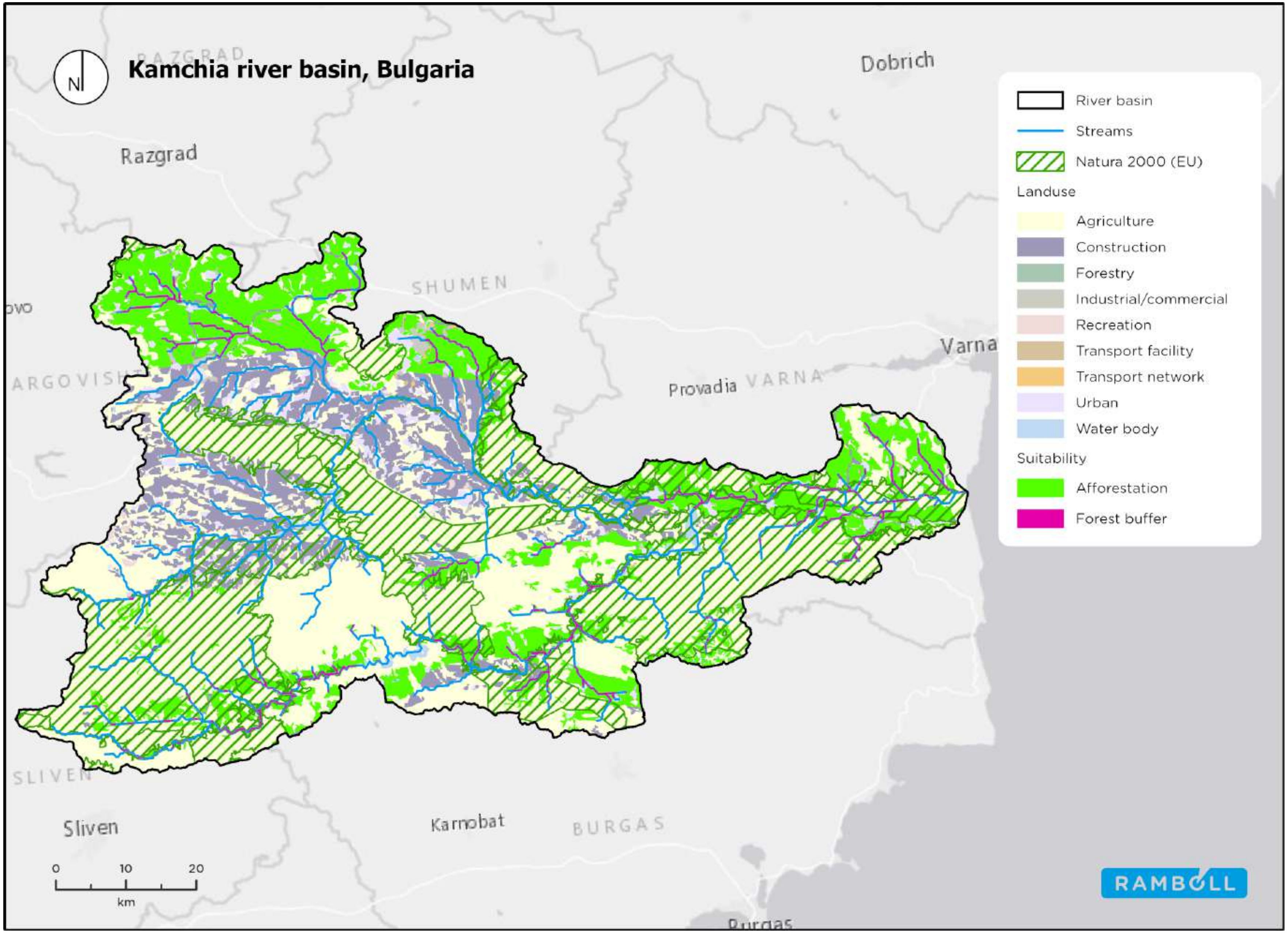

Figure 31 Suitability map of forest buffers and afforestation for Kamchia River Basin.

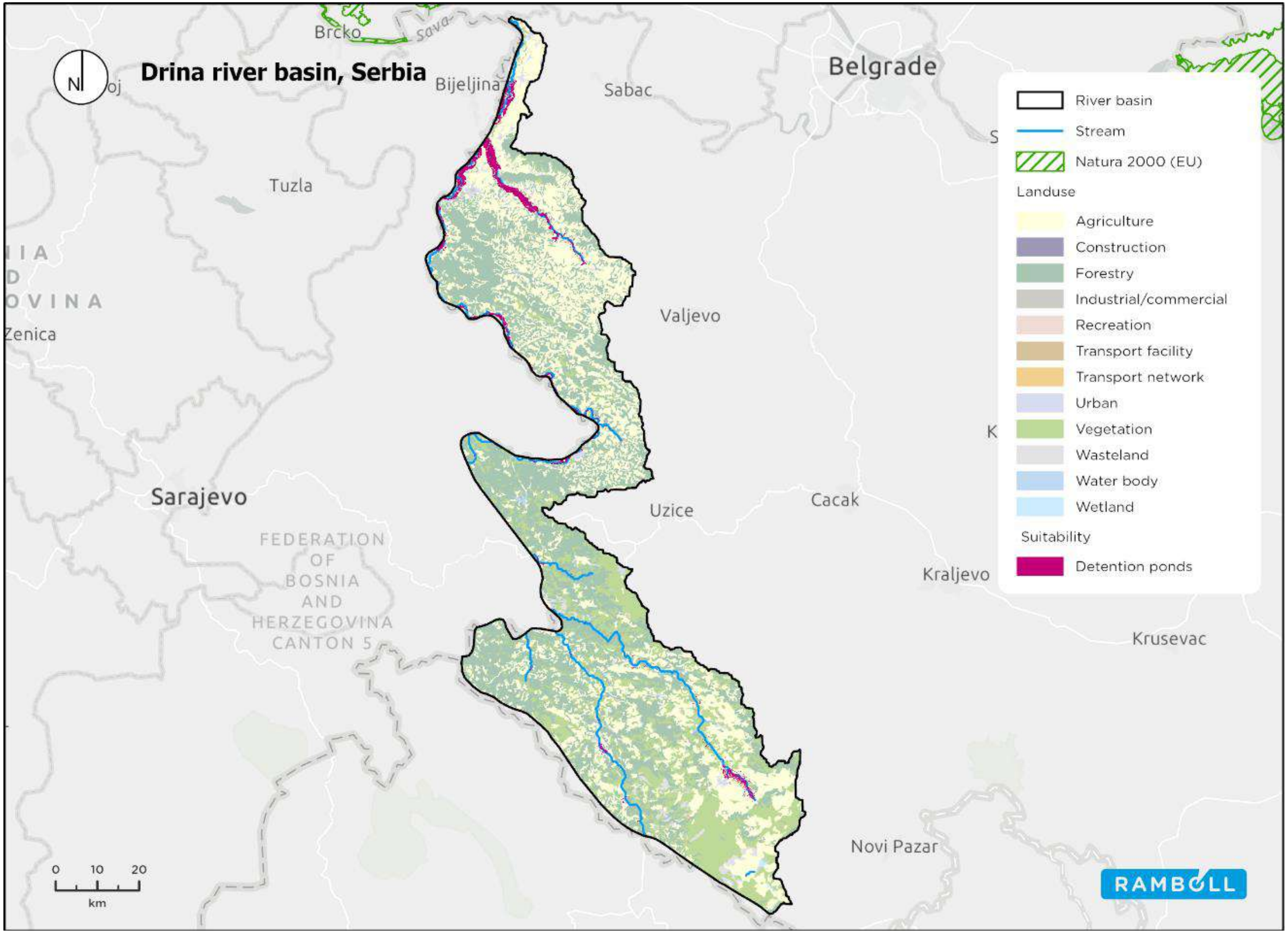

Figure 32 Suitability map of detention ponds for Drina River Basin.

