Catalogue of regulatory, economic and social barriers for upscaling of NBS

Deliverable D4.6

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Abstract (for dissemination, 100 words)	Task 4.6 in the RECONECT project focuses on assessing the framework conditions for implementing the proposed Nature-based solutions (NBS) at RECONECT's European Collaborator sites. Using a multi-method approach with a focus on workshops, the study identifies interconnected barriers, revealing that current legal, administrative, and policy frameworks for integrating NBS into risk management are in the initial stage. Key barriers such as financial resource availability, political commitment, and public understanding of NBS significantly influence uptake. Although EU policies provide foundational support for NBS, actual political backing remains limited. This research underscores the imperative of recognising and addressing barriers to ensure NBS's effective integration into mainstream risk management practices.
Keywords	Barriers, enablers, acceptance, institutions, law, politics

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Executive Summary

Nature-based solutions (NBS) offer a multitude of benefits, including enhancing resilience to climate change, reducing the risks of natural disasters, and improving air and water quality. In addition, they help to not only mitigate environmental challenges but can also help to promote economic growth and increase quality of life. However, although NBS can provide many benefits, the implementation of (NBS) faces a number of substantial barriers hampering their effective implementation at larger scale. In this report, we take a deep dive to identify the most relevant barriers in six case studies, the so called European Collaborator sites, in different European countries, i.e. Bulgaria, Croatia, Bosnia and Herzegovina, Poland and Serbia.

A barrier analysis is crucial for an efficient realisation of NBS and can help policy-makers and practitioners to identify and address obstacles hindering the implementation of NBS early in the process of implementation. By understanding these barriers, policymakers can develop strategies to overcome them, for instance, allocate resources effectively, and ensure that policies are practical and achievable. This not only promotes efficient and fair governance but also maximizes the impact of policies, making them more responsive to real-world challenges and leading to better outcomes for communities and the environment. Based on an in-depth analysis we identified relevant barriers the the different Collaborator sites.

There are three groups this report is addressing specifically: (1) Collaborators within the project. This report provides an evidence based view on the main barriers future NBS projecte will be confronted in their case studies. (2) Stakeholders involved in the realisation of NBS projects, either on the practical or the strategic level, including authorities (i.e. local, regional and national govnermental organisations), political representativies (u.e. people elected to politicl office) as well as representatives of civil society organisation. (3) The scienfitif community enganged with research on NBS and barrier analyses. The report provides empirical insights on the most relevant barriers and how they hamper the realization of NBS in six sites across Europe.

Stakehholders interested in the immediate results, might have a closer look at chapter 2. Here we provide a relatively detaileld summary of the key findings for each of the sites and also include first suggestion on how to overcome barriers with a great transformative potential. A in-depth analysis is provided in subsequent sections.

Our findings underline that barriers should not be understood as standalone obstacles, they rather form a complex, interconnected network of barriers. The analysis revealed three types of dominant barrier networks, each of them characterised by a set of dominant barrier types shaping the barrier networks in the different case studies.

1. Barrier networks dominated by institutional-legal-political barriers: These emerged as the foremost barriers, particularly prevalent in sites like Kamchia and Jadar. They encompass, among others, financial constraints, entrenched silo thinking, and a noticeable absence of political zeal towards NBS as the most relevant barriers.
2. Barrier networks dominated by lack of knowledge and awareness: Specifically evident in the Vrbanja site, there exists a profound gap in understanding the intrinsic and extrinsic benefits of NBS.
3. Tightly coupled networks of barriers: Seen in the Pilica case study, this type presents a complex interrelation of barriers not dominated by a single type of barriers.

Further, our analysis also revealed barriers with a transformation potential. What do we mean by this? Barriers have a high transformative potential if they have an outstanding influence on other barriers. They are thus on the one hand decisive for hampering the

realisation of NBS in the current situation. On the other hand, they would have a positive influence on the more effective uptake of NBS, if they are overcome in the future. Mainstreaming activities need to thus aim at developing practices that help to tap their transformative potential. Such barriers with a high transformative potential include, among others, financial support, consistent political commitment, and an informed knowledge base about NBS.

To pave the way for the broader adoption of NBS, a coordinated approach towards the realization of NBS is crucial. Our results underscores the need for robust policy changes, increased political will, enhanced public understanding, and the flexibility to adapt to emerging knowledge. Current legal, administrative, and policy systems are still in their early stages when it comes to considering NBS in the risk management process. The existing frameworks, processes, and funding systems are predominantly centred on traditional hard infrastructure measures. Despite the existence of a multitude of EU policies and directives that provide a solid legal basis for the use of NBS, political support for mainstreaming of NBS falls short of expectations at the RECONECT Collaborator sites. Political actors are generally seen as observers whose actions are often considered more symbolic than practical. At best, political actors might endorse the inclusion of NBS in relevant policy documents, but their commitment to actively supporting the execution of these policies is viewed as somewhat lacking. Nevertheless, numerous local experts underscore the importance of persuading political actors to establish the necessary legal foundation for mainstreaming NBS and to ensure the availability of required resources for successful implementation.

Based on our analysis, a more comprehensive **mainstreaming strategy** will be developed in the case studies as a next step. The outcomes will be presented in the upcoming report D4.7 (Mainstreaming NBS in the Collaboration sites).

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1 Introduction

This report represents a building block in preparing the two key outcomes of RECONECT'S work on "Overcoming barriers, upscaling and synergies with Collaborators" (WP4), i.e. the development of possible strategies for mainstreaming large-scale NBS as well as the prefeasibility studies for implementation of NBS in Collaborators" (D4.8). In this report, we focused on developing a framework for identifying barriers to the upscaling of NBS. The framework was applied to the European Collaborators case studies in order to identify relevant barriers that hamper the amplification of NBS in the specific context of the case studies. The work is based on the following steps:

- Development of a framework: In the first step, a comprehensive framework was developed. This framework builds upon a rapidly growing body of scientific publications focusing on identifying and assessing barriers to the realisation of NBS projects. In addition, we took into account reports from previous European projects, including the insights from the PHUSICOS project as well as OPERANDUM project. The framework aims to provide a more dynamic understanding of how barriers operate in the case studies and therefore focuses specifically on how barriers influence each other. In this sense, our analysis aims at identifying bundles of barriers within a governance context established in the different case studies.

- Barrier analysis: In the next step, the actual analysis was conducted. We, therefore, organised workshops in Collaborators' sites in order to provide local and regional stakeholders a forum to interactively exchange on the relevance of different kinds of barriers. This included identifying in a participatory setting the most relevant barriers for each of the Collaborator sites. In the next step, we focused stakeholders on analysing how the different barriers are interconnected in order to better understand how they work in practice from the perspective of stakeholders. This was done by means of fuzzy cognitive mapping.

- Finally, the outcomes of the analysis were presented to all project partners during a session at RECONECT General Assembly in Hamburg (22.05-24.05.2023) in order to not just validate results with Collaborators but to also provide a forum for facilitating reflexive learning among the partners about the barriers within their own context and identify possible strategies on how to overcome them (which will be dealt with more in-depth in the upcoming Deliverable 4.7).

Achieving the objectives of RECONECT's Task 4.6 required collecting and analysing data from local stakeholders and experts through workshop activities. Similarly, as for producing the report on "Local acceptance, institutional and political feasibility in Collaborators Sites" (D4.5), data collection demanded for local expertise and language skills not only for accessing local data sources but also for enabling low-threshold communication with local stakeholders and interviewees as well as successful workshop facilitation. Therefore, a culturally sensitive approach was applied, including the following roles and responsibilities: UFZ as task leader developed and delivered the methodological framework and supported data collection and analysis. Local RECONECT partners ("Collaborators") familiar with the site provided on-site organisational support, but did not possess the capabilities required for facilitating, conducting, and documenting the on-site activities for data collection and analysis. Hence, it was decided to contract highly qualified experts to fulfil these challenging tasks. Local RECONECT partners ("Collaborators") supported UFZ by screening the market for

potential Subcontractors. The role and responsibilities of Subcontractors included facilitating, conducting, and documenting the on-site activities for data collection and analysis. Thus, the main purpose of involving Subcontractors in this task was their local expertise, language, and facilitation skills as prerequisites for 1) access to local data sources; 2) familiarity with national, regional, and local governance settings; 3) low-threshold communication with stakeholders and interviewees; 4) successful local workshops facilitation and confidential interviews without a language barrier.

Figure 1 provides an overview of the co-creation activities along the lines of the preparatory meetings and webinars.

Figure 1 Roadmap of project activities/milestones within the task 4.6

Scope and structure of the report

This report builds on a thorough co-creation process in the Collaborator sites[1]. In total, almost 150 stakeholders were involved in 12 workshops which were organised in the sites of Collaborators. The empirical analysis is based on the ranking of potentially relevant barriers as well as fuzzy cognitive mapping to assess how the different barriers are interlinked.

The structure of the report is as follows: Chapter 2 explains RECONECT's framework for barrier analysis, then Chapter 3 illustrates the methodology and case study. Chapter 4 presents the results of the barrier analysis and finally, Chapter 5 synthesises and discusses the key findings and implications for RECONECT.

[1] Parts of the co-creation work were presented in a previous report. The focus in D4.5 was on the local acceptance, institutional and political feasibility. In this report (D4.6) we present the co-creation work with a focus on the participatory assessment of barriers. The two reports are based on two different methodological approaches.

2 Summary for stakeholders in the Collaboration sites

2.1 Summary of the Kamchia River Basin case study

In this section we provide a short summary for stakeholders in the Kamchia River Basin. More detailed explanation and results are provided in section 4.2.1.

The barrier analysis in the Kamchia River Basin (Bulgaria) is based on a strong stakeholder participation. In two workshops that took place on 07.12.2022 and on 24.02.2023 in Varna, a total of **40 stakeholders participated**, including representatives of public authorities, civil society, politics, academia, the private sector and the media.

What are the top-five central barriers in the Kamchia case study (in order of centrality)?

1. **Silo thinking**: Our analysis suggests that the established organisational-institutional structure is not yet ready to support the effective uptake of NBS. We can assume that the current structure is dominated by various sections of government or public organization working relatively independently from each other and focusing solely on their own goals and objectives, without sharing information or coordinating efforts with other units, which would be beneficial for a more effective uptake of NBS.
2. **Lacking compensation mechanism**: Our analysis suggests that individuals or communities whose land is required for construction the new NBS do not yet receive adequate financial reimbursement for giving up their property. This can result, among others, in economic hardships or discontent among those who are forced to give up their land. Fair compensation is a fundamental principle in land acquisition processes, and it is typically expected to cover not only the market value of the land but also additional costs, such as resettlement, rehabilitation, and losing livelihood.
3. **Insufficient public participation:** It is shown that the possibility to publicly participate in the decision-making and planning processes around the realisation of NBS are not yet sufficiently established in the case study. This can result in lacking transparency about the processes, that concerns about the negative effects of NBS are not acknowledged, or that the decisions made reflect the needs and preferences of affected stakeholders. Public participation enhances the legitimacy of decisions, fosters trust between the public and decision-makers, and contributes to the overall democratic governance of a society.
4. **Lacking political awareness of NBS:** There seems to be a limited understanding of the concept of NBS among relevant decision-makers, political and public authorities. They are not well informed or do not have sufficient knowledge about the concept of NBS. Raising awareness and knowledge about NBS is, however, an important first step to encourage a more effective uptake of NBS. If decision-makers are not aware of NBS they cannot be in favour of implementing NBS, eventually.
5. **Public understanding of NBS operations:** There also seems to be a lacking public understanding regarding the planning, implementation, functioning and potential benefits of NBS. A well-informed public can actively contribute to the success of NBS initiatives by supporting relevant policies or participating in community projects. It is also crucial to build a consensus on integrating nature into risk management strategies.

What are promising entry points for overcoming barriers and for supporting the mainstreaming of NBS in the Kamchia River Basin?

In our analysis, we identified barriers with a **high transformative potential**. What do we mean by this term? Barriers with a high transformative potential are defined by two key characteristics: First, they are not so strongly influenced by other barriers, which means they operate relatively independently. Second, they are influencing multiple other barriers and thus have a strong influence on the overall barriers system hampering the realisation of NBS in the case study. Overcoming these barriers may thus have a positive influence on other barriers; they may serve as leverage points in the case study.

Our analysis identified the following the **top barriers with a high transformative potential** in the Kamchia case study (see Table 1). We also included some examples of how to overcome these barriers. The examples should help to stimulate thinking and discussions in the case studies. They are not comprehensive or systematically screened for. A comprehensive mainstreaming strategy will be developed in the case studies as a next step. The outcomes will be presented in the upcoming report D4.7 (Mainstreaming NBS in the Collaboration sites).

Table 1 Transformative potential barriers and the examples of how to overcome barriers in Kamchia case study

Transformative barrier	Examples of how to overcome barriers
*Overcoming **siloed thinking** would serve as a lever for positively influencing other barriers*	• Create cross-sectorial/cross-functional teams with representatives of different departments, unit or agencies that have expertise on the realisation of NBS and/or are affected by the realisation of NBS; • Agree upon and define common goals or visions that require collaboration between different units and would support the uptake of NBS; • Establish channels for open communication and exchange of information across different units, including regular meeting, shared knowledge and exchange platforms.
*Enhancing **knowledge of NBS** & **Public understanding** of NBS would serve as a lever for positively influencing other barriers*	• Set-up an educational campaign including the organisation of workshops and seminars providing more detailed explanation on how NBS are operating, what their potential benefits and drawbacks are. From our own analysis, we know interactive formats are considered as a relevant means of knowledge generation (see Kuhlicke et al. 2022); • Integrate NBS into school curricular and other relevant hubs of education; • Organise community workshops and seminars in the area of a planned large-scale NBS to provide communities with a platform to learn more about NBS; • Identify other organisations (including civil society organisations) with a shared interest in NBS and set-up a multiplier network advocating for NBS. • Engage with the media to effectively disseminate information about NBS, including newspaper articles, documentaries, interviews and/or podcasts.

Transformative barrier	Examples of how to overcome barriers
*Developing a more **comprehensive legal basis for land acquisition, established compensation mechanisms and incentives** for NBS would serve as a lever for positively influencing other barriers*	• Develop comprehensive legislation and regulations specifically addressing land acquisition for NBS, including clear guidelines on how the process, criteria, and conditions for acquiring land. • Establish mechanisms for fair and transparent market valuation of the land in order to ensure that compensation is based on the actual value of the land and takes into account relevant factors (e.g. agricultural potential, ecological value, or cultural significance). • Introduce financial incentives for individuals, communities, and businesses adopting NBS. This could include tax breaks, subsidies, or grants to encourage the implementation of NBS.
*Raising **political awareness** of NBS would serve as a lever for positively influencing other barriers*	• Design targeted campaigns specifically tailored for policymakers. This can include workshops, seminars, and informational materials that highlight the relevance of NBS; • Develop concise policy briefs and white papers that present evidence-based information on the effectiveness of NBS. • Highlight successful NBS projects that have demonstrated positive outcomes. Showcase case studies and examples where NBS has been effectively implemented, emphasizing the social, economic, and environmental benefits; • Integrate references to NBS in relevant policy documents, strategies, and development plans. This ensures that the concept is officially recognized and considered in the formulation of government policies.