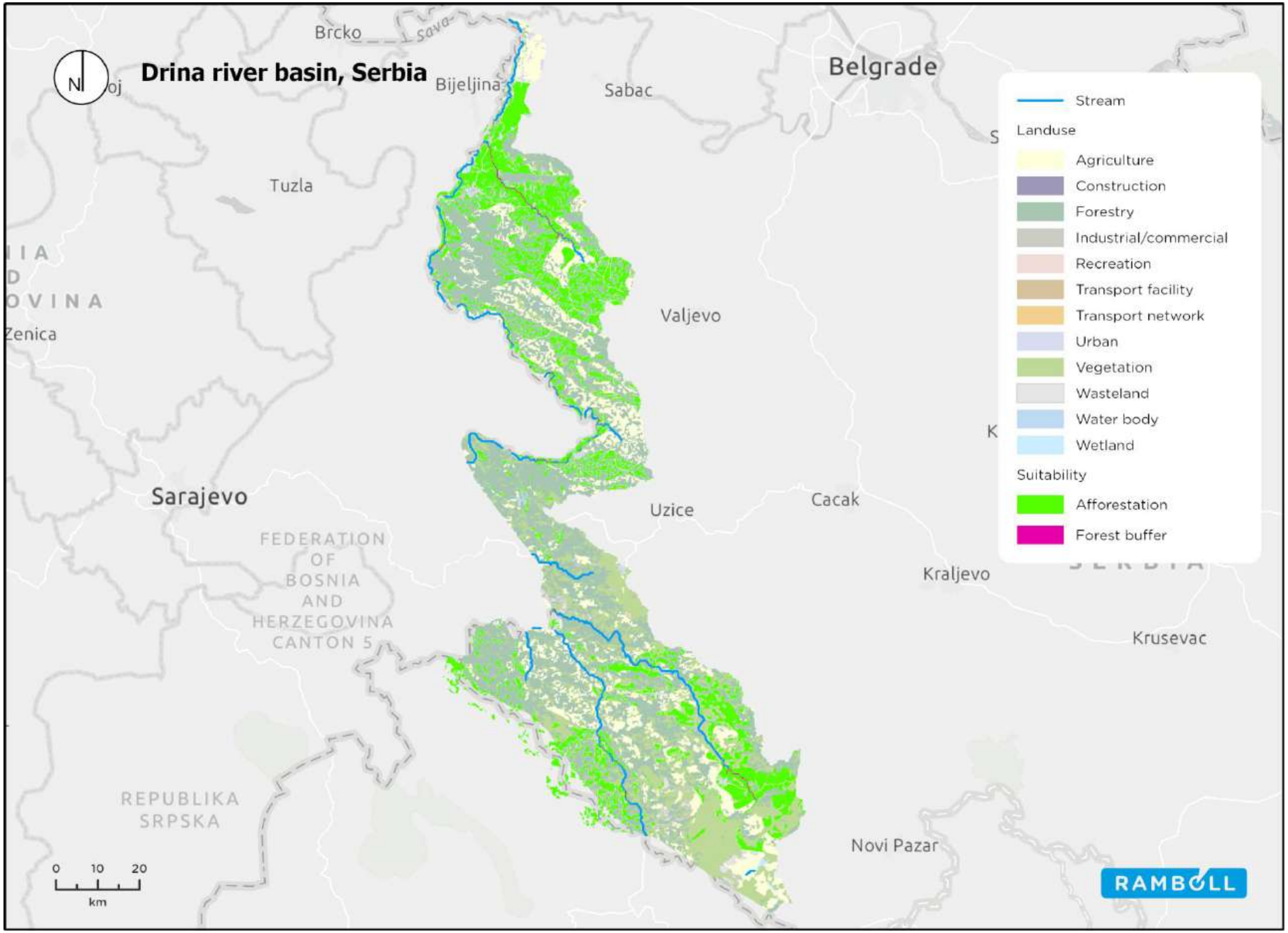

Figure 33 Suitability map of forest buffers for Drina River Basin.

10.5 Annex 5: Details of the workshop with Collaborators

Set-up and participants:

The workshop was organized by Ramboll on the 3rd of August 2021, online. All five EU Collaborators participated. Workshop facilitators were from Ramboll for two of them, and from IHE-Delft for the two others. The workshop followed this schedule:

	Activity
9:00-9:15	Welcome & Introduction
9:15-10:15	Session A – Discussion on survey results (barriers) – 1 room per collaborator
10:15-10:45	Wrap-up session on barriers
10:45-11:00	Break
11:00-12:30	Session B – Discussion on enablers – All together
12:30-13:00	Ways forward & Conclusions

The following participants to part in the workshop:

	Organisation	Country
EU Collaborators		
Jasna Plavsic	University of Belgrade	Serbia
Ivana Radojevic	University of Belgrade	Serbia
Draženka Kvesić	Proning-DHI	Croatia
Ratko Ramuscak	Proning-DHI	Croatia
Lyudmil IKonomov	Black Sea and Danube Development Association (BDCA)	Bulgaria
Valery Penchev	Black Sea and Danube Development Association (BDCA)	Bulgaria
Antoaneta Kirova	Black Sea and Danube Development Association (BDCA)	Bulgaria
Katarzyna Izydorczyk	European Regional Centre for Ecohydrology (ERCE)	Poland
Facilitators		
Alvaro Fonseca	Ramboll	Denmark
Julie Skrydstrup	Ramboll	Denmark
Viviana Franco Hernández	IHE-Delft	Netherlands
Vishal Balaji Devanand	IHE-Delft	Netherlands

Objectives:

The aim of the workshop was for each collaborator to identify and analyze key barriers and enablers for implementing large-scale NbS.

Expected outputs were:

1. Final list of specific enablers and barriers for each of the collaborators
2. Assessment of enablers and barriers based on suitability maps
3. Preliminary assessment of priority sites for implementation of NbS

Expected outcomes were:

1. Broader understanding of enablers and barriers
2. Broader understanding on how enablers and barriers can interact locally

Key take-aways - Session A – Discussion on barriers:

The discussion on barriers was divided into two sub-sessions. In the first sub-session, the results from the survey on barriers was presented, followed by a discussion of contradictory/surprising results, and feedback on the list of barriers. In the second sub-session, barriers were assessed spatially using the developed suitability maps.

All EU collaborators filled in the survey of barriers for the implementation of NbS. The survey was prepared by IHE-Delft and was distributed in July 2021. Collaborators ranked the relevance of barriers for different project phases: investigation, planning, implementation, and operation & maintenance. Barriers had to be ranked from 0 (not relevant) to 5 (highly relevant). The workshop did not distinguish between the different project phases. The most relevant barriers when looking across EU collaborators were determined when at least four collaborators assigned a score of minimum four to the barrier.

The following barriers were deemed the most relevant:

- Lack of knowledge/evidence and understanding of NbS
    - No guidelines/standards (Highly relevant for all collaborators!)
    - Low quality of construction and limited data
    - Estimation of long-term benefits (Cost-effectiveness)
- Involvement and cooperation from stakeholders
    - Long talks to agree with politicians
    - Non-receptive attitudes
    - Sense of urgency/Prioritization of budget
    - Transboundary issues
- Land ownership
- Environmental regulation
- Limited construction time and delay in implementation (legal)

In particular, land ownership, environmental regulation, (limited construction time), lack of receptive attitudes/cooperation, long talks to agree with local politicians, and lack of guidelines and standards were highly relevant (score of five) for minimum four collaborators.

Facilitators questioned the mixed answers to the barriers related to political will and long talks to agree with local politicians. Collaborators mentioned that they interpreted “political will” as politics on national level related to regulations, agendas, and something written in stone. The other barrier was particularly relevant for local authorities. Most collaborators felt they had to spend a lot of time answering questions from local authorities.

A discussion on the lack of mechanisms to attract the private sector was discussed at the workshop due to the mixed responses by the collaborators. Croatia responded that this barrier was highly relevant, whereas Bulgaria and Poland did not consider this a barrier but an enabler. Several of the collaborators have never seen partnerships with the private sector, as they are not interested in floods. In addition to this, one collaborator argued that the reason for this might be that many private companies are small and struggling to survive. However, the same collaborator mentioned that collaborations might be possible if the business of the company is threatened by floods.

After discussing the survey results, collaborators were asked to spatially assess relevant barriers by considering the following questions:

- Are these barriers relevant everywhere?
- Are some barriers more local?
- What type of information do you need to assess this barrier spatially?
- Did this process exclude areas for NbS implementation?

Collaborators then had to insert post-its with barriers on their suitability maps (see results in the end of this section). Collaborators could freely define the barriers and did not have use the same wording as the barriers listed in the survey. Collaborators worked individually on their maps. Afterwards, each collaborator presented their results.

The overall results are presented in the following. This exercise did not introduce new barriers when comparing to the barriers in the survey. All barriers that were assessed spatially are shown Table 13 (Workshop post-it) and connected to barriers from the survey for comparison (Associated survey barrier).

Table 13 Barriers that could be spatially assessed on maps.

	Associated survey barrier	**Comment**
Poland, Pilica river basin		
Drainage area and limited information about existing infrastructure	Adaptation of infrastructure/ Limited information	
Prohibition of converting good agricultural soil to forest. Regulated by law.	Political will	
Restrictions on change of use in protected areas. For example, cannot change wetland to forest	Permits of land/protected areas	

	Associated survey barrier	Comment
Bulgaria, Kamchia river basin		
8 Natura 2000 zones, A Biosphere reserve	Permits of land/protected areas, Environmental regulation	
200 landowners	Land ownership	
Collaboration between three municipalities and the regional administration	Long talks to agree with local politicians, Lack of cooperation between institutions (Legally), Lack of receptive attitude/ cooperation	Suggests that this could be a barrier and enabler. Currently the collaboration is working well.
Floodplain restoration possible, but not approved by local authority	Long talks to agree with local politicians, Lack of receptive attitude/ cooperation	
Croatia, Bregana river basin		
Large, protected area (Natura 2000), Protected area (fish species)	Permits of land/protected areas, Environmental regulation	
Environmental agencies find it difficult to approve any construction measures	Lack of guidelines and standards, Lack of cooperation between institutions	Not spatial, but connected to very spatial barriers (protected areas, Natura 2000)
An area inhabited by a small population; they may not need recreation within the NbS	Lack of receptive attitude/ cooperation	
Transboundary Issues in inhabited areas	Transboundary issues	
Land ownership could be an issue since there is a lot of small private owned land areas	Land ownership	
Scarce agriculture area, afforestation of the area could receive pushback	Lack of receptive attitude/ cooperation	
Serbia, Sava river basin		
Potential archeological sites	Archaeological recognition over the land	
Transboundary issues are related to flood management in upstream Sava River Basin (Slovenia, Croatia, Bosnia, and Herzegovina).	Transboundary issues, Lack of cooperation between institutions	
Environmental regulation could be important for marshlands with protected species along the Sava River	Environmental Regulation	
Different responsible authorities on two banks of the Sava River (Vojvodinavode on the north, Srbijavode on the south). This is already a problem for maintenance of water infrastructure	Lack of cooperation between institutions	
Two municipalities in Tamnava: Cooperation in the 1 phase	Lack of cooperation between institutions	

	Associated survey barrier	Comment
Serbia, Drina river basin		
Transboundary issues on two levels: (a) Basin shared by 3 countries (Serbia, Montenegro and Bosnia and Herzegovina, (b) two entities in B&H, generally not cooperating well. This is a major obstacle.	Transboundary issues, Lack of cooperation between institutions	
NbS could therefore be favored by the environmentalists, but the mainstream politicians favor hydropower maximization ("political will").	Political will	Connected to barrier listed below
Hydropower reservoirs already built and provide protection from floods.	Lack of receptive attitude/ cooperation, Political will	Connected to barrier listed above

Key take-aways - Session B – Discussion on enablers:

In Session B, collaborators had to identify enablers that could overcome the barriers identified in Session A. Participants considered the following questions:

- Which of the barriers can potentially be overcome by enablers?
- Are some enablers local/general?
- What type of information do you need to assess these enablers spatially?
- Did this process exclude/include areas for NbS implementation?

Compared to previous exercise, this exercise was performed in plenum, taken one collaborator at a time. The purpose of doing this exercise in plenum, was for collaborators to better discuss and inspire each other.

The overall results are presented in the following. Collaborators defined enablers not only as the opposite of barriers, but as conditions to act upon to tackle barriers. All identified enablers and their connection to barriers are shown in Table 14. All barriers connected to enablers is shown, and it thus not limited to barriers that can be spatially assessed like in Table 13.

Table 14 Enablers identified during the workshop.
Not connected: Collaborator did not connect enabler with specific barrier.

	Barrier – Workshop post-it	Associated survey barrier
Poland, Pilica river basin		
Need digitalization of information	Drainage area and limited information about existing infrastructure	Adaptation of infrastructure/ Limited information
What NbS feeds the purpose of the area	Restrictions on change of use in protected areas. For example, cannot change wetland to forest	Permits of land/protected areas
Training, materials for local society, local politicians - easy to read and show co-benefits and examples	Local authority + Water authority --> no knowledge on NbS and better understand grey infrastructure	

	Need guidelines - especially guidelines that can be understood by local+water authorities	
	Need to show the good examples of cost-effectiveness of NbS (hereunder co-benefits)	
EC pressure to use NbS will hopefully change	Lack of money	
How to talk and collaborate them --> show them the benefits (WP4, UFZ)	Need methods to involve farmers (main local stakeholders) + people in small villages	
Understand local conditions and their interests	Overall	Overall
Bulgaria, Kamchia river basin		
Good attitudes by institutions	Collaboration between three municipalities and the regional administration	Long talks to agree with local politicians, Lack of cooperation between institutions (Legally), Lack of receptive attitude/ cooperation
Area used to be huge floodplain (*restore parts to natural state*)	*Not connected*	*Not connected*
People in this area are affected by flooding. Some might need compensation, but resistance is not expected. Need arable land, but no resistance IF compensation provided	200 landowners	Land ownership
Collected information and data for numerical modelling --> have feasibility by end of reconect	*Not connected*	*Not connected*
Croatia, Bregana river basin		
No enablers identified		
Serbia, Sava river basin		
Consider land ownership early in the planning phase - don't wait until construction phase!	Land ownership is a barrier everywhere in the river basin	Land ownership
Training materials for planners and community of engineers		
Data: Project on developing early-warning systems and monitoring		
Sava river committee collecting a lot of data. Ensures good collaboration between countries. Participate in projects and initiate them. Good place to look large scale	Transboundary issues are related to flood management in upstream Sava River Basin (Slovenia, Croatia, Bosnia, and Herzegovina).	Lack of cooperation between institutions (Legally), Transboundary issues

Small farmers might be okay with being flooded if compensated (Room for the river) --> create room for negotiation	How to motivate citizens and authorities	Lack of receptive attitude/ cooperation
Raising awareness of co-benefits - showed the Room for River project and they were very interested (Municipalities). Environmental problems very important to them.	How to motivate citizens and authorities	Long talks to agree with local politicians, Lack of receptive attitude/ cooperation
Involve as many stakeholders as possible --> change mind-set between local people and authorities	How to motivate citizens and authorities	Long talks to agree with local politicians, Lack of receptive attitude/ cooperation
Serbia, Drina river basin		
Goes under the Sava River Basin Committee	Major issues are geopolitical --> many countries involved --> 30 major authorities participating	Lack of cooperation between institutions (Legally), Transboundary issues

Feedback from Collaborators on the survey, suitability maps and workshop:

- Some of the collaborators felt they had too little experience to fill out the survey. For example, one collaborator mentioned, that they would have liked to discuss the barriers with the local/water authorities. Collaborators were questioning the objectivity of the survey results and stated that results would vary depending on the level of knowledge of the respondent. One collaborator said this was unavoidable and suggested that multiple could fill out the survey for deeper insights. Another collaborator was struggling with the economic and financial barriers, as this was outside their area of expertise, which provide another reason for having multiple respondents for the same area.