2.2 Summary of the Bregana River Basin case study

In this section we provide a short summary for stakeholders in the Bregana River Basin. More detailed explanation and results are provided in section 4.2.2.

The barrier analysis in the Bregana River Basin (Croatia) is based on a strong stakeholder participation. In two workshops that took place on 16.12.2022 and on 17.02.2023, in Zagreb, a total of **32 stakeholders participated**, including representatives of public authorities, politics, academia and the private sector.

What are the top-five central barriers in the Bregana case study (in order of centrality)?

1. **Lacking political will and long-term commitment:** Our analysis suggests that there is a lack of sustained determination and readiness of political leaders over an extended period of time to take decisions and allocate resources necessary to support the effective uptake of NBS and by doing so pursue certain policy objectives favouring NBS. Political will is crucial for overcoming obstacles and implementing impactful changes.
2. **Land acquisition from private landowners**: Acquiring land from private landowners is seen as a barrier. The procedures, regulations or legal frameworks in place are posing a challenge for acquiring land for NBS projects, resulting potentially in legal, procedural, and ethical complications in the process of realising NBS.
3. **'Untouched nature' aspect of NBS:** Realising NBS implies to allow natural processes to function without significant human alterations, they thus acknowledge the intrinsic value of ecosystems. For example, rather than constructing traditional infrastructure like a dike to prevent flooding, an NBS approach can involve restoring wetlands or using blue-green infrastructures to absorb and manage excess water in a more natural and ecologically sensitive way. However, in this case study stakeholder seem to regard this constitutive characteristic for NBS as a barrier as they potentially anticipate resistance and public scepticisms towards NBS (see also barrier 5).
4. **Lacking financial resources for NBS solutions:** There seems to be a shortage or inadequacy of funds to implement and sustain NBS. However, without sufficient financial resources, the planning, realisation, and maintenance of NBS projects can be compromised.
5. **Natural appearance or features of NBS compared to technical measures:** The high centrality of a barrier similar to barrier 3 ('untouched nature') underlines that the acceptance of and trust in NBS seems to be a key overarching barrier, potentially hampering the realisation of NBS.

What are promising entry points for overcoming barriers and for supporting the mainstreaming of NBS in the Bregana River Basin?

Our analysis identified barriers with a **high transformative potential**. What do we mean by this term? Barriers with a high transformative potential are defined by two key characteristics: First, they are not so strongly influenced by other barriers, which means they operate relatively independently. Second, they are influencing multiple other barriers and thus have a strong influence on the overall barriers system hampering the realisation of NBS in the case study. Overcoming these barriers may thus have a positive influence on other barriers; they may serve as leverage points in the case study.

Our analysis identified the following the **top barriers with a high transformative potential** in the Bregana case study (see Table 2). We also included some examples of how to overcome these barriers. The examples should help to stimulate thinking and discussions in the case studies. They are not comprehensive or systematically screened for. A comprehensive mainstreaming strategy will be developed in the case studies as a next step. The outcomes will be presented in the upcoming report D4.7 (Mainstreaming NBS in the Collaboration sites).

Table 2 Transformative potential barriers and the examples of how to overcome barriers in Bregana case study

Transformative barrier	**Examples of how to overcome barriers**
*Enhancing **political will** and **long-term commitment** would serve as a lever for positively influencing other barriers*	• Put a strategic effort to engage and influence policymakers, government officials, and other key stakeholders by fostering partnerships and collaborations with influential organizations, NGOs, and advocacy groups in the region; • Identify and engage political champions who support environmental issues and/or NBS. Build alliance among these promoters and build a network advocating for NBS; • Position NBS as a means to achieve broader national goals, such as sustainable development, biodiversity conservation or climate resilience/climate adaptation. This might help to increase its perceived value among policymakers; • Work towards integrating NBS principles into existing policy frameworks. Ensure that NBS is explicitly mentioned in relevant policy documents and strategic plans, reinforcing its importance in the eyes of decision-makers.
*Enhancing a **sense of urgency** would serve as a lever for positively influencing other barriers*	• Of overarching relevance is communicating the importance of immediate actions and the potential consequences of delayed implementation, including current and impending environmental threats to the region (e.g. climate change, loss of biodiversity, occurrence of more frequent natural hazards); • Point out global/European trends as well as relevant international commitments to sustainability and climate action underscoring the general relevance and urgency of adopting NBS; • Align with broader environmental and/or social movements to enhance the perceived significance of local efforts; • Mobilize influential leaders, celebrities, and public figures to champion NBS and communicate the urgency of addressing environmental challenges. Their endorsement can reach a wide audience and amplify the sense of urgency.
*Using **'untouched nature'** as a selling point and a lever for positively influencing other barriers*	• Emphasize unique ecosystem of Bregana River, highlighting on its importance of its preservation. This can attract attention from conservation groups and people with high environmental stewardship. • Organize educational initiatives that inform the local community and stakeholders about the benefits of untouched nature. Workshops can be conducted in schools, community centers, and businesses to raise awareness.

Transformative barrier	Examples of how to overcome barriers
*Providing **incentives for marketability and business** as a lever for positively influencing other barriers*	• Introduce financial incentives for individuals, communities, and businesses adopting NBS. This could include tax breaks, subsidies, or grants to encourage the implementation of NBS; • Establish an incubator program that supports startups and entrepreneurs who are developing innovative solutions for environmental conservation or leveraging the natural assets of the Bregana River Basin; • Facilitate partnerships between the government and private sector to implement NBS projects. This can include joint investments, shared research, and development initiatives.
*Providing **scientific proof** for the benefits of NBS would serve as a lever for positively influencing other barriers*	• Develop and share insightful case studies that document successful NBS projects; • Develop simulation models that project the potential outcomes of NBS under different scenarios. Modelling can help predict ecological, social, and economic impacts and provide evidence for decision-makers; • Collaborate with universities, research institutions, and scientific organizations to conduct rigorous studies on NBS. The involvement of research institutions can add credibility to the scientific evidence generated; • Establish robust monitoring and evaluation frameworks for NBS projects; • Conduct cost-benefit analyses comparing NBS with traditional engineering solutions.

2.3 Summary of the Vrbanja River Basin case study

In this section we provide a short summary for stakeholders in the Vrbanja River Basin. More detailed explanation and results are provided in section 4.2.3.

The barrier analysis in the Vrbanja River Basin (Bosnia and Herzegovina) is based on a strong stakeholder participation. In two workshops that took place on 12.12.2022 and on 17.02.2023, in Banja Luka, a total of **28 stakeholders participated**, including representatives of public authorities, civil society, politics, academia and the private sector.

What are the top-five central barriers in the Vrbanja case study (in order of centrality)?

1. **Insufficient knowledge of NBS:** Our analysis suggests that individuals, communities, organizations, or policymakers have limited understanding or awareness of NBS. This can relate to specific applications of NBS, of their benefits, of specific implementation practices, or even to relevant policy frameworks. Establishing a solid knowledge base is a prerequisite for establishing NBS more effectively in the case study.
2. **Lacking public understanding of NBS operations:** There also seems to be a lacking public understanding regarding the planning, implementation, functioning and potential benefits of NBS. A well-informed public can actively contribute to the success of NBS initiatives by supporting relevant policies or participating in community projects. Public understanding of NBS operations is crucial for building a consensus on the importance of integrating nature into risk management strategies.
3. **Lacking political awareness of NBS**: Similarly as among the public, also among decision-makers there seems to be a lack of awareness and understanding of NBS.
4. **Lacking financial resources for NBS solutions:** There seems to be a shortage or inadequacy of funds to implement and sustain NBS. However, without sufficient financial resources, the planning, realisation, and maintenance of NBS projects can be compromised.
5. **Insufficient public participation:** Our analysis suggests that the possibility to publicly participate in the decision-making and planning processes around the realisation of NBS are not yet sufficiently established in the case study. This can result in lacking transparency about the processes, that concerns about the negative effects of NBS are not acknowledged, or that the decisions made reflect the needs and preferences of affected stakeholders. Public participation enhances the legitimacy of decisions, fosters trust between the public and decision-makers, and contributes to the overall democratic governance of a society.

What are promising entry points for overcoming barriers and for supporting the mainstreaming of NBS in the Vrbanja River Basin?

In our analysis, we identified barriers with a **high transformative potential**. What do we mean by this term? Barriers with a high transformative potential are defined by two key characteristics: First, they are not so strongly influenced by other barriers, which means they operate relatively independently. Second, they are influencing multiple other barriers and thus have a strong influence on the overall barriers system hampering the

realisation of NBS in the case study. Overcoming these barriers may thus have a positive influence on other barriers; they may serve as leverage points in the case study.

Our analysis identified the following the **top barriers with a high transformative potential** in the Vrbanja River Basin (see **Error! Reference source not found.**). We a lso included some examples of how to overcome these barriers. The examples should help to stimulate thinking and discussions in the case studies. They are not comprehensive or systematically screened for. A comprehensive mainstreaming strategy will be developed in the case studies as a next step. The outcomes will be presented in the upcoming report D4.7 (Mainstreaming NBS in the Collaboration sites).

Table 3 Transformative potential barriers and the examples of how to overcome barriers in Vrbanja case study

Transformative barrier	Examples of how to overcome barriers
*Enhancing **knowledge & public understanding** of NBS would serve as a lever for positively influencing other barriers*	• Set-up an educational campaign including the organisation of workshops and seminars providing more detailed explanation on how NBS are operating, what their potential benefits and drawbacks are. From our own analysis, we know interactive formats are considered as a relevant means of knowledge generation (see Kuhlicke et al. 2022); • Integrate NBS into school curricular and other relevant hubs of education; • Organise community workshops and seminars in the area of a planned large-scale NBS to provide communities with a platform to learn more about NBS; • Identify other organisations (including civil society organisations) with a shared interest in NBS and set-up a multiplier network advocating for NBS; • Engage with the media to effectively disseminate information about NBS, including newspaper articles, documentaries, interviews and/or podcasts.
*Providing **adequate financial resources** would serve as a lever for positively influencing other barriers*	• Involve leveraging various funding mechanisms and strategies to support projects that support the effective realisation of NBS; • Advocate for the allocation of government funds specifically dedicated to NBS projects in local, regional and national budgets. Work towards integrating NBS into environmental and development agendas, securing dedicated financial commitments. • Seek financial support from international organizations, development agencies, and donor countries. Many global funds and initiatives prioritize projects that contribute to sustainability, climate resilience, and biodiversity conservation. • Foster collaborations between public and private sectors to co-finance NBS projects. Public-Private Partnerships can bring together resources, expertise, and innovation to implement large-scale and impactful nature-based initiatives. • Tap into climate finance mechanisms, such as the Green Climate Fund (GCF), which supports projects addressing climate change mitigation and adaptation, including those based on nature-based approaches.

Transformative barrier	Examples of how to overcome barriers
*Raising **political awareness of NBS** would serve as a lever for positively influencing other barriers*	• Design targeted campaigns specifically tailored for policymakers. This can include workshops, seminars, and informational materials that highlight the relevance of NBS; • Develop concise policy briefs and white papers that present evidence-based information on the effectiveness of NBS. • Highlight successful NBS projects that have demonstrated positive outcomes. Showcase case studies and examples where NBS has been effectively implemented, emphasizing the social, economic, and environmental benefits; • Integrate references to NBS in relevant policy documents, strategies, and development plans. This ensures that the concept is officially recognized and considered in the formulation of government policies.
*Improving **political will and long-term commitment** would serve as a lever for positively influencing other barriers*	• Put a strategic effort to engage and influence policymakers, government officials, and other key stakeholders by fostering partnerships and collaborations with influential organizations, NGOs, and advocacy groups in the region; • Identify and engage political champions who are already supportive of environmental issues and/or support NBS. Build alliance among these promoters and build a network of multiplier advocating for NBS; • Position NBS as a means to achieve broader national goals, such as sustainable development, biodiversity conservation or climate resilience/climate adaptation. This might help to increase its perceived value among policymakers; • Work towards integrating NBS principles into existing policy frameworks. Ensure that NBS is explicitly mentioned in relevant policy documents and strategic plans, reinforcing its importance in the eyes of decision-makers.

2.4 Summary of the Pilica River Basin case study

In this section we provide a short summary for stakeholders in the Pilica River Basin. More detailed explanation and results are provided in section 4.2.4.

The barrier analysis in the Pilica River Basin (Poland) is based on a strong stakeholder participation. In two workshops that took place on 11.01.2023 and on 15.02.2023 in Rozprza a total of **56 stakeholders participated**, including representatives of public authorities, civil society, politics, academia, private sector and the media.

What are the top-five central barriers in the Pilica case study (in order of centrality)?

1. **Lacking public understanding of NBS operations:** Our analysis suggests that there seems to be a lacking public understanding regarding the planning, implementation, functioning and potential benefits of NBS. A well-informed public can actively contribute to the success of NBS initiatives by supporting relevant policies or participating in community projects. Public understanding of NBS operations is crucial for building a consensus on the importance of integrating nature into risk management strategies.
2. **Lacking financial resources for NBS solutions:** There seems to be a shortage or inadequacy of funds to implement and sustain NBS. However, without sufficient financial resources, the planning, realisation, and maintenance of NBS projects can be compromised.
3. **Lacking political will and long-term commitment:** From the point of view of stakeholder, there is a lack of sustained determination and readiness of political leaders over an extended period of time to take decisions and allocate resources necessary to support the effective uptake of NBS and by doing so pursue certain policy objectives favouring NBS. Political will is crucial for overcoming obstacles and implementing impactful changes.
4. **Insufficient knowledge of NBS.** It is shown that individuals, communities, organizations, or policymakers have limited understanding or awareness of NBS. This can relate to specific applications of NBS, of their benefits, of specific implementation practices, or even to relevant policy frameworks. Establishing a solid knowledge base is a prerequisite for establishing NBS more effectively in the case study.
5. **Lack of valuing nature in the legal systems**. The legal framework seems to not adequately recognise or protect the intrinsic value of nature, which is a relevant condition for the successful integration of NBS into environmental planning.

What are promising entry points for overcoming barriers and for supporting the mainstreaming of NBS in the Pilica River Basin?

In our analysis, we identified barriers with a **high transformative potential**. What do we mean by this term? Barriers with a high transformative potential are defined by two key characteristics: First, they are not so strongly influenced by other barriers, which means they operate relatively independently. Second, they are influencing multiple other barriers and thus have a strong influence on the overall barriers system hampering the realisation of NBS in the case study. Overcoming these barriers may thus have a positive influence on other barriers; they may serve as leverage points in the case study.

Our analysis identified the following the **top barriers with a high transformative potential** in the Pilica River Basin (see Table 4). We also included some examples of how to overcome these barriers. The examples should help to stimulate thinking and discussions in the case studies. They are not comprehensive or systematically screened for. A comprehensive mainstreaming strategy will be developed in the case studies as a next step. The outcomes will be presented in the upcoming report D4.7 (Mainstreaming NBS in the Collaboration sites).