- Several collaborators mentioned that more broadly defined barriers would reduce subjectivity and better fit the river basin scale of the suitability maps. For example, the barrier Accessibility for construction and maintenance was not deemed relevant on river basin scale. One collaborator stated that it is very difficult to make the list exhaustive, providing an additional argument for more broad barriers.

- Most of the collaborators thought it was difficult to assign scores depending on project phases. Especially the grouping of the “Design phase” within the pre-defined project phases proved to be difficult. To solve this, one collaborator suggested to organize the project phases according to national and local project phases.

- Many Collaborators highlighted that there was a mismatch between the level of detail of barriers and the large scale of suitability maps. Maps included too many potential locations, for example for detention ponds and flood restoration for Poland. Moreover, some of the suitability maps suggested NbS in areas where NbS already exist. Better consideration of existing land use and NbS is needed.

- Collaborators mentioned that more data was needed for suitability maps:

  - Location and extent of flooding and drought
  - Hydrological data
  - Heavily modified water bodies

    - Big reservoirs (Water supply)
    - More detailed land use with existing NbS

- Collaborators mentioned that it proved difficult to consider enablers compared to barriers. Most of them felt that the more involved and knowledgeable they were getting with their focus area and associated challenges, the more focused they were on barriers and the least on enablers.

Ways forward

Based on the workshop and the feedback given, the following is suggested as a way forward:

- Multiple people from the same focus area should fill out the survey and/or participate in a discussion of barriers and enablers. Optimally these people come from different organizations and have different professional background.
- There was a mismatch between the list of barriers in the survey and assessing these on river basin scale. More broad barrier categories should be defined if we want to continue using river basin scale.
- Developing standards, guidelines and training materials is really needed in this field
    - These should be easy to read so all professionals and local authorities can understand them
- Additional sessions/workshops focusing more on enablers, business cases and benefits should be conducted.

Workshop outputs for each Collaborator:

DISCLAIMER

The suitability maps in Figures 34 to 42 are different from the suitability maps presented in the core text of the report and in Annex 4. The reason for such a difference is that there has been a change in the criteria used to generate suitability maps. This change was operated after the workshop took place.

The criteria used to generate the maps below are the following:

	Elevation (slope)	Distance from streams	Distance from roads	Land use	Aquifer type
Forest buffers	< 5%	≥ 100 m	> 100 m	Suitable[1]	Suitable[1]
Afforestation	< 5%	≤ 75 m	> 100 m	Suitable[1]	Suitable[2]
Floodplain restoration	< 5%	≤ 1 km	≥ 50 m	Suitable[1]	Suitable[2]
Retention basins	< 5%	≤ 1 km	≥ 50 m	Suitable[1]	Suitable[2]

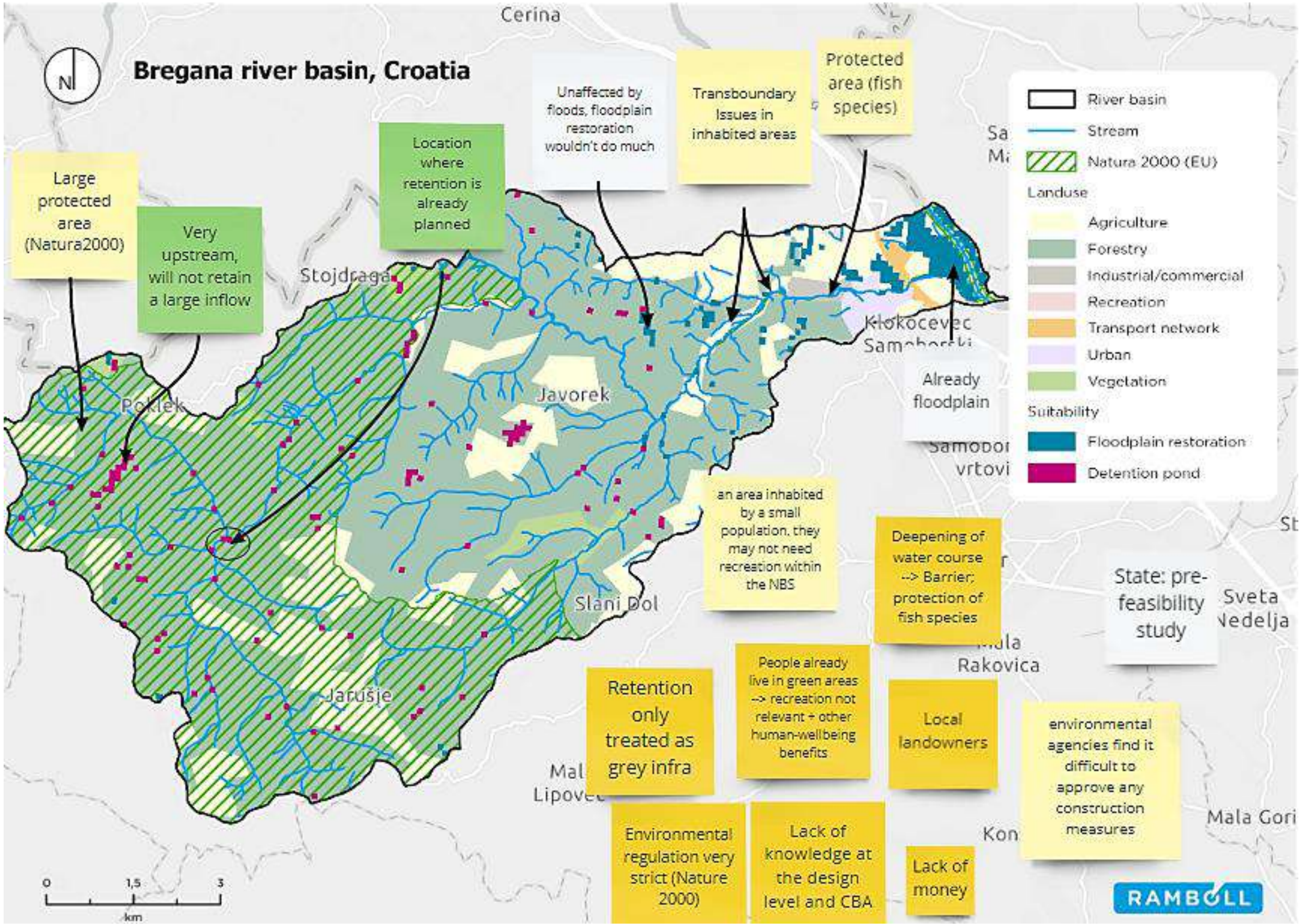

Figure 34 Workshop outputs for Bregana river basin, Croatia - floodplain restoration and detention ponds

Exercise was performed in Miro (www.miro.com). Yellow post-its = Barrier, Green post-it = Lack of data/information, Blue post-it = Enabler.

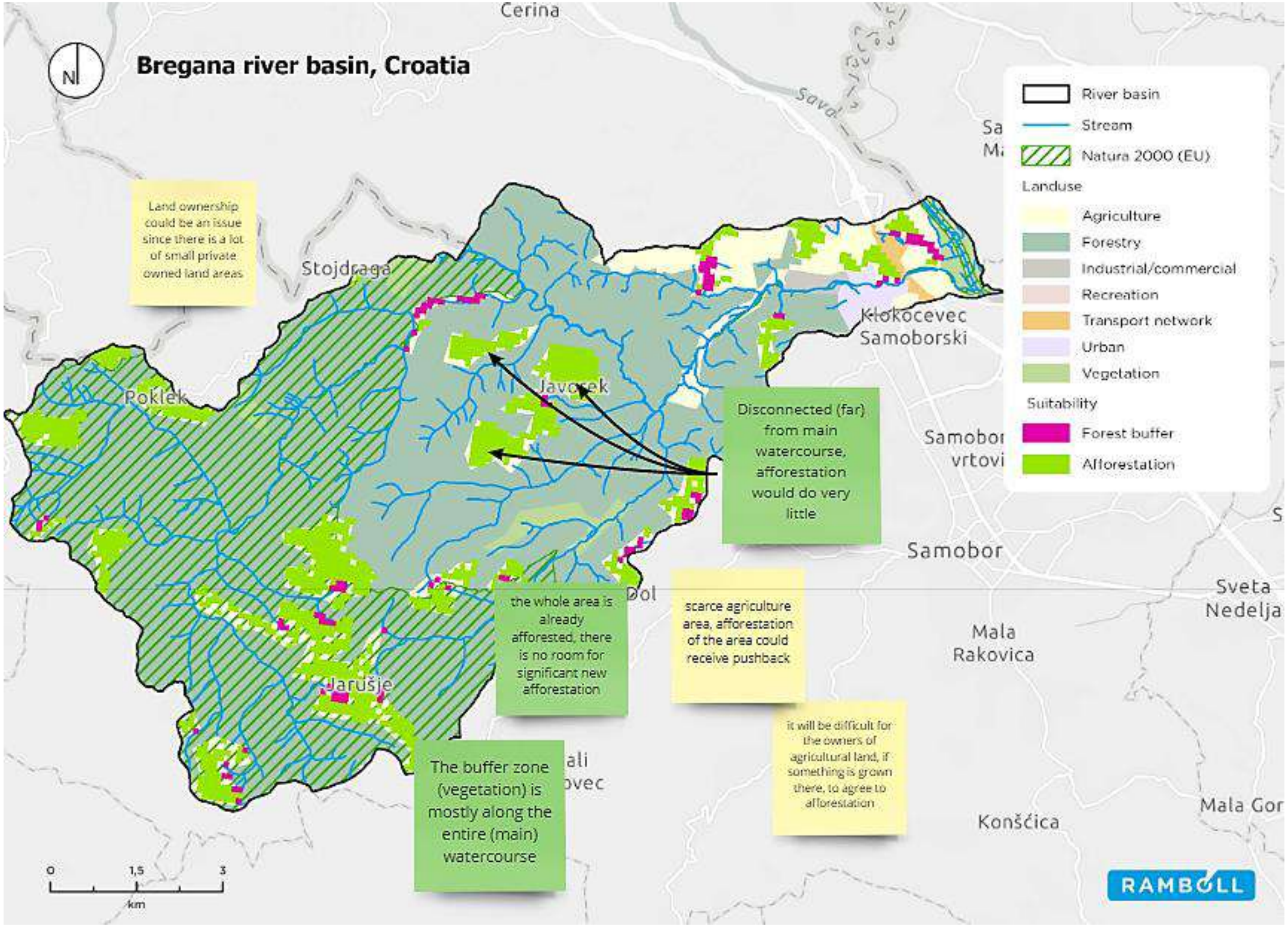

Figure 35 Workshop outputs for Bregana river basin, Croatia – forest buffer and afforestation

Exercise was performed in Miro (www.miro.com). Yellow post-its = Barrier, Green post-it = Lack of data/information, Blue post-it = Enabler.

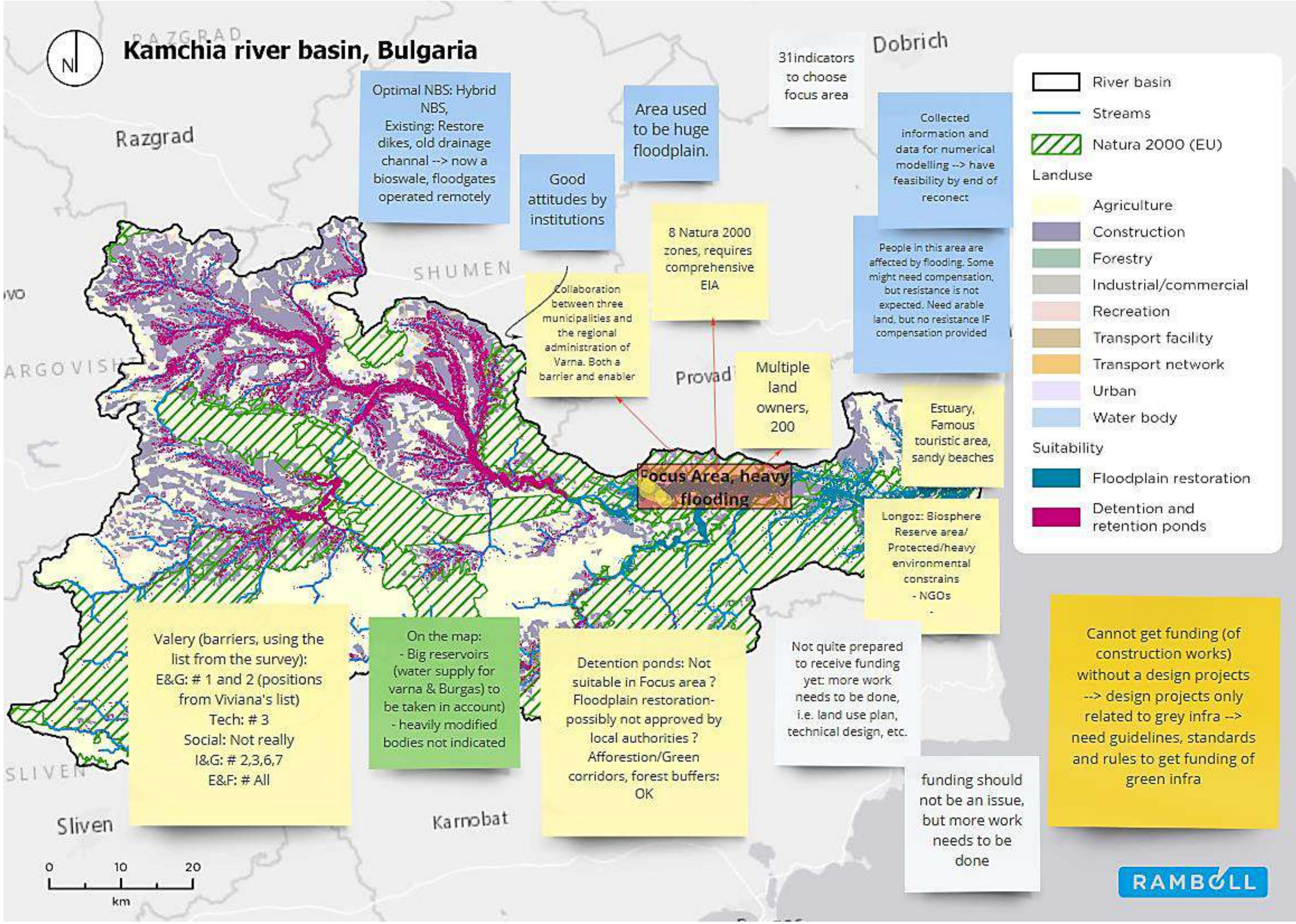

Figure 36 Workshop outputs for Kamchia river basin, Bulgaria – floodplain restoration and detention ponds

Exercise was performed in Miro (www.miro.com). Yellow post-its = Barrier, Green post-it = Lack of data/information, Blue post-it = Enabler.