Table 4 Transformative potential barriers and the examples of how to overcome barriers in Pilica case study

Transformative barrier	Examples of how to overcome barriers
*Providing **adequate financial resources** would serve as a lever for positively influencing other barriers*	• Leverage various funding mechanisms and strategies to support projects that support the effective realisation of NBS; • Advocate for the allocation of government funds specifically dedicated to NBS projects in local, regional and national budgets. Work towards integrating NBS into environmental and development agendas, securing dedicated financial commitments; • Seek financial support from international organizations, development agencies, and donor countries. Many global funds and initiatives prioritize projects that contribute to sustainability, climate resilience, and biodiversity conservation; • Foster collaborations between public and private sectors to co-finance NBS projects. Public-Private Partnerships can bring together resources, expertise, and innovation to implement large-scale and impactful nature-based initiatives; • Tap into climate finance mechanisms, such as the Green Climate Fund (GCF), which supports projects addressing climate change mitigation and adaptation, including those based on nature-based approaches.
*Enhancing **public understanding/knowledge of NBS** would serve as a lever for positively influencing other barriers*	• Set-up an educational campaign including the organisation of workshops and seminars providing more detailed explanation on how NBS are operating, what their potential benefits and drawbacks are. From our own analysis, we know interactive formats are considered as a relevant means of knowledge generation (see Kuhlicke et al. 2022); • Integrate NBS into school curricular and other relevant hubs of education; • Organise community workshops and seminars in the area of a planned large-scale NBS to provide communities with a platform to learn more about NBS; • Identify other organizations (including civil society organizations) with a shared interest in NBS and set-up a multiplier network advocating for NBS. • Engage with the media to effectively disseminate information about NBS, including newspaper articles, documentaries, interviews and/or podcasts.

Transformative barrier	Examples of how to overcome barriers
*Improving **political will and long-term commitment** would serve as a lever for positively influencing other barriers*	• Put a strategic effort to engage and influence policymakers, government officials, and other key stakeholders by fostering partnerships and collaborations with influential organizations, NGOs, and advocacy groups in the region; • Identify and engage political champions who are already supportive of environmental issues and/or support NBS. Build alliance among these promoters and build a network of multiplier advocating for NBS; • Position NBS as a means to achieve broader national goals, such as sustainable development, biodiversity conservation or climate resilience/climate adaptation. This might help to increase its perceived value among policymakers; • Work towards integrating NBS principles into existing policy frameworks. Ensure that NBS is explicitly mentioned in relevant policy documents and strategic plans, reinforcing its importance in the eyes of decision-makers.
*Raising **political awareness of NBS** would serve as a lever for positively influencing other barriers*	• Design targeted campaigns specifically tailored for policymakers. This can include workshops, seminars, and informational materials that highlight the relevance of NBS; • Develop concise policy briefs and white papers that present evidence-based information on the effectiveness of NBS; • Highlight successful NBS projects that have demonstrated positive outcomes. Showcase case studies and examples where NBS has been effectively implemented, emphasizing the social, economic, and environmental benefits; • Integrate references to NBS in relevant policy documents, strategies, and development plans. This ensures that the concept is officially recognized and considered in the formulation of government policies.
*Overcoming **siloed thinking** would serve as a lever for positively influencing other barriers*	• Create cross-sectorial/cross-functional teams with representatives of different departments, unit or agencies that have expertise on the realisation of NBS and/or are affected by the realisation of NBS; • Agree upon and define common goals or visions that require collaboration between different units and would support the uptake of NBS; • Establish channels for open communication and exchange of information across different units, including regular meeting, shared knowledge and exchange platforms.

2.5 Summary of the Jadar River Basin case study

In this section we provide a short summary for stakeholders in the Jadar River Basin. More detailed explanation and results are provided in section 4.2.5.

The barrier analysis in the Jadar River Basin (Serbia) is based on a strong stakeholder participation. In two workshops that took place on 09.12.2022 and on 23.02.2023 in Krupanj a total of **41 stakeholders participated**, including representatives of public authorities, civil society, politics, academia, private sector and the media.

What are the top-five central barriers in the Jadar case study (in order of centrality)?

1. **Lacking financial resources for NBS solutions:** There seems to be a shortage or inadequacy of funds to implement and sustain NBS. However, without sufficient financial resources, the planning, realisation, and maintenance of NBS projects can be compromised.
2. **Lacking political will and long-term commitment:** There is a lack of sustained determination and readiness of political leaders over an extended period of time to take decisions and allocate resources necessary to support the effective uptake of NBS and by doing so pursue certain policy objectives favouring NBS. Political will is crucial for overcoming obstacles and implementing impactful changes.
3. **Lacking Sense of urgency:** There is a lack of immediate drive or perceived need to implement NBS, which can delay decision-making and action.
4. **Lacking legal basis for land acquisition**: Acquiring land from private landowners is a central barrier in the case study. The procedures, regulations or legal frameworks in place are posing a challenge for acquiring land for NBS projects, resulting potentially in legal, procedural, and ethical complications in the process of realising NBS.
5. **Silo thinking:** The established organisational-institutional in the case-study is not yet ready to support the effective uptake of NBS. We can assume that the current structure is dominated by various sections of a government or public organization working relatively independently from each other and focusing solely on their own goals and objectives, without sharing information or coordinating efforts with other units, which would be beneficial for a more effective uptake of NBS.

What are promising entry points for overcoming barriers and for supporting the mainstreaming of NBS in the Jadar River Basin?

In our analysis, we identified barriers with a **high transformative potential**. What do we mean by this term? Barriers with a high transformative potential are defined by two key characteristics: First, they are not so strongly influenced by other barriers, which means they operate relatively independently. Second, they are influencing multiple other barriers and thus have a strong influence on the overall barriers system hampering the realisation of NBS in the case study. Overcoming these barriers may thus have a positive influence on other barriers; they may serve as leverage points in the case study.

Our analysis identified the following the **top barriers with a high transformative potential** in the Jadar River Basin (see Table 5). We also included some examples of how to overcome these barriers. The examples should help to stimulate thinking and discussions in the case studies. They are not comprehensive or systematically screened

for. A comprehensive mainstreaming strategy will be developed in the case studies as a next step. Its outcomes will be presented in the upcoming report D4.7 (Mainstreaming NBS in the Collaboration sites).

Table 5 Transformative potential barriers and the examples of how to overcome barriers in Jadar case study

Transformative barrier	**Examples of how to overcome barriers**
*Providing **adequate financial resources** would serve as a lever for positively influencing other barriers*	• Leverage various funding mechanisms and strategies to support projects that support the effective realisation of NBS; • Advocate for the allocation of government funds specifically dedicated to NBS projects in local, regional and national budgets. Work towards integrating NBS into environmental and development agendas, securing dedicated financial commitments; • Seek financial support from international organizations, development agencies, and donor countries. Many global funds and initiatives prioritize projects that contribute to sustainability, climate resilience, and biodiversity conservation; • Foster collaborations between public and private sectors to co-finance NBS projects. Public-Private Partnerships can bring together resources, expertise, and innovation to implement large-scale and impactful nature-based initiatives; • Tap into climate finance mechanisms, such as the Green Climate Fund (GCF), which supports projects addressing climate change mitigation and adaptation, including those based on nature-based approaches.
*Improving **political will and long-term commitment** would serve as a lever for positively influencing other barriers*	• Put a strategic effort to engage and influence policymakers, government officials, and other key stakeholders by fostering partnerships and collaborations with influential organizations, NGOs, and advocacy groups in the region; • Identify and engage political champions who are already supportive of environmental issues and/or support NBS. Build alliance among these promoters and build a network of multiplier advocating for NBS; • Position NBS as a means to achieve broader national goals, such as sustainable development, biodiversity conservation or climate resilience/climate adaptation. This might help to increase its perceived value among policymakers; • Work towards integrating NBS principles into existing policy frameworks. Ensure that NBS is explicitly mentioned in relevant policy documents and strategic plans, reinforcing its importance in the eyes of decision-makers.

Transformative barrier	Examples of how to overcome barriers
*Enhancing **knowledge of NBS** would serve as a lever for positively influencing other barriers*	• Set-up an educational campaign including the organisation of workshops and seminars providing more detailed explanation on how NBS are operating, what their potential benefits and drawbacks are. From our own analysis, we know interactive formats are considered as a relevant means of knowledge generation (see Kuhlicke et al. 2022); • Integrate NBS into school curricular and other relevant hubs of education; • Organise community workshops and seminars in the area of a planned large-scale NBS to provide communities with a platform to learn more about NBS; • Identify other organisations (including civil society organisations) with a shared interest in NBS and set-up a multiplier network advocating for NBS. • Engage with the media to effectively disseminate information about NBS, including newspaper articles, documentaries, interviews and/or podcasts.
*Overcoming **siloed thinking** would serve as a lever for positively influencing other barriers*	• Create cross-sectorial/cross-functional teams with representatives of different departments, unit or agencies that have expertise on the realisation of NBS and/or are affected by the realisation of NBS; • Agree upon and define common goals or visions that require collaboration between different units and would support the uptake of NBS; • Establish channels for open communication and exchange of information across different units, including regular meeting, shared knowledge and exchange platforms.
*Raising **political awareness of NBS** would serve as a lever for positively influencing other barriers*	• Design targeted campaigns specifically tailored for policymakers, this can include workshops, seminars, and informational materials that highlight the relevance of NBS; • Develop concise policy briefs and white papers that present evidence-based information on the effectiveness of NBS. • Highlight successful NBS projects that have demonstrated positive outcomes. Showcase case studies and examples where NBS has been effectively implemented, emphasizing the social, economic, and environmental benefits; • Integrate references to NBS in relevant policy documents, strategies, and development plans. This ensures that the concept is officially recognized and considered in the formulation of government policies.

2.6 Summary of the Tamnava River Basin case study

In this section we provide a short summary for stakeholders in the Tamnava River Basin. More detailed explanation and results are provided in section 4.2.6.

The barrier analysis in the Tamnava River Basin (Serbia) is based on a strong stakeholder participation. In two workshops that took place on 12.12.2022 and on 21.02.2023 in Ub, a total of **41 stakeholders participated**, including representatives of public authorities, civil society, politics, academia, private sector and the media.

What are the top-five central barriers in the Tamnava case study (in order of centrality)?

1. **Lacking financial resources for NBS solutions:** There seems to be a shortage or inadequacy of funds to implement and sustain NBS. However, without sufficient financial resources, the planning, realisation, and maintenance of NBS projects can be compromised.
2. **Operational capacity**: Challenges exist in effectively implementing and managing NBS projects because of limitations in skills, resources, and organisational capabilities.
3. **Lacking Sense of urgency:** There is a lack of immediate drive or perceived need to implement NBS, which can delay decision-making and action.
4. **Lacking legal basis for land acquisition**: Acquiring land from private landowners is a barrier in the case study. The procedures, regulations or legal frameworks in place are posing a challenge for acquiring land for NBS projects, resulting potentially in legal, procedural, and ethical complications in the process of realising NBS.
5. **Lacking political will and long-term commitment:** There is a lack of sustained determination and readiness of political leaders over an extended period of time to take decisions and allocate resources necessary to support the effective uptake of NBS and by doing so pursue certain policy objectives favouring NBS. Political will is crucial for overcoming obstacles and implementing impactful changes.

What are promising entry points for overcoming barriers and for supporting the mainstreaming of NBS in the Tamnava River Basin?

In our analysis, we identified barriers with a **high transformative potential**. What do we mean by this term? Barriers with a high transformative potential are defined by two key characteristics: First, they are not so strongly influenced by other barriers, which means they operate relatively independently. Second, they are influencing multiple other barriers and thus have a strong influence on the overall barriers system hampering the realisation of NBS in the case study. Overcoming these barriers may thus have a positive influence on other barriers; they may serve as leverage points in the case study.

Our analysis identified the following the **top barriers with a high transformative potential** in the Tamnava River Basin (see Table 6). We also included some examples of how to overcome these barriers. The examples should help to stimulate thinking and discussions in the case studies. They are not comprehensive or systematically screened for. A comprehensive mainstreaming strategy will be developed in the case studies as a next step. Its outcomes will be presented in the upcoming report D4.7 (Mainstreaming NBS in the Collaboration sites).

Table 6 Transformative potential barriers and the examples of how to overcome barriers in Tamnava case study

Transformative barrier	Examples of how to overcome barriers
*Providing **adequate financial resources** would serve as a lever for positively influencing other barriers*	• Involve various funding mechanisms and strategies to support projects that support the effective realisation of NBS; • Advocate for the allocation of government funds specifically dedicated to NBS projects in local, regional and national budgets. Work towards integrating NBS into environmental and development agendas, securing dedicated financial commitments; • Seek financial support from international organizations, development agencies, and donor countries. Many global funds and initiatives prioritize projects that contribute to sustainability, climate resilience, and biodiversity conservation; • Foster collaborations between public and private sectors to co-finance NBS projects. Public-Private Partnerships can bring together resources, expertise, and innovation to implement large-scale and impactful nature-based initiatives; • Tap into climate finance mechanisms, such as the Green Climate Fund (GCF), which supports projects addressing climate change mitigation and adaptation, including those based on nature-based approaches.
*Enhancing a **sense of urgency** would serve as a lever for positively influencing other barriers*	• Of overarching relevance is communicating the importance of immediate actions and the potential consequences of delayed implementation, including current and impending environmental threats to the region (e.g. climate change, loss of biodiversity, occurrence of more frequent natural hazards); • Point out global/European trends as well as relevant international commitments to sustainability and climate action underscoring the general relevance and urgency of adopting NBS; • Align with broader environmental and/or social movements to enhance the perceived significance of local efforts; • Mobilize influential leaders, celebrities, and public figures to champion NBS and communicate the urgency of addressing environmental challenges. Their endorsement can reach a wide audience and amplify the sense of urgency.
*Improving **political will and long-term commitment** would serve as a lever for positively influencing other barriers*	• Put a strategic effort to engage and influence policymakers, government officials, and other key stakeholders by fostering partnerships and collaborations with influential organizations, NGOs, and advocacy groups in the region; • Identify and engage political champions who are already supportive of environmental issues and/or support NBS. Build alliance among these promoters and build a network of multiplier advocating for NBS; • Position NBS as a means to achieve broader national goals, such as sustainable development, biodiversity conservation or climate resilience/climate adaptation. This might help to increase its perceived value among policymakers; • Work towards integrating NBS principles into existing policy frameworks. Ensure that NBS is explicitly mentioned in relevant policy documents and strategic plans, reinforcing its importance in the eyes of decision-makers.

Transformative barrier	Examples of how to overcome barriers
*Developing a more **comprehensive legal basis for land acquisition, established compensation mechanisms and incentives** for NBS would serve as a lever for positively influencing other barriers*	• Develop comprehensive legislation and regulations specifically addressing land acquisition for NBS, including clear guidelines on how the process, criteria, and conditions for acquiring land; • Establish mechanisms for fair and transparent market valuation of the land in order to ensure that compensation is based on the actual value of the land and takes into account relevant factors (e.g. agricultural potential, ecological value, or cultural significance); • Introduce financial incentives for individuals, communities, and businesses adopting NBS. This could include tax breaks, subsidies, or grants to encourage the implementation of NBS.
*Raising **political awareness of NBS** would serve as a lever for positively influencing other barriers*	• Design targeted campaigns specifically tailored for policymakers. This can include workshops, seminars, and informational materials that highlight the relevance of NBS; • Develop concise policy briefs and white papers that present evidence-based information on the effectiveness of NBS; • Highlight successful NBS projects that have demonstrated positive outcomes. Showcase case studies and examples where NBS has been effectively implemented, emphasizing the social, economic, and environmental benefits; • Integrate references to NBS in relevant policy documents, strategies, and development plans. This ensures that the concept is officially recognized and considered in the formulation of government policies.