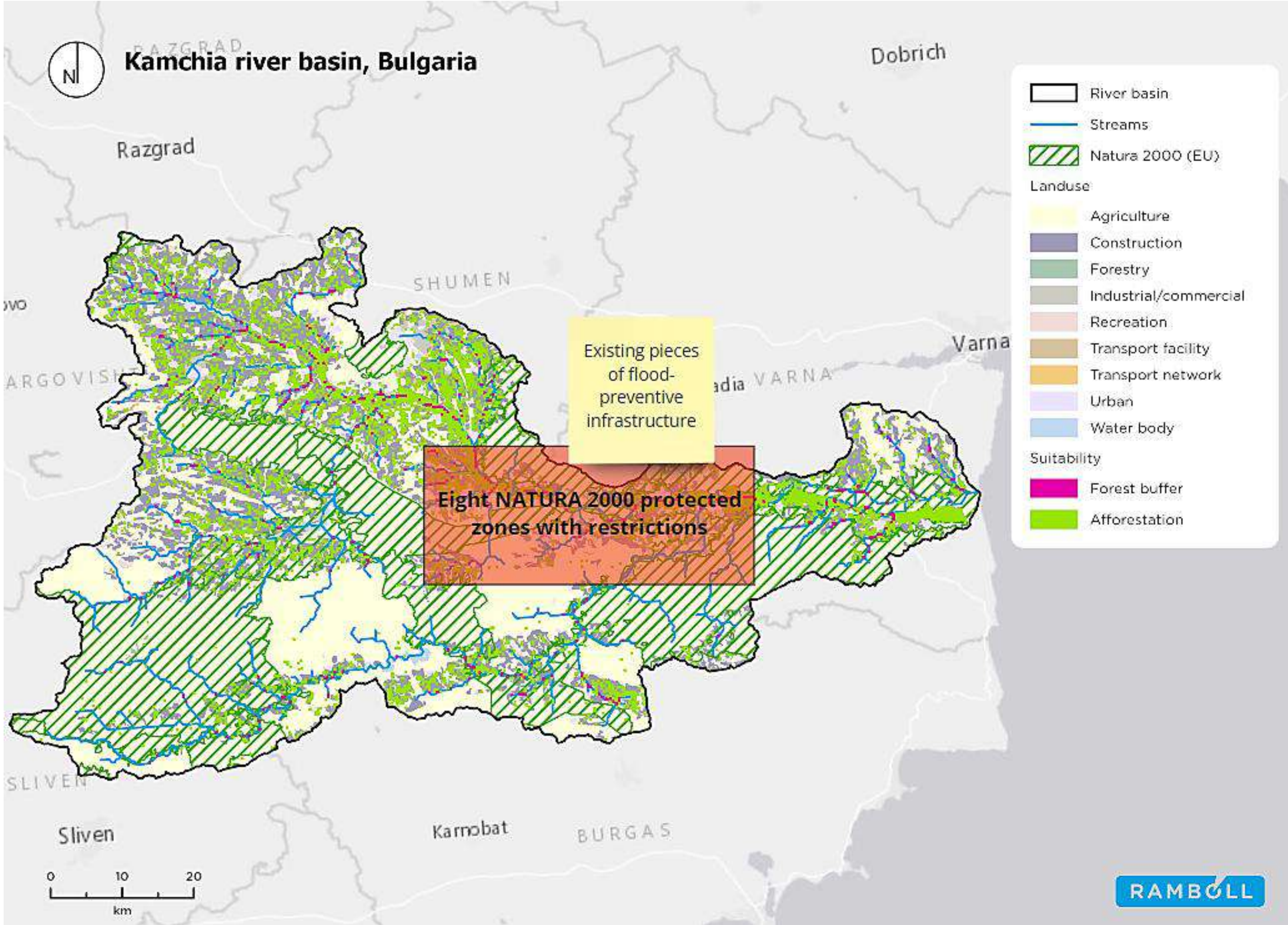

Figure 37 Workshop outputs for Kamchia river basin, Bulgaria – forest buffer and afforestation

Exercise was performed in Miro (www.miro.com). Yellow post-its = Barrier, Green post-it = Lack of data/information, Blue post-it = Enabler.

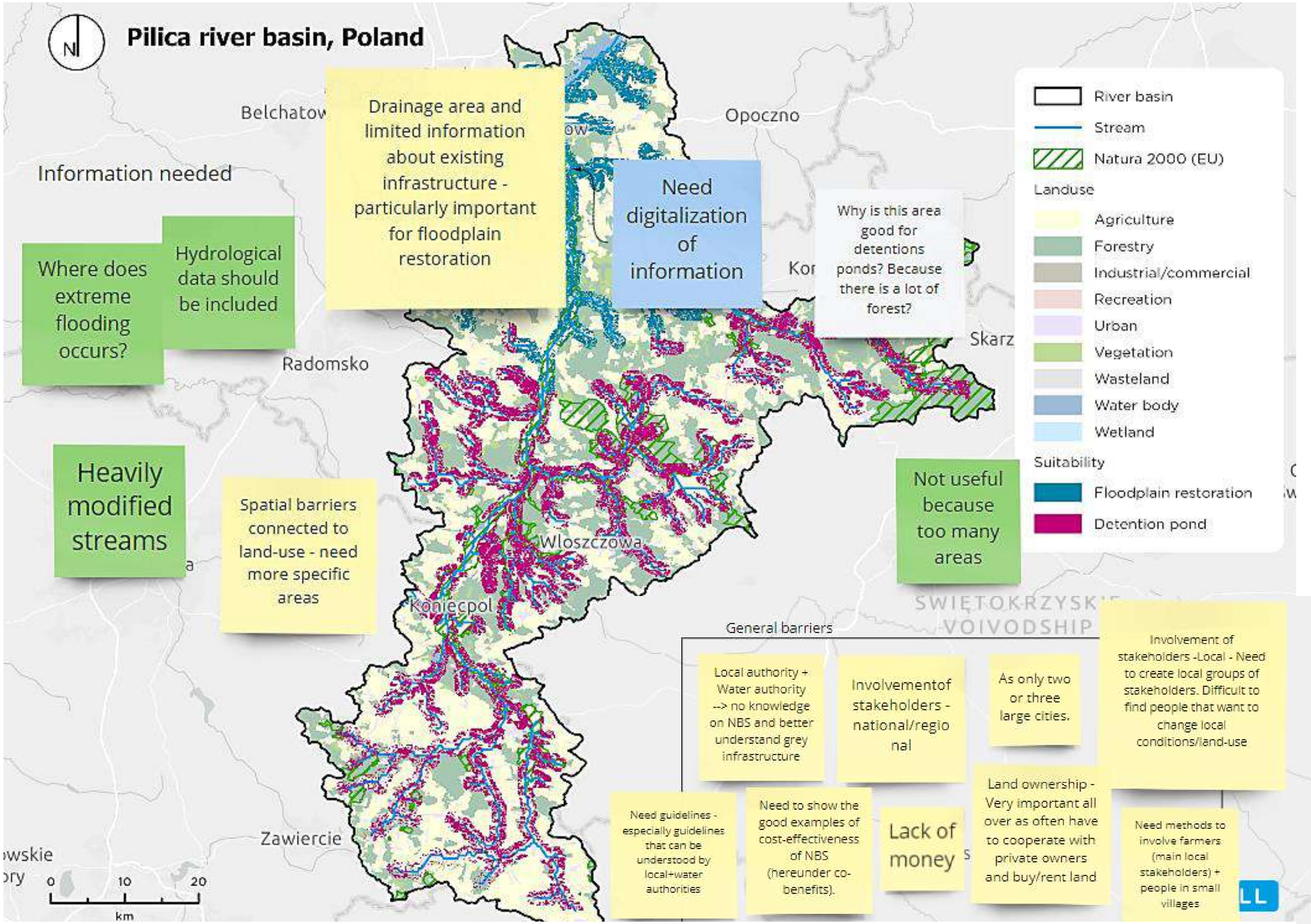

Figure 38 Workshop outputs for Pilica river basin, Poland – floodplain restoration and detention ponds

Exercise was performed in Miro (www.miro.com). Yellow post-its = Barrier, Green post-it = Lack of data/information, Blue post-it = Enabler.