3 RECONECT's Framework for the barrier analysis

3.1 Shortcomings of existing barrier analyses

In the face of escalating environmental challenges and an increasing number of hydro-meteorological risks, the implementation of NBS has gained relevance in addressing societal challenges, reducing vulnerability, and increasing the resilience of natural systems to face climate change and guide sustainable transformations (Seddon et al., 2020). NBS are framed as a promising way to address both climate change adaptation and mitigation and at the same time protect or even restore natural habitats while also providing multiple co-benefits for society (Cohen-Shacham et al., 2016).

However, while the benefits of NBS are well documented and there is high support for NBS on the international policy level, the transformative potential of NBS remains untapped, as there exist still several barriers which are challenging the mainstreaming of NBS beyond demonstrator projects (Schröter et al., 2022). Therefore, a rapidly growing number of studies have been conducted in recent years aiming at identifying the most relevant barriers to the realisation of NBS.

In this section, we provide a synoptic review of relevant studies with the aim of informing the catalogue of barriers as well as the methodological design presented in subsequent sections.

Most of the studies we reviewed are either review studies, often extended and validated through expert knowledge, or in-depth qualitative case studies. They usually follow a similar objective: by identifying relevant barriers researchers aim to support decision-makers and practitioners involved in the realisation of NBS projects (Deely et al., 2020). In this sense, barriers are perceived as a risk to the realisation of NBS projects. If such risks are identified early in the implementation process, more specific strategies and practices can be developed on how to overcome potential barriers (Deely et al., 2020).

Case studies play an important role in this field of research. They are often based on expert-interviews and follow an inductive study design (i.e. hypotheses are not specified initially, and the theoretical framework is not explicated). There are only very few studies that are based on a multi-case study design (i.e. studies conducted in different settings) (see Table 7).

Table 7 A selection of different categorisation of barriers to realise NBS

Authors (Year)	Suggested categories for grouping barriers	Total number/ description of barriers	Study design
Matthews et al. (2015)	• Biophysical capability • Socio-political feasibility	• Qualitative description	Mixed-methods, literature review, interview analysis
Thorne et al., (2018)	• Asset performance and service provision • Community expectations and change • Environmental change and hazard • Regulatory environment and city planning • Climate change uncertainty	• Qualitative description	Local in-depth case study, interview analysis

O'Donnell et al. (2017)	• Socio-political • Biophysical	• 17 barriers	Single case study design; interview analysis
Zuniga-Teran et al. (2019)	• Design standards • Regulatory pathways • Socio-economic challenges • Financiability • Innovation	• Qualitative description	
Han and Kuhlicke (2021)	• Attitudinal barriers (perceived coping capacity/cost effectiveness/co-benefits/self-interest) • Contextual barriers (institutional/legal/political/social)	• 29 barriers	Single case study design; interview analysis
Deely et al. (2020)	• Institutions and governance • Funding and market • Knowledge • Technical and biophysical barriers	• 56 barriers	
Dorst et al. (2022)	• Limited collaborative governance • Knowledge, data, and awareness challenges • Low private-sector engagement • Competition over urban space • Insufficient policy development, implementation, and enforcement oriented at NBS • Citizens engagement challenges	• Qualitative description	Multi-case study design; interview analysis along the pre-existing framework
Blackwood et al. (2022)	• Safety concerns • Lack of evidence • Time constraints • Limited costs-benefit analysis • Land use constraints • Stakeholders' dependencies • Climate change uncertainties	• Qualitative description	
Martin et al. (2023)	• Socio-cultural • Institutional • Human resources and capacities • Legal • Political • Environmental	• 264 barriers	Systematic literature review

Meanwhile, a multitude of barriers have been identified. In a systematic review, the PHUSICOS consortium identified more than 260 barriers (Martin et al. 2023). However, while there is a rapidly increasing number of studies published, their analytical depths and practical relevance beyond single case studies remain limited. Several shortcomings characterise the current mode of analysis.

First, inductive studies usually focus on a specific cultural-socio-economic-political-institutional context. This raises the question of whether a set of barriers identified as relevant in one case study is also of relevance in another case study. If for instance, legal framework conditions are considered as being highly relevant in case study A, this does not mean that such barriers are also of relevance in case study B, particularly if in case study B a legal framework exists that is highly supportive for the uptake of NBS. This implies that the findings of single studies are hardly comparable, as they often address quite specific contexts without relying on a previously defined conceptual or theoretical

framework. This shortcoming is also grounded in the fact that most studies do not explicate their theoretical assumptions. There are only a few studies following a more theory-grounded approach. Thorne et al. (2018), for instance, argue that uncertainties with respect to hydrological performance as well as public confidence and acceptability are the two major barriers to a more effective uptake of BGI in urban flood risk management. By building on the framework of 'Relevant Dominant Uncertainties' (RDUs), a concept originally proposed by Smith and Petersen (2015) in order to assess uncertainties in the physical sciences (such as climate modelling), Thorne et al. (2018) expand this framework by including also socio-cultural uncertainties as relevant barriers. They result from a lack of education and/or confidence or the absence of trusted legal sanctions. While some of these uncertainties are very hard to overcome (e.g. uncertainties related to the inherent natural variability), others can be addressed through more research, for instance. Similarly, Matthews et al. (2015) propose to assess the capacities of green infrastructures for climate adaptation as a function of the biophysical capability of such infrastructures as well as the socio-political feasibility, the latter being influenced by societal characteristics such as knowledge, attitudes, policy, costs, etc. Dorst et al. (2022) systematically analyse how barriers to urban NBS are generated by the structural conditions of the socio-technical regime that shape urban development. By referring to the research field of urban studies and socio-technical transitions, their analysis aims at uncovering the deeper structural conditions that result in specific barriers that hamper the realisation of NBS.

Second, the attempt to aggregate and group barriers along overarching categories (see Table 1) may help to reduce underlying complexity and transform a variety of information into digestible pieces (Martin et al. 2023); however, it also comes at some costs. Since the conceptual or theoretical basis for defining the different categories is usually not explicated, categories often "emerge" out of the empirical material or are defined by following a common sense approach. Therefore, it is challenging to compare the different overarching categories literally because (1) what is included under one category might also be included in other categories as categories are not distinct; (2) categories can be rather broad (e.g. bio-physical or socio-political barriers) or rather narrow (e.g. time constraints); (3) categories can be on different levels. Legal barriers, for instance, could be considered as a sub-category of institutional barriers, and hence merged they can be kept separate depending on how the different categories are defined.

Third, there are also methodological shortcomings. Most studies are based on qualitative interviews, inductive coding, or predefined surveys. The result of the analysis is often a ranking of how different barriers hamper the realisation of NBS projects. Only a small number of studies take methodologically a more elaborate approach. Sarabi et al. (2020), for instance, applied interpretative structural modelling in order to identify through expert interviews how single elements of a comprehensive model are systematically interlinked. A key finding of their analysis is that overcoming political and institutional challenges can help to address knowledge-related as well as attitudinal barriers.

3.2 RECONECT'S catalogue of barriers

In RECONECT, we propose an approach that acknowledges the identified shortcomings whilst enabling us to comprehend the interconnectedness of barriers in a systematic manner. We therefore propose a conceptual framework that allows comparing results gained in different contexts and at the same is sensitive to the interconnected of different barriers. In this sense, the framework shall not just provide a basis for comparability but also for assessing barriers and their interlinkages in a more complex system perspective.

While in our view both aspects (conceptual framework and system perspective) are relevant for this field of research, they are rarely applied.

RECONECT's catalogue of barriers is created in three iterative steps: on an overarching conceptual framework, on lessons learned by the Demonstrators B of the RECONECT project, and on a thorough literature review.

The management of hydro-meteorological risks has undergone profound transformations in recent years. This includes the establishment of risk-based management approaches aiming at providing a more rational way of balancing costs and benefits in the management of risks in order to identify appropriate protection levels as well as the broadening and diversification of measures for mitigation of such risks. As an implication, a great number and diversity of actors need to be involved in the management of risks. Therefore, the idea of risk governance, both as a normative idea (Begg et al., 2017; Kuhlicke & Demeritt, 2016; Renn, 2008) as well as an analytical concept (Kaufmann & Wiering, 2017; Matczak et al., 2018; Pettersson et al., 2017; Wiering et al., 2017) has gained considerable attraction more recently. With the emphasis on governance, the focus turns towards the role of non-governmental actors in the management of risk and how to legitimately coordinate the interaction of stakeholders from the state, economy, civil society, etc. (Hartmann et al., 2018). As a response to these shifts, polycentric governance structures have evolved and are understood as systems in which decisions are taken through formally independent decision-centres.

However, although the shift from risk management to risk governance implies an increasing sensitivity towards the relevance of informal institutions and participatory processes, established structural conditions and more formally established institutionalised rules and norms (i.e. legal frameworks), organisational responsibilities, financing schemes as well as path-dependencies still play an important role. Even more, such structural regimes can represent themselves as a profound system of barriers to the realisation of NBS if they are not designed to support them effectively (Dorst et al., 2022).

Based on our initial reflections, we have formulated a **heuristic framework** that encompasses various domains. On one hand, it is responsive to the NBS project's unique characteristics and how they differ from conventional technical solutions. On the other hand, it enables us to factor in the broader socio-institutional-legal-political contexts. The framework aims to simplify the process and assist stakeholders in identifying the relevant obstacles.

The framework also builds **lessons learned from Demonstrator B cases** in RECONECT. The most relevant source of information in this context was the Dutch **Room for the River Programme**, which is one of the central Demonstrators cases in RECONECT (see Franco Hernández, 2021 for more details). Through a semi-structured interview with the former General Director of the program, substantive information on relevant barriers was collected. The interview covered diverse topics, such as background information about the program, identification of barriers, and the relationship between project stages and barriers. Based upon the interviews an initial framework was developed. The framework was then applied to different test sites in Serbia. The study was understood as a pilot and should allow us to assess whether relevant barriers were included in the framework. The most relevant barriers were included in the catalogue of barriers for this study. Barriers identified as relevant were included in RECONECT catalogue of barriers. In addition, a extensive literature review was conduced and as a

result the RECONECT catalogue of barriers was derived (see Table 8). The barriers were crouped along overarching domains.

The first domain is concnerd with the NBS themelves and include:

- **Effectiveness of NBS:** This domain of barriers is concerned with the physical appearance of NBS and how they are perceived (often in comparison to more established technical solutions, including their effectiveness). This includes, how they appear and how they operate (uncertainty, time scales), how they are designed (more space), how costly they are (implementation, maintenance), and whether they are beneficial at all.

- **Values and demerits of NBS**: This domain of barriers is concerned with how NBS are valued (also financially) and potential demerits that might result from their realisation. This includes co-benefits (aesthetic and recreational value, health benefits, and quality of life) as well as drawbacks (access to sites, landscape changes, threads to places, and land acquisition from private owners).

The next two domains are concerned with the institutional-legal-political framework and whether it supports the uptake of NBS:

- **Institutional context:** This domain of barriers is concerned with whether and how NBS are institutionally supported, whether organisations have the operational capacity, whether financial resources are made available, whether silo thinking and path dependency are dominant, and whether the institutional context provides incentives for the marketability of NBS.

- **Legal context:** This domain of barriers is concerned with whether and how NBS are legally supported. It is about design standards, the existence of legal frameworks for land acquisition, compensation and incentives for realising NBS, and the liability between local governments but also about whether nature (and the services it provides) is valued in the legal system.

- **Political context:** This domain of barriers is concerned with whether and how NBS are politically supported. This includes political commitment, a sense of urgency for change, and awareness about the topic but also questions of ideologicalization and populism.

The last domain is concerned with the wider social and political context.

- **Social context:** This domain of barriers is concerned with whether and how NBS are socially supported. This includes the public understanding of as well as knowledge about NBS, publication participation, and the role of stakeholder groups as well as intermediators and knowledge brokers.

Table 8 Catalogue of relevant barriers

Category	*Components used for FCM activity*	*Reference*
A. Effectiveness of NBS	A1. Natural appearance or features of NBS (compared to technical measures)	Chou (2012, 2013); Martinez-Juarez et al. (2019)
	A2. Uncertainty about the effectiveness of NBS	Geels (2011); Han and Kuhlicke (2021); Kabisch et al. (2016); Sarabi et al. (2019); van der Jagt et al. (2017)
	A3. Long time scale of NBS implementation/effective operation	Krauze and Wagner (2019); Pontee et al. (2016)
	A4. Need of more space than traditional flood risk measures	Krauze and Wagner (2019); Pontee et al. (2016)
	A5. Perception of NBS as having limited and supplemental effectiveness for risk reduction	Kabisch et al. (2016); Krauze and Wagner (2019)
	A6. Implementation cost compared to technical solutions	Han and Kuhlicke (2021)
	A7. Maintenance cost compared to technical solutions	Han and Kuhlicke (2021)
	A8. Cost-efficiency of NBS	Han and Kuhlicke (2021)
	A9. Scientific proof for their benefit	Geels (2011); Han and Kuhlicke (2021); Kabisch et al. (2016); van der Jagt et al. (2017)
B. Values and demerits of NBS	B1. Aesthetic and recreational value	Barthelemy and Armani (2015); Gray et al. (2017)
	B2. Health benefits	Vujcic et al. (2017)
	B3. “Untouched nature” aspect of nature-based solutions	Han and Kuhlicke (2021)
	B4. Accessibility to NBS sites	Wolff et al. (2022)
	B5. Impact on residents’ quality of life due to the construction of NBS	Han and Kuhlicke (2021)
	B6. Compensation mechanism	Santiago Fink (2016)
	B7. Landscape-scale change in the place	Han et al. (2023)
	B8. Place attachment to the place before NBS implementation	Anderson et al. (2021); Geels (2011); Han and Kuhlicke (2021); Han (2023); van der Jagt et al. (2017)
	B9. Land acquisition from private owners	Raška et al., (2022)
C. Institutional	C1. Operational capacity	Han and Kuhlicke (2021)
	C2. Financial Resources for NBS	Horst et al. (2020); Kabisch et al. (2016); Sarabi et al. (2019); Seddon et al. (2020)
	C3. Path dependence	Sarabi et al. (2020)
	C4. Incentives for marketability and business environment	Han and Kuhlicke (2021)
	C5. Misalignments between short-term plans and long-term goals	Han and Kuhlicke (2021)
	C6. Silo thinking	Randrup et al. (2020)
D. Legal	D1. Nature value in the legal system	Han and Kuhlicke (2021)
	D2. Design standards and guidelines for maintenance and monitoring	Sarabi et al. (2019)

	D3. Legal basis for land acquisition, compensation, and incentives	Han and Kuhlicke (2021)
	D4. Liability between local governments or within the organizations	Bush and Doyon (2019); Kauark-Fontes et al. (2023); van der Jagt et al. (2017); Wamsler et al. (2016); C. Wamsler et al. (2020)
E. Political	E1. Political will and long-term commitment	Clar et al. (2013); Christine Wamsler et al. (2020)
	E2. Sense of urgency	Sarabi et al. (2020)
	E3. Populism in nature-based solutions politics	Han and Kuhlicke (2021)
	E4. Ideologicalization of nature-based solutions policy	Han and Kuhlicke (2021)
	E5. Awareness of NBS	C. Wamsler et al. (2020)
F. Social	F1. Public participation	C. Wamsler et al. (2020)
	F2. Coalitions and stakeholder groups	Han and Kuhlicke (2021)
	F3. Public understanding of nature-based solutions operations	C. Wamsler et al. (2020)
	F4. Knowledge of nature-based solutions	Han and Kuhlicke (2021); Horst et al. (2020); Kabisch et al. (2016)
	F5. Intermediaries and facilitators/knowledge brokers/training programs	Han and Kuhlicke (2021)

4 Methodology and case studies

This study employs a multi-method approach to effectively respond to the relevant research questions. The summary of the methodologies used for the given research questions is shown in Table 9, which also indicates the sections of this report describing the methods.

Table 9 Methodological Framework

Chapter	Method	Goal
3.1. Barrier Identification	Ranking	Identification of max. 20 influential barriers/drivers
	Methodological steps	
	1. Group Formation by Sectors	Participants are grouped by their sectors
	2. Barrier/Enabler Card Selection	Use a board to select barriers/enablers based on criteria
	3. Ranking and Consensus Building	Groups discuss and rank barriers/enablers, aiming for consensus on their rankings.
	4. Visual Representation	A board is used to visually identify the barriers
3.2 Fuzzy Cognitive Mapping (FCM)	**Method**	**Goal**
	Fuzzy Cognitive Mapping (FCM)	Visual representation to model causal connections between system components
	Methodological steps	
	1. Pre-established components from 'Barrier identification activity	The components are pre-selected from prior barrier identification activity.
	2. Mapping Process	Three steps: 1. Connection: Link components based on perceived causal relationships 2. Direction Assignment: Specify the nature (positive/negative) of each relationship 3. Strength Assignment: Quantify the strength of each relationship
	3. Integration of Enablers	Add 'enablers' to the system representation to ensure a comprehensive understanding

4.1 Identifying relevant barriers

In the first step, the most relevant barriers/drivers for realizing successful NBS in each collaborator's site were identified. This activity was the foundation for FCM. The aim was to identify 20 barriers/drivers (maximum) out of around 40 that can be most influential and important. Most importantly, participants were also invited to add any other barriers/drivers which was not yet included in the framework. The selection criteria are as follows:

- Multifaceted Influence: Barriers/Drivers that can influence many other barriers/drivers
- System-wide Impact: Barriers/Drivers that can impact the entire system and governance

For example, a ‘lack of financial resources’ can impact marketability, operational capacity, political will, etc. This can impact the entire system of NBS for a successful realization. Therefore this can be considered an influential and important barrier.

The activity followed the following steps:

1. Group Formation by Sectors
Participants were segregated based on their professional sectors, such as academia & research, private sector organizations, public authorities, political representation, civil society organizations, and media.

2. Barrier/Enabler Card Selection
A board displaying the barriers and drivers was provided to each group. Participants were tasked with selecting barrier/enabler cards that they deemed significant based on the established selection criteria.

3. Ranking and Consensus Building
Each group embarked on a discussion, evaluating each barrier and driver, and subsequently laying them out in a rank order. The task was not just in ranking but ensuring that the entire group reached a consensus on the list and the ranks.

A visual representation of this activity can be seen in Figure 2, which shows the board utilized by participants for the identification process.

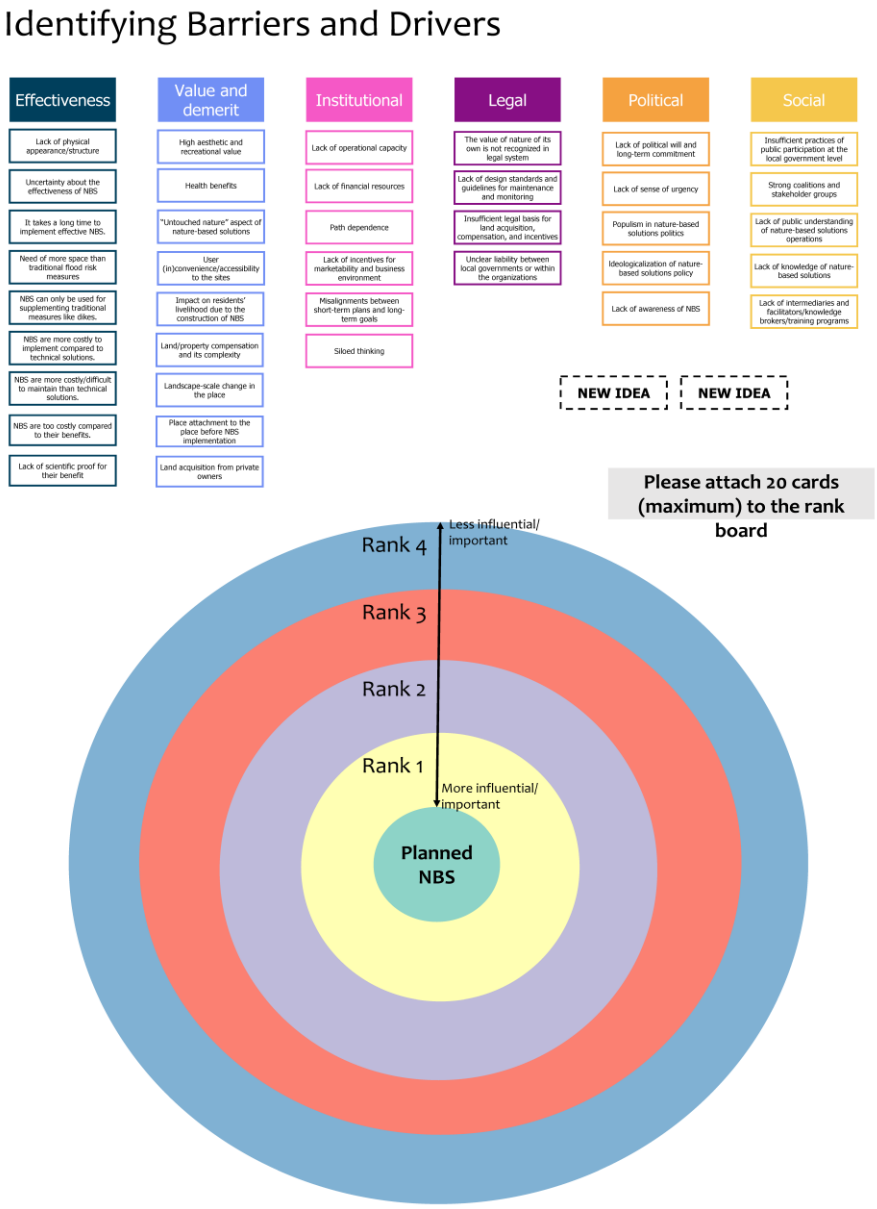

Figure 2 Identifying relevant barriers/drivers from the perspective of stakeholders

4.2 Fuzzy Cognitive Mapping (FCM)

In the next step, we conducted Fuzzy Cognitive Mapping (FCM). FCM is a graphical interpretation of a system represented by cause-effect relationships among elements (e.g. concepts, events, project resources) (Kosko, 1986). Rooted in the principles of fuzzy logic and cognitive structure, FCMs provide a framework to capture and portray the complexities and intricacies of various systems, making it particularly popular in scenarios where the exact mathematical model of the system is either unknown or too complex. Also, it can build on stakeholder understanding and experience of the system and can be used to compute the "strength of impact" of a barrier on the overall system of barriers.

It is a formal way of representing social scientific knowledge and modelling decision-making in social and political systems brought in the computation of fuzzy logic (Kosko, 1986). It is a research method suitable for getting an insight into stakeholders' perceptions of some issue or problem (Hester, 2015). It is a qualitative or rather semi-quantitative and dynamic method to structure expert knowledge that aims to capture a person's perception of a particular issue in a diagrammatic format. Fuzzy cognitive map graphs provide both the researchers and the participants with an informal structured process having the ability to give additional beliefs, insights and concepts about a certain domain. Furthermore, the interrelations and interdependencies of these concepts are also revealed, providing information about how the change of one issue can affect the others.

The main aim is the elicitation of qualitative data which are then used to build a model of the system in terms of a set of variables and the causal relations among these variables, which are recorded as directed links in a graph. Variables can be physical quantities that can be measured, such as the amount of precipitation or percent vegetation cover, or complex aggregate and abstract One of the foundational steps in creating an FCM is identifying and establishing the relationships between components (or variables) of the system. This process can be guided by the following pertinent questions: ideas, such as political forces or aesthetics which are not assigned any number.

One of the foundational steps in creating an FCM is identifying and establishing the relationships between components (or variables) of the system. This process can be guided by the pertinent questions in Figure 3.

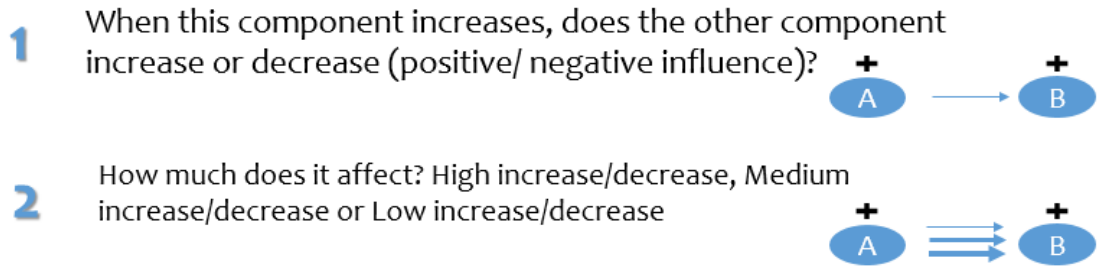

Figure 3 Relevant questions for determining the relationship of components in FCM

Furthermore, the analysis of aggregated models also makes it possible to identify particularly critical nodes and system structures that influence the complex network of barriers that were not immediately apparent in the individual mental models. For this purpose, we rely on network algorithms to identify key nodes.

A typical FCM visualization would comprise nodes and directed edges. Nodes represent the components or variables of the system, while directed edges signify the relationships between these components. The direction of an edge indicates the direction of influence, and its weight (thickness of the arrows) represents the magnitude of the influence. Figure 4 shows the FCM with 16 aggregated variables; the line thickness reflects the strength of the association, with thicker lines denoting stronger relationships. Positive causal relationships are represented by solid lines, whereas negative causal relationships are depicted by dashed lines. For instance, the association between industry and increased lake pollution on the map is the strongest. Agriculture increases income while simultaneously increasing lake pollution, which is another strong beneficial association. Income also rises when the ecosystem is healthy. By developing concise cognitive maps for various individuals or stakeholder groups, we can quickly visualize the key variables and connections that matter most to them, highlighting both their commonalities and differences.

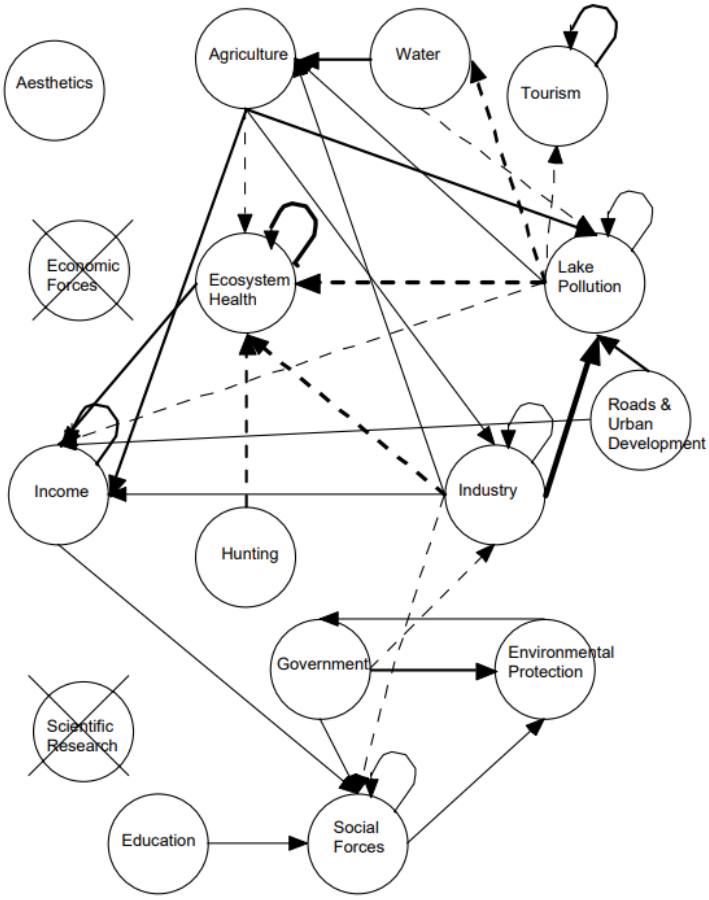

Figure 4 Example of components and relationships in FCM

(Source: Özesmi & Özesmi, 2004)

Here, we clarify some terminologies and concepts that are often used in the context of FCM (Table 10).

Table 10 Definition of terms and metrics related to FCM, adapted to the context of NBS[2]

Components	Number of variables included in model; higher number of concepts indicates more components in the mental model (Özesmi & Özesmi, 2004)
Connections	Number of connections included between variables; higher number of connections indicates higher degree of interaction between components in a mental model (Özesmi & Özesmi, 2004)
Driver Components	Components which only have "forcing" functions; indicate number of components that effect other system components but are not affected by others (Eden et al., 1992)
Receiver Components	Components which have only receiving functions; indicate the number of components that are affected by other system components but have no effect (Eden et al.1992)
Ordinary Components	Components with both transmitting and receiving functions; indicate the number of concepts that influence and are influenced by other concepts (Eden et al.1992)
Indegree	Cumulative strength of connections through which a concept is affected by other concepts (Yoon & Jetter, 2016, p. 1902)
Outdegree	Cumulative strength of connections through which a concept influences other concepts (Yoon & Jetter, 2016, p. 1902)
Centrality	The degree how linked a concept to other concept and the cumulative strength of connections the concept has. (Yoon & Jetter, 2016, p. 1902)
Complexity	Ratio of receiver components to driver components, degree of complexity or resolution; higher ratio indicates more complex cause-effect relationships between concepts. (Yoon & Jetter, 2016, p. 1902)
Density	Ratio of actual number of connections of components to the total number of possible connections of all components in the model; higher/lower ration indicates more densely/sparsely connected concepts. (Yoon & Jetter, 2016, p. 1902)
Connectedness	Ratio of connections to components, degree of connectivity between concepts; Higher ratio indicates the connection between concepts are denser. (Yoon & Jetter, 2016, p. 1902)
Transformative potential	Difference between outdegree and indegree score; The higher the outdegree scores and the lower the indegree scores of barriers the higher their transformative potential as they are, thus, not only operating relatively independently in the system, but they offer also a great potential for overcoming barriers linked to them. Overcoming such barriers may support a more effective uptake of NBS (Own definition).