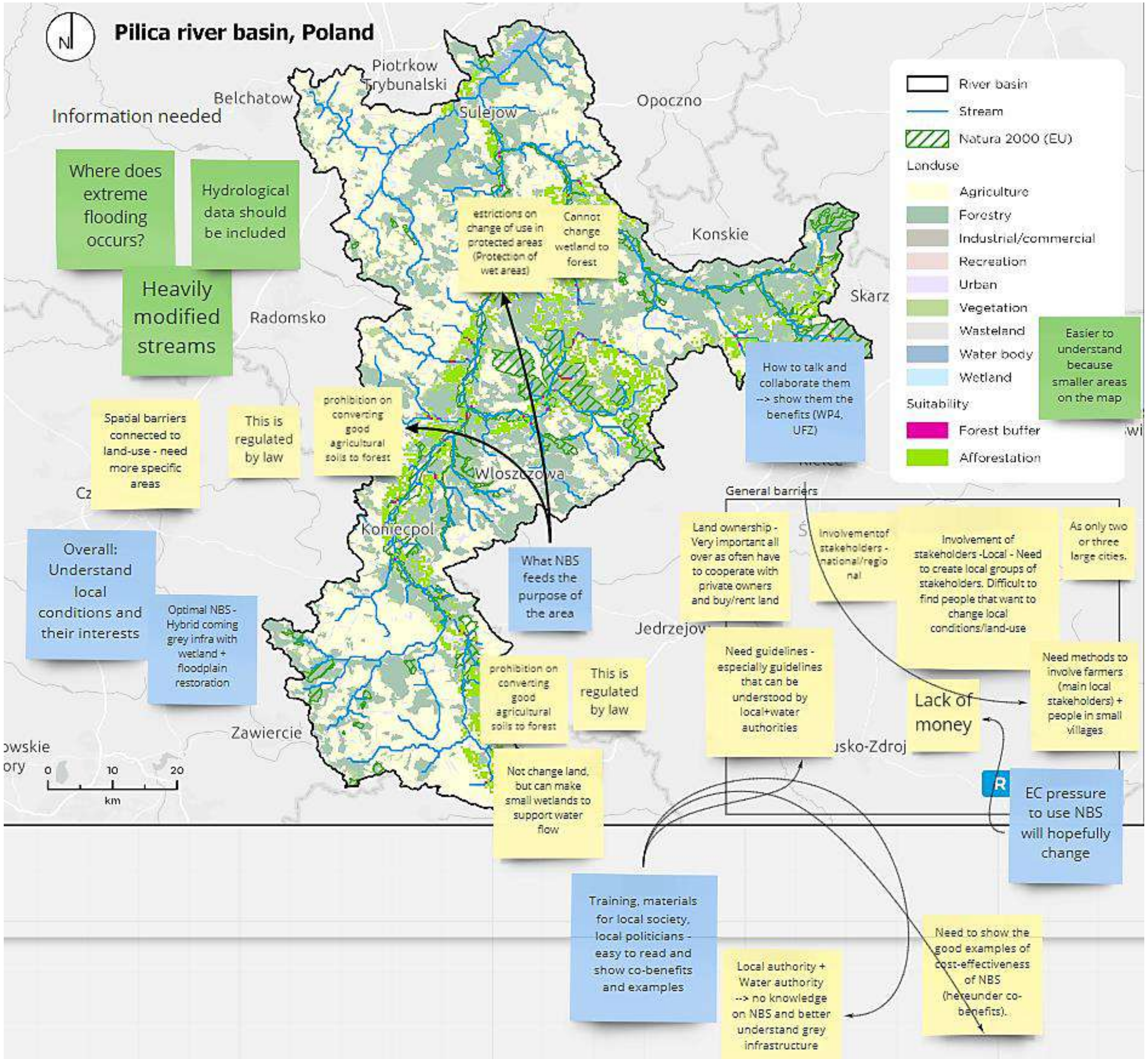

Figure 39 Workshop outputs for Pilica river basin, Poland – forest buffer and afforestation

Exercise was performed in Miro (www.miro.com). Yellow post-its = Barrier, Green post-it = Lack of data/information, Blue post-it = Enabler.

Figure 41: Outputs for Drina river basin, Serbia – detention ponds

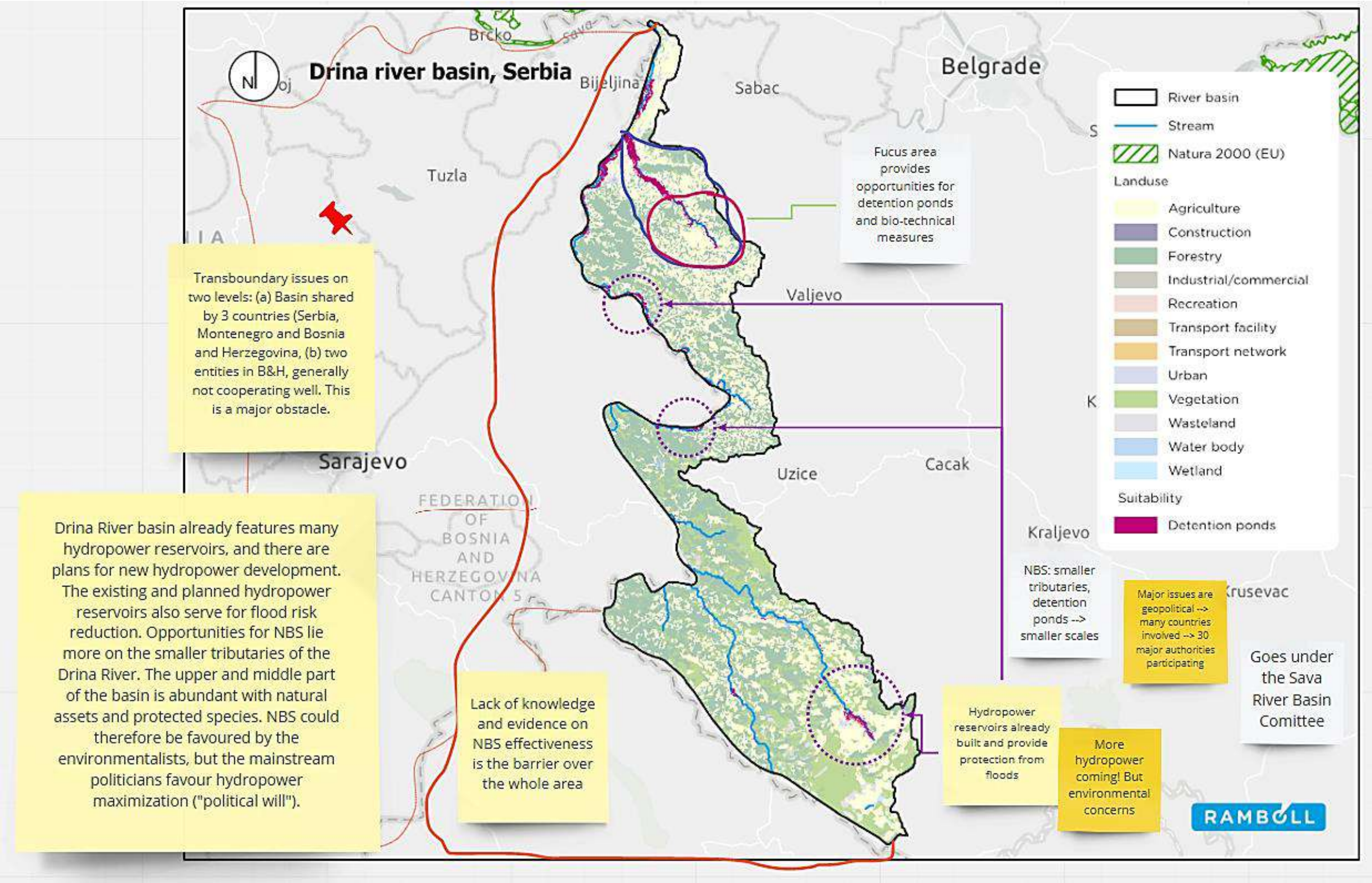

Figure 40 Workshop outputs for Drina river basin, Serbia – detention ponds

Exercise was performed in Miro (www.miro.com). Yellow post-its = Barrier, Green post-it = Lack of data/information, Blue post-it = Enabler.