As part of our analysis, we included an FCM exercise in our workshop. This method aimed to create a visual representation and model the causal connections between system components, based on participant perceptions and understanding. To facilitate this activity, we used the 'Mental Modeler' software (Gray et al., 2017). The activity was carried out by stakeholder groups according to their sector, with one facilitator per group.

[2] Some of the elements of the table have been taken and adapted from "An Introduction to Mental Modeler: A tool for environmental planning and research, accessed 30.08.2023, URL: https://www.mentalmodeler.com/articles/Mental%20Modeler%20Manual%20for%20Workshop.pdf)

This software offers a user-friendly platform for creating cognitive maps and incorporates fuzzy logic to model imprecise or ambiguous relationships that are typical in human cognition. This results in a structured and adaptable method for capturing the complex network of relationships within our system of interest.

1. Pre-established components from 'Barrier identification activity'

Before embarking on the FCM activity, we ensured that the components within the 'Mental Modeler' map were pre-selected and displayed. These components were derived from the prior barrier identification activity, ensuring a continuity of data and consistency in the concepts being mapped.

2. Mapping process

The mapping process was divided into three steps:

- Connection: Participants began by identifying the 'focal' component – the one deemed to be the most influential within the system from the previous barrier identification activity. From this focal point, participants then created connections, linking components based on perceived causal relationships.

- Direction Assignment: Once connections were established, participants were prompted to determine the nature of each causal relationship. They specified whether each connection had a positive or negative influence on the linked component. This step allowed us to discern not only the existence of a relationship but also its general effect.

- Strength Assignment: After determining the direction of influence, participants were tasked with quantifying the strength of each causal relationship. This was achieved by assigning numbers or weights to the arrows representing the connections. This numeric assignment provided a semi-quantitative measure of how profoundly one component influences another.

3. Integration of Enablers

Upon completing the mapping activity, participants were given an additional task: the integration of 'enablers'. Participants were encouraged to add these enablers if they believed they were essential to creating a comprehensive and accurate system representation. Enablers, in this context, are factors or elements that facilitate or promote the functioning of the mapped system.

1.3 Collaborator sites

The analysis builds upon case studies situated in different European countries: Bulgaria, Poland, Croatia, Serbia, and Bosnia and Herzegovina. Despite the diverse hydro-meteorological landscapes of these regions, all have seen limited NBS implementation in the past, while facing heightened hydro-meteorological risks due to climate change. More details are provided in Figure 5 and Table 11.

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Figure 5 Map of Collaborators' Sites

Table 11 Description of the case study areas[3]

Site name	Description & characteristics	Significant flood events & damages	Main hazards	Proposed NBS
Kamchia River (Bulgaria)	• Located in the eastern part of Bulgaria • It consists of more than 30 rivers and 70 streams • The major part of it and its tributaries flow through rural areas with well-developed agriculture	• Usage of mean annual flow is 53.9%, the highest in the country	• Floods	• Detention basins • Afforestation/re-forestation • Soil infiltration improvement • Deepening water bodies • Floodplain rehabilitation • Removing obstacles • Dike restoration • Bio swales • Wetland channels • Urban trees/parks • Gates with control system
Pilica River (Poland)	• Located in central Poland • Longest left tributary of the Vistula. • Pilica River basin is a forest and agricultural catchment area.	• Fast run-off region, flood event in 2010 caused failure of the dyke and ice blockage, drought in 2015 • Annual precipitation of 633 mm	• Floods • Drought	• Wetland restoration/enh-ancement • Restoration/rec-onnection of oxbow lakes • Re-meandering • Retention ponds • Afforestation
Bregana River (Croatia)	• Transboundary river between Croatia and Slovenia • Distinctive torrential character, with specific flood sites • The watercourse regulation is partial and incomplete	• High probability floods (10-year return): 0.84 km^2, Low probability floods (500-year return): 2.22 km^2 • Flood events in 2005, 2014, and 2015 resulted in damage to houses, embankments, concrete cascades, bridges, roads, and more	• Floods • Erosion	• Retention ponds • Detention basins • Upper watershed restoration • Natural bank stabilisation • Deepening water bodies • Removal of obstacles
Jadar River (Serbia)	• Right tributary of the Drina River • Its longest left tributary is the Likodra River which	• Devastating flash floods in May 2014 affecting Krupanj	• Flash flood • Erosion processes • Landslides	• Check dams • Afforestation and reforestation • Forest conservation

[3] The table has been taken from the manuscript submitted (Han, 2023, submitted)

	starts in Krupanj, where four torrential tributaries meet			• Retention ponds • Removing obstacles • Bank stabilisation • Buffer strips
Vrbanja River (Bosnia and Herzegovina)	• Part of the Vrbas River Basin. • Located in the Republic of Srpska, the central part of Bosnia and Herzegovina.	• Significant increase in runoff from the basin • Larger flood waves have almost doubled in 25 years. • Flash floods in Josavka sub-basin	• Riverine floods • Flash floods • Landslides	• Retention ponds • Afforestation and reforestation • Floodplain excavation/enla-rgement/restorati on • Removing obstacles • Widening of water bodies
Tamnava River (Serbia)	• Part of the larger Kolubara watershed • The upper watershed is hilly and prone to flash floods, while the middle and lower parts have flat river valleys • Main tributaries are Ub and Gračica rivers	• Frequent flooding due to insufficient protection • Current flood mitigation measures include levees designed for 25- to 100-year floods	• Fluvial floods • Flash floods • Erosion processes	• Retention ponds • Afforestation and reforestation • Floodplain restoration • Buffer strips • Removal of obstacles from river channels • Wet swales

4 Results of the barrier analysis

4.1 Identifying relevant barriers

In the first step of the analysis, the participants of workshops were asked to rank barriers according to their potential to influence other barriers/drivers and/or the entire management and governance systems.

Table 12 provides an overview of the analysis. Each barrier, ranked on a scale of 1 to 4, gives insight into the perceived influence or importance of that barrier, with 1 being the most influential and 4 being the least. The mean score column provides an aggregated view of each barrier's significance across all the case study areas.

Table 12 Ranking of barriers for single case studies and across all case studies (mean values)

1=ranked as most influential; 4=least influential

Barriers	*Pilica*	*Bregana*	*Jadar*	*Kam-chia*	*Tam-nava*	*Vrba-nja*	*Mean score*
C2. Financial Resources for NBS	1.6	1.3	1.5	1.4	1.4	2.7	**1.6**
C1. Operational capacity	-	1.0	2.0	1.8	2.0	1.0	**1.6**
E1. Political will and long-term commitment	1.6	2.3	1.0	1.8	2.8	2.0	**1.9**
A7. Maintenance cost compared to technical solutions	1.5	-	3.0	1.5	-	-	**2.0**
B9. Land acquisition from private owners	3.0	1.8	1.6	1.5	1.8	3.0	**2.1**
D1. Nature value in the legal system	1.7	1.0	1.5	3.0	2.7	3.0	**2.1**
D3. Legal basis for land acquisition. compensation. and incentives	2.3	-	2.0	2.7	2.3	1.5	**2.2**
D4. Liability between local governments or within the organizations	2.0	1.5	2.2	2.0	2.8	2.0	**2.2**
B6. Compensation mechanism	3.0	1.0	2.0	2.2	2.8	2.0	**2.3**
E2. Sense of urgency	2.5	2.3	2.0	2.3	2.2	3.3	**2.4**
E5. Awareness of NBS	2.0	1.5	2.6	3.0	3.2	1.8	**2.4**
F4. Knowledge of nature-based solutions	2.3	2.0	2.8	2.3	3.3	1.8	**2.4**
B2. Health benefits	2.3	-	3.0	2.0	2.3	3.0	**2.5**
B3. "Untouched nature" aspect of nature-based solutions	2.5	2.0	4.0	2.0	4.0	2.3	**2.5**
A3. Long time scale of NBS implementation/effective operation	2.2	3.0	2.8	1.0	3.3	2.0	**2.6**

D2. Design standards and guidelines for maintenance and monitoring	2.0	2.0	2.7	3.3	3.0	2.0	**2.6**
A9. Scientific proof for their benefit	4.0	2.0	2.0	-	-	2.5	**2.6**
F2. Coalitions and stakeholder groups	4.0	2.0	1.5	2.5	4.0	2.0	**2.6**
F3. Public understanding of nature-based solutions operations	3.2	2.5	1.5	3.0	3.6	1.0	**2.6**
F5. Intermediaries and facilitators/knowledge brokers/training programs	3.3	-	1.5	3.0	4.0	2.0	**2.6**
C5. Misalignments between short-term plans and long-term goals	2.3	2.5	2.5	2.7	3.0	2.5	**2.6**
A4. Need of more space than traditional flood risk measures	3.4	2.0	2.2	2.7	2.8	-	**2.7**
C3. Path dependence	2.5	2.0	2.7	2.0	4.0	1.0	**2.7**
C6. Silo thinking	3.0	1.7	2.0	3.2	3.8	2.0	**2.7**
B1. Aesthetic and recreational value	2.0	3.0	4.0	2.0	3.5	2.3	**2.8**
E4. Ideologicalization of nature-based solutions policy	-	3.0	2.0	3.0	-	-	**2.8**
B5. Impact on residents' quality of life due to the construction of NBS	3.0	2.7	3.0	2.5	3.3	1.0	**2.8**
E3. Populism in nature-based solutions politics	1.0	-	3.0	3.5	-	-	**2.8**
A6. Implementation cost compared to technical solutions	2.0	-	3.5	2.7	-	-	**2.8**
F1. Public participation	3.0	2.5	3.7	3.0	3.4	1.7	**3.0**
B4. Accessibility to NBS sites	3.0	3.0	2.5	-	4.0	3.0	**3.0**
B7. Landscape-scale change in the place	2.0	3.0	4.0	2.0	4.0	3.0	**3.0**
C4. Incentives for marketability and business environment	2.0	2.0	-	3.0	3.8	-	**3.0**
A5. Perception of NBS as having limited and supplemental effectiveness for risk reduction	4.0	3.0	3.5	3.5	3.0	2.3	**3.1**
A2. Uncertainty about the effectiveness of NBS	4.0	4.0	4.0	4.0	2.5	1.7	**3.2**
A1. Natural appearance or features of NBS	3.5	1.5	3.0	4.0	4.0	3.5	**3.2**

(compared to technical measures)							
A8. Cost-efficiency of NBS	3.3	-	-	-	3.0	-	**3.3**
B8. Place attachment to the place before NBS implementation	4.0	3.0	2.5	-	3.5	4.0	**3.3**

Highest ranked barriers

The analysis demonstrates that **financial resources (C2)** for implementing NBS are a considerable concern in most case study areas, with an average score of 1.6. The costs associated with transitioning to or integrating NBS into existing infrastructural frameworks continue to be a hindrance. Closely related to this is the **operational capacity (C1),** which highlights the logistical challenges in executing these solutions. Another noteworthy barrier is the **political will and long-term commitment (E1)** to NBS. Without ongoing support from political bodies, implementing NBS may encounter significant obstacles. This is reflected in its average score of 1.9.

Middle ranked barriers

Knowledge of nature-based solutions (F4) and understanding of the **health benefits (B2)** show moderate influence as barriers. In general, there is a clear indication that more **awareness (E5)** and education may be needed to ensure the uptake of NBS. Similarly, legal aspects such as the **value of nature in the legal system (D1)** and the **legal basis for land acquisition, compensation and incentives (D3)** show an average mean score of 2.1. These indicate the need for a more streamlined legal framework to support the adoption of NBS.

Low ranked Barriers

Interestingly, the table suggests that public perceptions such as the **natural appearance or features of NBS compared to engineering measures (A1)** are less of a concern, with a mean score of 3.2. In addition, the **cost efficiency of NBS (A8)** and the **place attachment prior to NBS implementation (B8)** show a mean score of 3.3. The result suggests that (in)effectiveness of NBS and values and demerits of NBS may not be primary concerns for most case study areas.

The main purpose of the ranking was, above all, to reduce the longer list of barriers to a manageable shorter list. This short-list was then the basis for the next step in the analysis: The Fuzzy Cognitive Mapping of barriers to assess not just how relevant barriers are but also how they are interconnected.

4.2 Site-specific analysis

4.2.1 Kamchia river basin, Bulgaria

4.2.1.1 Results of FCM

In sum, 33 barriers were included by participants of the workshops in the FCM analysis. The total interlinkages between the different barriers sum up to 60 connections, which results in an average connection between the different barriers of 1.82. The density score is 0.057 and the complexity score is 0.833.

Table 13 provides an overview of how the different barriers influence each other, including information about their outdegree (i.e. how they positively/negatively influence others) and their indegree (i.e. how they are positively/negatively influenced by others) as well as their centrality (i.e. the sum of indegree and outdegree). It also identifies the most central barriers (i.e. the top-25% barriers with regard to the centrality score, bold).

Among the top-25% barriers characterising the system in the Kamchia case study are above all contextual factors. **Institutional-legal-political barriers** are considered as the most central ones. Particularly, silo-thinking (C6) is a highly influential barrier with a strong influence on other barriers. In addition, a bundle of **legal barriers**, centring on topics such as compensation mechanisms (how NBS are valued within the legal system (B6) and legal basis for acquisition, compensation and incentives (D3) are regarded as central. Similarly, **political barriers** such as awareness of NBS (E5) as well as political will and long-term commitment (E1) are also of relevance. **Social contextual factors** are central too, including public participation (F1), public understanding of how NBS operate (F3), and knowledge about NBS (F4).

In the following, we provide the mean score of the centrality values for the different domains of barriers. The mean scores underline that **contextual barriers** falling into the **institutional** (mean: 0.72), **political** (mean: 0.71), **legal** (mean: 0.62) and **social** realm (mean: 0.67) are particularly central in this case study. Barriers related to the NBS are of lower relevance (effectiveness mean: 0.34; values and demerit mean: 0.47).

Table 13 Centrality values in the Kamchia case study

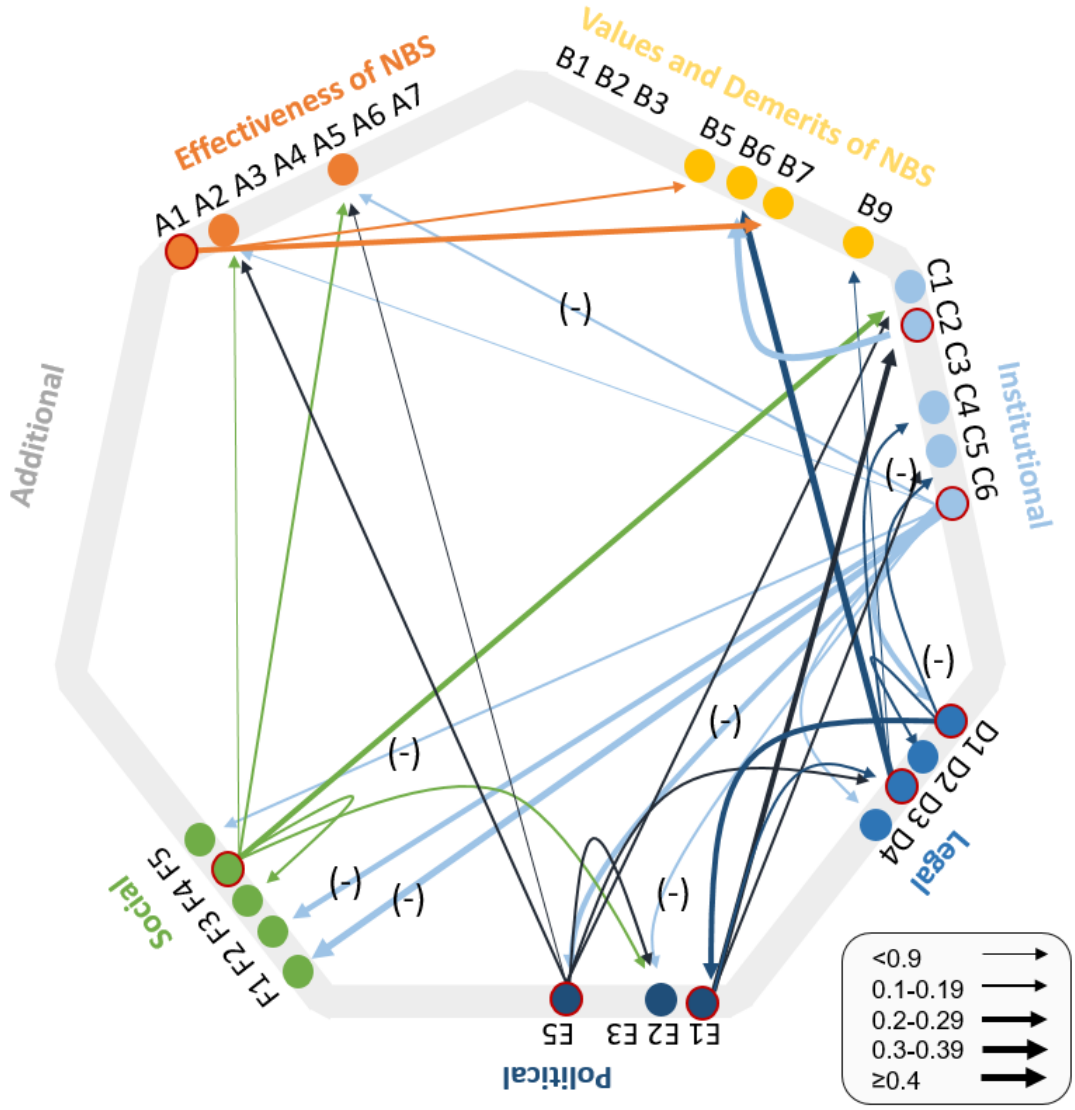
	Component	Indegree	Outdegree	Centrality
1	**C6. Silo thinking**	**0.09**	**1.71**	**1.80**
2	**B6. Compensation mechanism**	**1.01**	**0.12**	**1.13**
3	**F1. Public participation**	**0.70**	**0.38**	**1.08**
4	**E5. Awareness of NBS**	**0.41**	**0.64**	**1.05**
5	**F3. Public understanding of nature-based solutions operations**	**0.68**	**0.31**	**0.98**
6	**E1. Political will and long-term commitment**	**0.51**	**0.44**	**0.95**
7	**D3. Legal basis for land acquisition, compensation, and incentives**	**0.28**	**0.63**	**0.91**
8	**F4. Knowledge of nature-based solutions**	**0.10**	**0.72**	**0.82**
9	C2. Financial Resources for NBS	0.33	0.46	0.79
10	D1. Nature value in the legal system	0.20	0.51	0.71
11	C5. Misalignments between short-term plans and long-term goals	0.67	0.00	0.67

12	E2. Sense of urgency	0.37	0.28	0.66
13	C1. Operational capacity	0.38	0.15	0.53
14	A5. Perception of NBS as having limited and supplemental effectiveness for risk reduction	0.53	0.00	0.53
15	A7. Maintenance cost compared to technical solutions	0.25	0.23	0.48
16	D4. Liability between local governments or within the organizations	0.26	0.18	0.44
17	A2. Uncertainty about the effectiveness of NBS	0.31	0.12	0.44
18	C4. Incentives for marketability and business environment	0.29	0.13	0.42
19	A1. Natural appearance or features of NBS (compared to technical measures)	0.00	0.41	0.41
20	D2. Design standards and guidelines for maintenance and monitoring	0.19	0.22	0.41
21	B7. Landscape-scale change in the place	0.24	0.14	0.38
22	B2. Health benefits	0.38	0.00	0.38
23	B3. 'Untouched nature' aspect of nature-based solutions	0.00	0.38	0.38
24	B1. Aesthetic and recreational value	0.18	0.18	0.35
25	B5. Impact on residents' quality of life due to the construction of NBS	0.34	0.00	0.34
26	B9. Land acquisition from private owners	0.15	0.16	0.31
27	F2. Coalitions and stakeholder groups	0.21	0.09	0.30
28	A4. Need of more space than traditional flood risk measures	0.00	0.25	0.25
29	F5. Intermediaries and facilitators/knowledge brokers/training programs	0.18	0.00	0.18
30	A3. Long time scale of NBS implementation/effective operation	0.00	0.18	0.18
31	E3. Populism in nature-based solutions politics	0.06	0.11	0.17
32	C3. Path dependence	0.00	0.09	0.09
33	A6. Implementation cost compared to technical solutions	0.00	0.09	0.09

* Top 25% barriers are presented in bold

Generally, if barriers show a high outdegree score, they are more relevant for shaping the system than those with a lower outdegree score. If they also show a low indegree score (i.e. they are not strongly influenced by any other barriers) they are operating relatively independently in the system. They can be considered as the most influential barriers within the system, i.e. the “root causes” for some of the challenges NBS are facing. From a transformative perspective, overcoming such barriers can have a strong influence on positively changing other barriers. If such barriers a lowered they may support a more effective uptake of NBS in the case-study regions.

Figure 6 shows the top 25% outdegree barriers and how they influence other barriers within the Kamchia case study. It underlines that contextual barriers embedded in the **institutional-legal-political** systems are not just central, they also seem to be the ones with the highest transformative potential as they have a strong influence on other barriers. Barriers related to the NBS itself (i.e. effectiveness, values, and demerits) are considered to be less influential, similar to social context factors, except for knowledge of the NBS.



* The top-25% outdegree barriers are circled in red; thickness of arrows indicates outdegree score.

Figure 6 Impacts of the most influential barriers on other barriers in Kamchia case study

From the perspective of stakeholders, **silo thinking (C6) is the most relevant barrier** within the system (See Table 13). It is at the same time, a barrier not strongly influenced by other barriers as it shows a low indegree score. Overcoming this barrier would have a **broad positive impact on changing the legal-political-social context** currently hampering the realisation of NBS in the Kamchia case study as well as on the **perception of the effectiveness** of NBS. If silo thinking were less dominant in the case study, **legal aspects** (D1 Nature value in the legal system, D4 Liability between local governments or within the organizations), **political aspects** (E2 Sense of urgency, E5 Awareness of NBS) as well as **social aspects** (F1 Public participation, F3 Public understanding of nature-based solutions operations, F5 Intermediaries and facilitators/knowledge brokers/training programs) would improve. In addition, the **perception of the effectiveness** of NBS would change as uncertainty about the effectiveness of NBS (A2) would be reduced and the perception of NBS as having limited and supplemental effectiveness for risk reduction (A5) would decrease.

More detailed information on how the most influential barriers affect other barriers is summarised in Table A1 in the Annex.

4.2.1.2 Kamchia river basin results in a nutshell

In the case of the Kamchia river basin, 33 barriers with 60 connections were mapped. Based on the comparatively low density and moderate complexity score, the mapped barriers appear to be rather sparsely connected and the cause-effect relationships between them moderately complex.

In particular, contextual barriers covering institutional, legal, political and social aspects are of high relevance. Among the most influential barriers for shaping the system at the Kamchia site are silo thinking (C6), legal barriers focusing on incentives, acquisition and compensation mechanisms (D3), and recognition of nature values in the legal system (D1), political will and long-term commitment (E1), public participation (F1), public understanding of the NBS and its operation (F3), and finally financial resources (C2).

Overcoming silo thinking (C6) and enhancing knowledge about NBS (F4) are barriers of central importance, as they have the greatest transformation potential. Overcoming them can have a strong positive impact on the related barriers and thus on the effective use of NBS on the ground.

4.2.2 Bregana river basin, Croatia

4.2.2.1 Results of FCM

In sum, 34 barriers were identified as relevant by the participants of the workshops. The total interlinkages between the different barriers sum up to 80 connections, which results in an average connection between the different barriers of 2.35. The density score is 0.071 and the complexity score is 0.8.

Table 14 provides an overview of how the different barriers influence each other, including information about their outdegree (i.e. how they positively/negatively influence others) and their indegree (i.e. how they are positively/negatively influenced by others) as we as their centrality (i.e. the sum of indegree and outdegree). It also identifies the most central barriers (i.e. the top-25% barriers concerning the centrality score, bold).

Among the top-25% barriers that characterise the system in the Bregana case study, contextual factors and factors related to NBS in the narrower sense are predominant. The most relevant contextual factor is a **political** barrier, namely E1. Political will and long-term commitment (with a high outdegree value). In addition, as other barriers are based on the political system (E2. Sense of urgency and E5. Awareness of NBS), the analysis points to the high centrality of political decision-making processes in this case study. Furthermore, **institutional** factors are also considered to be quite important in hindering the implementation of NBS quite strongly (C2. Financial Resources for NBS, C4. Incentives for marketability and business environment C1. Operational capacity). Also, B8. Furthermore, Land acquisition from private owners underlines the relevance of regulatory aspects in this case study.

In addition, the **perception of the effectiveness** (A1. Natural appearance or features of NBS (compared to technical measures)) and how NBS are **valued** (B2. 'Untouched nature' aspect of nature-based solutions) are perceived as central barriers.

In the following, we present the mean of the centrality scores for the different domains of barriers. The mean scores underline that barriers falling into the **political realm** are particularly central in this case study (mean: 1.34), followed by the **perception of the effectiveness** of NBS mean: (0.79) as well as **institutional** (mean) and **social** barriers (mean: 0.75). There seems to be a moderate consensus among the participants that the two barriers added (scientific evidence and ecosystem services) are also central (mean: 0.57). **Legal** barriers (mean: 0.28) as well as **values and demerits** (0.29) of NBS are considered to be less central within the barrier system.

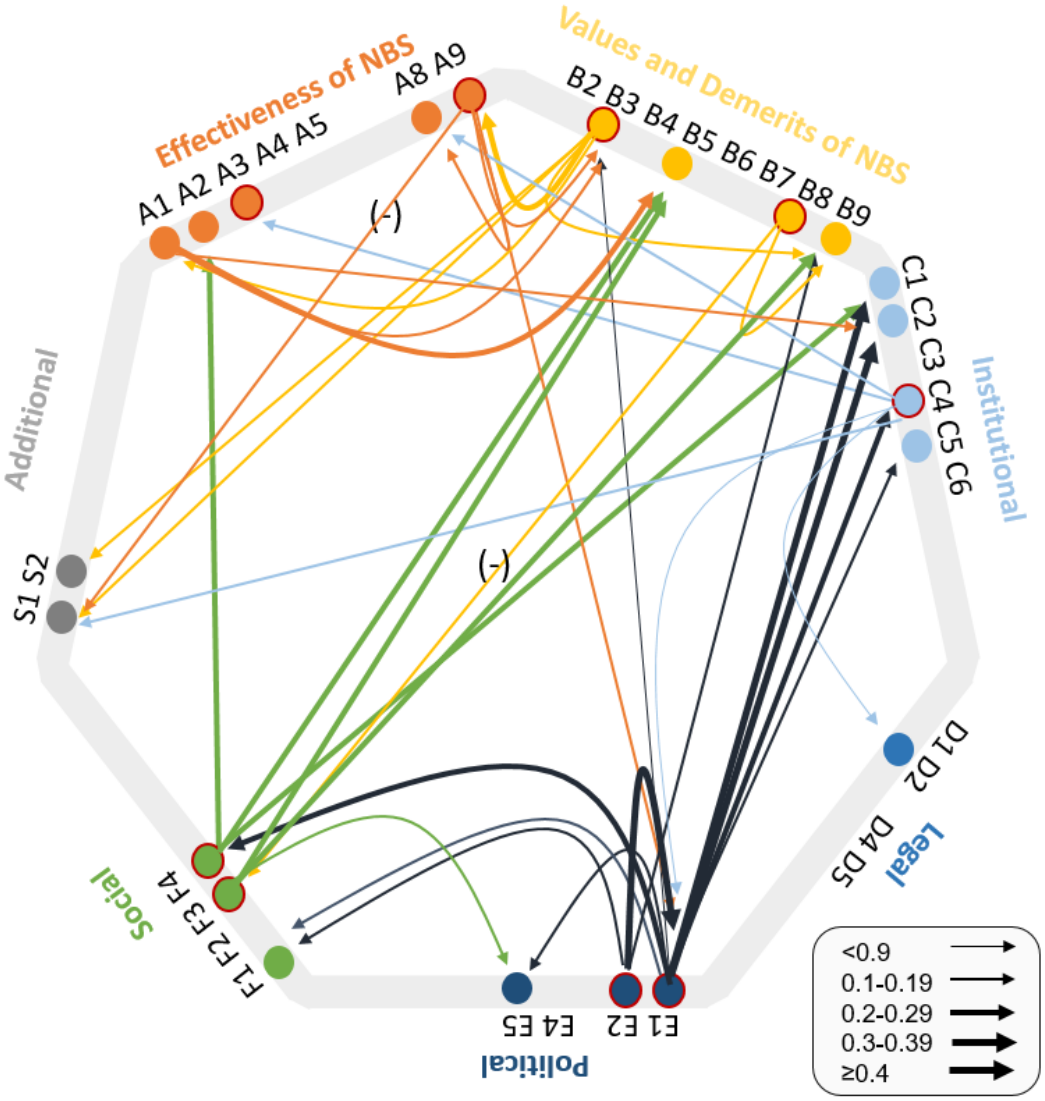
Table 14 Centrality values in the Bregana case study

	Component	Indegree	Outdegree	Centrality
1	**E1. Political will and long-term commitment**	**1.13**	**1.63**	**2.76**
2	**B8. Land acquisition from private owners**	**1.18**	**0.64**	**1.82**
3	**B3. 'Untouched nature' aspect of nature-based solutions**	**0.70**	**0.91**	**1.61**
4	**C2. Financial Resources for NBS**	**0.78**	**0.55**	**1.33**
5	**C4. Incentives for marketability and business environment**	**0.50**	**0.76**	**1.25**
6	**A1. Natural appearance or features of NBS (compared to technical measures)**	**0.61**	**0.55**	**1.16**
7	**E2. Sense of urgency**	**0.15**	**1.01**	**1.16**