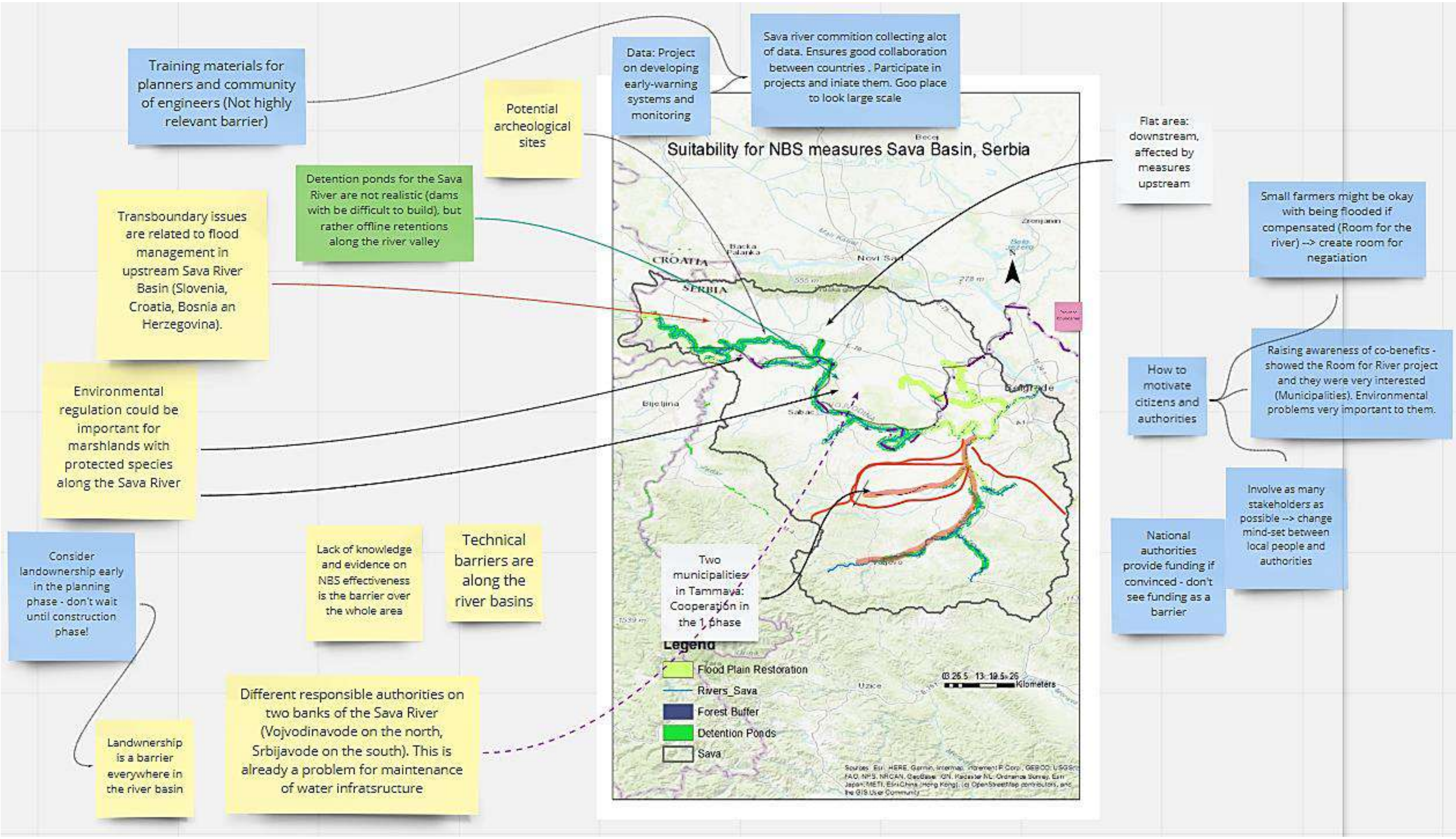

Figure 42 Workshop outputs for Sava river basin, Serbia – detention ponds

Exercise was performed in Miro (www.miro.com). Yellow post-its = Barrier, Green post-it = Lack of data/information, Blue post-it = Enabler.

10.6 Annex 6: Suitability conditions for land use and aquifers (example of afforestation)

Land use:

LABEL1	LABEL2	LABEL3	YES / NO
Artificial surfaces	Urban fabric	Continuous urban fabric	0
Artificial surfaces	Urban fabric	Discontinuous urban fabric	0
Artificial surfaces	Industrial, commercial and transport units	Industrial or commercial units	0
Artificial surfaces	Industrial, commercial and transport units	Road and rail networks and associated land	0
Artificial surfaces	Industrial, commercial and transport units	Port areas	0
Artificial surfaces	Industrial, commercial and transport units	Airports	0
Artificial surfaces	Mine, dump, and construction sites	Mineral extraction sites	0
Artificial surfaces	Mine, dump, and construction sites	Dump sites	0
Artificial surfaces	Mine, dump, and construction sites	Construction sites	0
Artificial surfaces	Artificial, non-agricultural vegetated areas	Green urban areas	1
Artificial surfaces	Artificial, non-agricultural vegetated areas	Sport and leisure facilities	1
Agricultural areas	Arable land	Non-irrigated arable land	1
Agricultural areas	Arable land	Permanently irrigated land	1
Agricultural areas	Arable land	Rice fields	1
Agricultural areas	Permanent crops	Vineyards	1
Agricultural areas	Permanent crops	Fruit trees and berry plantations	1
Agricultural areas	Permanent crops	Olive groves	1
Agricultural areas	Pastures	Pastures	1
Agricultural areas	Heterogeneous agricultural areas	Annual crops associated with permanent crops	1
Agricultural areas	Heterogeneous agricultural areas	Complex cultivation patterns	1
Agricultural areas	Heterogeneous agricultural areas	Land principally occupied by agriculture, with significant areas of natural vegetation	1
Agricultural areas	Heterogeneous agricultural areas	Agro-forestry areas	1
Forest and semi natural areas	Forests	Broad-leaved forest	0
Forest and semi natural areas	Forests	Coniferous forest	0
Forest and semi natural areas	Forests	Mixed forest	0

Forest and semi natural areas	Scrub and/or herbaceous vegetation associations	Natural grasslands	0
Forest and semi natural areas	Scrub and/or herbaceous vegetation associations	Moors and heathland	0
Forest and semi natural areas	Scrub and/or herbaceous vegetation associations	Sclerophyllous vegetation	0
Forest and semi natural areas	Scrub and/or herbaceous vegetation associations	Transitional woodland-shrub	0
Forest and semi natural areas	Open spaces with little or no vegetation	Beaches, dunes, sands	0
Forest and semi natural areas	Open spaces with little or no vegetation	Bare rocks	0
Forest and semi natural areas	Open spaces with little or no vegetation	Sparsely vegetated areas	1
Forest and semi natural areas	Open spaces with little or no vegetation	Burnt areas	1
Forest and semi natural areas	Open spaces with little or no vegetation	Glaciers and perpetual snow	0
Wetlands	Inland wetlands	Inland marshes	0
Wetlands	Inland wetlands	Peat bogs	0
Wetlands	Maritime wetlands	Salt marshes	0
Wetlands	Maritime wetlands	Salines	0
Wetlands	Maritime wetlands	Intertidal flats	0
Water bodies	Inland waters	Water courses	0
Water bodies	Inland waters	Water bodies	0
Water bodies	Marine waters	Coastal lagoons	0
Water bodies	Marine waters	Estuaries	0
Water bodies	Marine waters	Sea and ocean	0
NODATA	NODATA	NODATA	
UNCLASSIFIED	UNCLASSIFIED LAND SURFACE	UNCLASSIFIED LAND SURFACE	
UNCLASSIFIED	UNCLASSIFIED WATER BODIES	UNCLASSIFIED WATER BODIES	

Aquifers:

AQUIF_CODE	AQUIF_NAME	Suitability
1	Highly productive porous aquifers	1
2	Low and moderately productive porous aquifers	0
3	Highly productive fissured aquifers (including karstified rocks)	1
4	Low and moderately productive fissured aquifers (including karstified rocks)	0
5	Locally aquiferous rocks, porous or fissured	1
6	Practically non-aquiferous rocks, porous or fissured	0
200	Inland water	0
300	Snow field / ice field	0