8	**E5. Awareness of NBS**	**0.76**	**0.36**	**1.13**
9	**C1. Operational capacity**	**0.80**	**0.28**	**1.08**
10	A3. Long time scale of NBS implementation/effective operation	0.80	0.25	1.05
11	B4. Impact on residents' quality of life due to the construction of NBS	0.95	0.00	0.95
12	A9. Scientific proof for their benefit	0.25	0.70	0.95
13	F4. Knowledge of nature-based solutions	0.25	0.68	0.93
14	S1. Ecosystem Services	0.73	0.18	0.91
15	A8. Cost-efficiency of NBS	0.34	0.55	0.89
16	A2. Uncertainty about the effectiveness of NBS	0.54	0.29	0.83
17	F1. Public participation	0.27	0.50	0.77
18	B5. Compensation mechanism	0.52	0.24	0.76
19	F3. Public understanding of nature-based solutions operations	0.13	0.60	0.73
20	C6. Silo thinking	0.30	0.36	0.66
21	F2. Coalitions and stakeholder groups	0.33	0.24	0.57
22	A4. Need of more space than traditional flood risk measures	0.22	0.25	0.47
23	D5. Liability between the local governments or within the organizations	0.00	0.43	0.43
24	D1. Nature value in the legal system	0.00	0.33	0.33
25	E4. Ideologicalization of nature-based solutions policy	0.15	0.17	0.32
26	D4. Liability between local governments or within the organizations	0.13	0.14	0.27
27	B7. Place attachment to the place before NBS implementation	0.00	0.25	0.25
28	S2. Scientific evidence	0.14	0.09	0.22
29	B3. Accessibility to NBS sites	0.18	0.00	0.18
30	C5. Misalignments between short-term plans and long-term goals	0.17	0.00	0.17
31	A5. Perception of NBS as having limited and supplemental effectiveness for risk reduction	0.00	0.16	0.16
32	B6. Landscape-scale change in the place	0.13	0.00	0.13
33	C3. Path dependence	0.00	0.09	0.09
34	D2. Design standards and guidelines for maintenance and monitoring	0.05	0.02	0.07

* Top 25% barriers are presented in bold

Figure 7 shows how the **political** factor E1 Political will and long-term commitment influences the institutional context, in particular C1 operational capacity, C2 the availability/lack of financial resources, and C4 Incentives for marketability and business environment. From the perspective of workshop participants, it is therefore the task of politicians to create an institutional environment that is conductive to the uptake of NBS. Political barriers are also closely linked to with **social** barriers, such as F1 Public participation and F4 Knowledge of nature-based solutions. Furthermore, **social** barriers F3. Public understanding of nature-based solutions operations and F4. Knowledge of nature-based solutions also have a strong impact in this case study.



* The top-25% outdegree barriers are circled in red; thickness of arrows indicates outdegree score.

Figure 7 Impacts of the most influential barriers on other barriers in Bregana case study

More detailed information on how the most influential barriers affect other barriers is summarised in A.2 in the Annex.

4.2.2.2 Bregana river basin results in a nutshell

In the Bregana case study, 34 barriers with 80 connections were mapped. Based on the relatively low density and moderate complexity score, the mapped barriers appear to be rather sparsely connected and the cause-effect relationships between them moderately complex.

The central barriers include both contextual and NBS-related factors. In this case, political barriers stand out as particularly influential. These include political will and long-term commitment (E1), sense of urgency (E2) and awareness of NBS (E5). However, there are also some institutional factors that significantly hinder the realisation of NBS

from the stakeholders' perspective, namely financial resources for NBS (C2), incentives for marketability and business environment (C4), operational capacity (C1) and regulatory aspects such as schemes for land acquisition from private owners (B8). In addition, NBS-related factors such as perceptions of their effectiveness (A1) and how they are valued (B3) are identified as central.

At a general level, political challenges are by far the most important ones, followed by perceptions of NBS effectiveness and some institutional and social barriers. Political will and long-term commitment (E1) and sense of urgency (E2) are seen as having the highest transformative potential. This means that not only do they operate relatively independently in the system, but they also offer great potential for overcoming the barriers associated with them. The possibility of overcoming these barriers to initiate many positive processes towards a more effective use of NBS underlines the particular responsibility of policy makers in initiating the transformation process in this case study.

4.2.3 Vrbanja river basin. Bosnia and Herzegovina

4.2.3.1 Results of FCM

In sum, 27 barriers were identified as relevant by the participants of the workshops. The total interlinkages between the different barriers sum up to 74 connections, which results in an average connection between the different barriers of 2.74. The density score is 0,105 and the complexity score is 2.

Table 15 provides an overview of how the different barriers influence each other, including information about their outdegree (i.e. how they positively/negatively influence others) and their indegree (i.e. how they are positively/negatively influenced by others) as we as their centrality (i.e. the sum of indegree and outdegree). It also identifies the most central barriers (i.e. the top-25% barriers with regard to the centrality score, bold).

Among the top-25% barriers characterising the system in the Vrbanja case study, **awareness and knowledge**-related factors (F4 Knowledge of nature-based solutions, F3 Public understanding of nature-based solutions operations, E5 Awareness of NBS) are predominant, accompanied by a mix of other barriers, including **institutional** (C2 Financial Resources for NBS, C1 Operational capacity), **political** (E1 Political will and long-term commitment) and **social** ones (F1 Public participation).

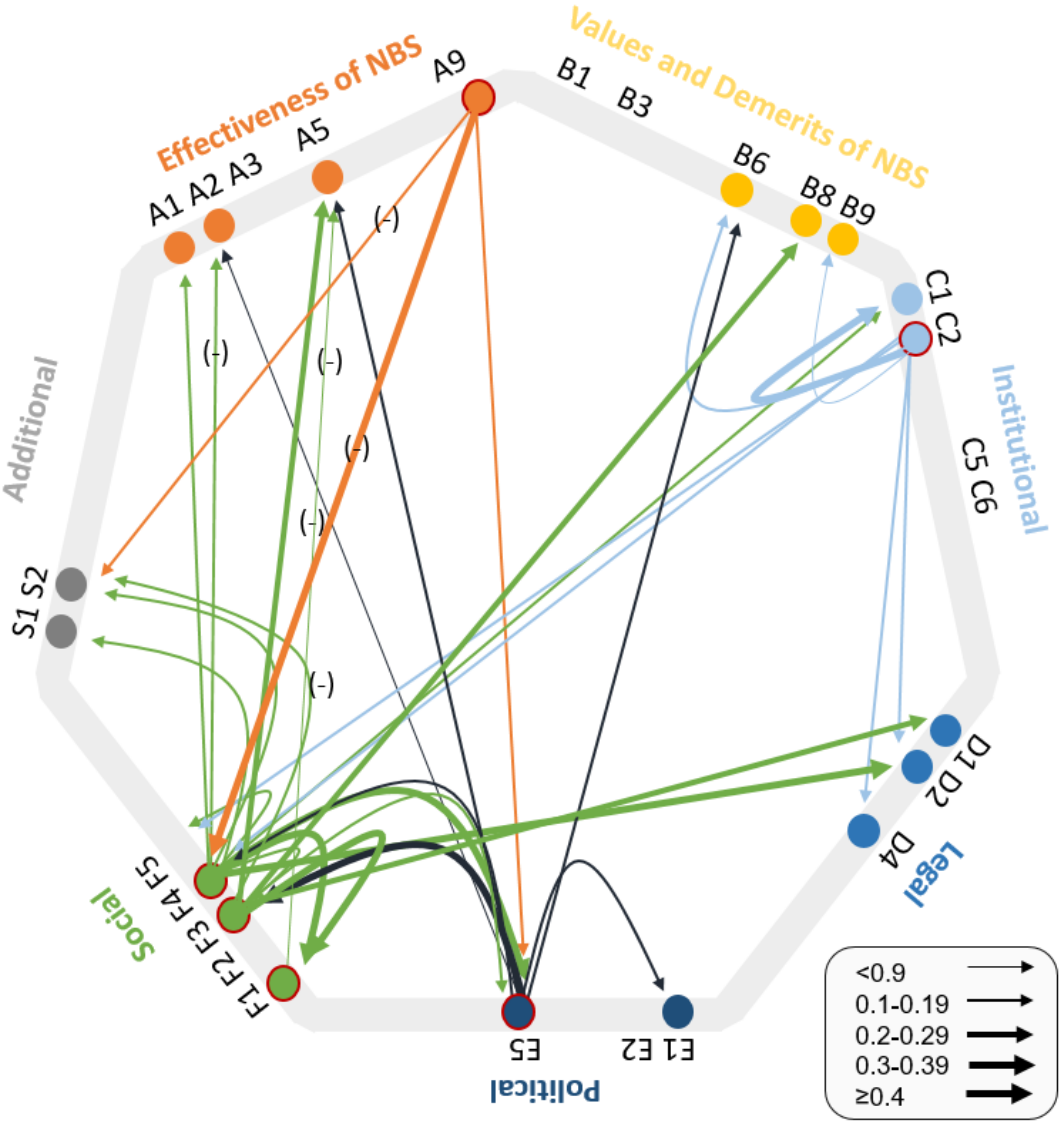
Below, we present the mean centrality scores for the different domains of barriers. The mean scores underline that **social** barriers are particularly central in this case study (mean: 1.48), followed by **political** barriers (mean: 1.42), **institutional** barriers (mean: 0.93) as well as the **perception of the effectiveness** of NBS (mean: 0.76). There is a moderate consensus among the workshop participants that the two barriers added (S1. Government consent: Decision to accept the project; S2. Inexperience and ignorance of interested parties in the issue and implementation of the chosen solution (mean: 0.58) are also central to the case study. **Legal** barriers (mean: 0.35) as well as **values and demerits** (mean: 0.39) of NBS are considered less central within the barrier system.

Table 15 Centrality values for relevant barriers in the Vrbanja case study

Component	Indegree	Outdegree	Centrality
F4. Knowledge of nature-based solutions	**0.79**	**1.75**	**2.54**
F3. Public understanding of nature-based solutions operations	**1.14**	**1.09**	**2.23**
E5. Awareness of NBS	**0.80**	**1.31**	**2.11**
C2. Financial Resources for NBS	**0.52**	**1.34**	**1.86**
F1. Public participation	**0.90**	**0.67**	**1.57**
E1. Political will and long-term commitment	**0.44**	**1.08**	**1.52**
C1. Operational capacity	**1.13**	**0.37**	**1.49**
A2. Uncertainty about the effectiveness of NBS	0.81	0.47	1.28
A3. Long time scale of NBS implementation/effective operation	0.50	0.45	0.95
F5. Intermediaries and facilitators/knowledge brokers/training programs	0.34	0.54	0.88
G1. Government consent: Decision to accept the project	0.39	0.36	0.74
D4. Liability between local governments or within the organizations	0.50	0.20	0.70
A9. Scientific proof for their benefit	0.00	0.65	0.65
E2. Sense of urgency	0.42	0.20	0.62
B3. 'Untouched nature' aspect of nature-based solutions	0.24	0.36	0.60
D2. Design standards and guidelines for maintenance and monitoring	0.30	0.30	0.60
B6. Compensation mechanism	0.48	0.00	0.48
A1. Natural appearance or features of NBS (compared to technical measures)	0.26	0.21	0.46
B8. Place attachment to the place before NBS implementation	0.41	0.05	0.46
A5. Perception of NBS as having limited and supplemental effectiveness for risk reduction	0.44	0.00	0.44
G2. Inexperience and ignorance of interested parties in the issue and implementation of the chosen solution	0.42	0.00	0.42
B1. Aesthetic and recreational value	0.21	0.07	0.28
C5. Misalignments between short-term plans and long-term goals	0.00	0.27	0.27
F2. Coalitions and stakeholder groups	0.16	0.00	0.16
B9. Land acquisition from private owners	0.13	0.00	0.13
C6. Silo thinking	0.00	0.10	0.10
D1. Nature value in the legal system	0.10	0.00	0.10

* Top 25% barriers are presented in bold

Figure 8 shows how strong social barriers are shaping the system in this case study, at least from the perspective of workshop participants. **Knowledge and awareness** are key in this case study as a lack of knowledge about NBS (F4), a lack of public understanding of NBS (F3) and political awareness of NBS (E5) as well as a lack of scientific proof of their benefits (A9) are basically shaping the barrier system in the Vrabanja case study. In addition, the availability of financial resources (C2), and political will and long-term commitment (E5) are also considered as central.



* The top-25% outdegree barriers are circled in red; thickness of arrows indicates outdegree score.

Figure 8 Impacts of the most influential barriers on other barriers in Vrbanja case study

More detailed information on how the most influential barriers affect other barriers is summarised in Table A.3 in the Annex.

4.2.3.2 Vrbanja river basin results in a nutshell

In the Vrbanja case study, 27 barriers with 74 connections were mapped, which results in a moderately dense network a moderate complexity score.

From the stakeholder perspective, knowledge and awareness are central in Vrbanja. Lack of knowledge (F4) and public understanding of NBS (F3) as well as lack of scientific evidence of their benefits (A9) and political awareness of NBS (E5) dominate the barrier

system in the Vrbanja case study. These are accompanied by concerns about the availability of financial resources (C2) and political will and long-term commitment (E5).

A relatively large number of barriers are identified with a high transformative potential. In line with the key barriers identified above, the barriers with the highest transformative potential include awareness and knowledge of NBS (F4), scientific evidence of the benefits of NBS (A9), financial resources for NBS (C2), and political will and long-term commitment (E1). Activities aimed at overcoming these barriers are promising for many positive knock-on effects.

4.2.4 Pilica river basin, Poland

4.2.4.1 Results of FCM

In sum, 49 barriers were identified as relevant by the participants of the workshops (including 12 barriers, which were added during the workshop). The total interlinkages between the different barriers sum up to 170 links, which results in an average connection between the different barriers of 3.47. The density score is 0.073 and the complexity score is 0.428.

Table 16 provides an overview of how the different barriers influence each other, including information about their outdegree (i.e. how they positively/negatively influence others) and their indegree (i.e. how they are positively/negatively influenced by others) as we as their centrality (i.e. the sum of indegree and outdegree). It also identifies the most central barriers (i.e. the top-25% barriers with regard to the centrality score, bold).

Looking at the details of the analysis,

Table 16 shows that the key central barriers characterising the barrier system in the Pilica case study, relate mainly to contextual factors, including **social** (F3 Public understanding of nature-based solutions operations; F4 Knowledge of nature-based solutions), **institutional** (C2 Financial Resources for NBS), **political** (E1 Political will and long-term commitment; E5 Awareness of NBS) and **legal aspects** (D1 Nature value in the legal system). In addition, the way in which **NBS are valued** plays an important role (B5 Impact on residents' quality of life due to the construction of NBS; B6 Compensation mechanism).

In the following, we present the mean centrality scores for the different domains of barriers. The mean scores underline that **social barriers** (mean: 1.20), as well as institutional barriers (mean: 1.02), are considered to be most central**. Political** (mean: 0.75) and **legal** barriers (mean: 0.58) as well as barriers related to the **value and demerits** of NBS (mean: 0.63) are considered to be of medium centrality. Barriers related to the **effectiveness** of NBS (mean: 0.28) and **additional barriers** are considered to be of low centrality (mean: 0.23).

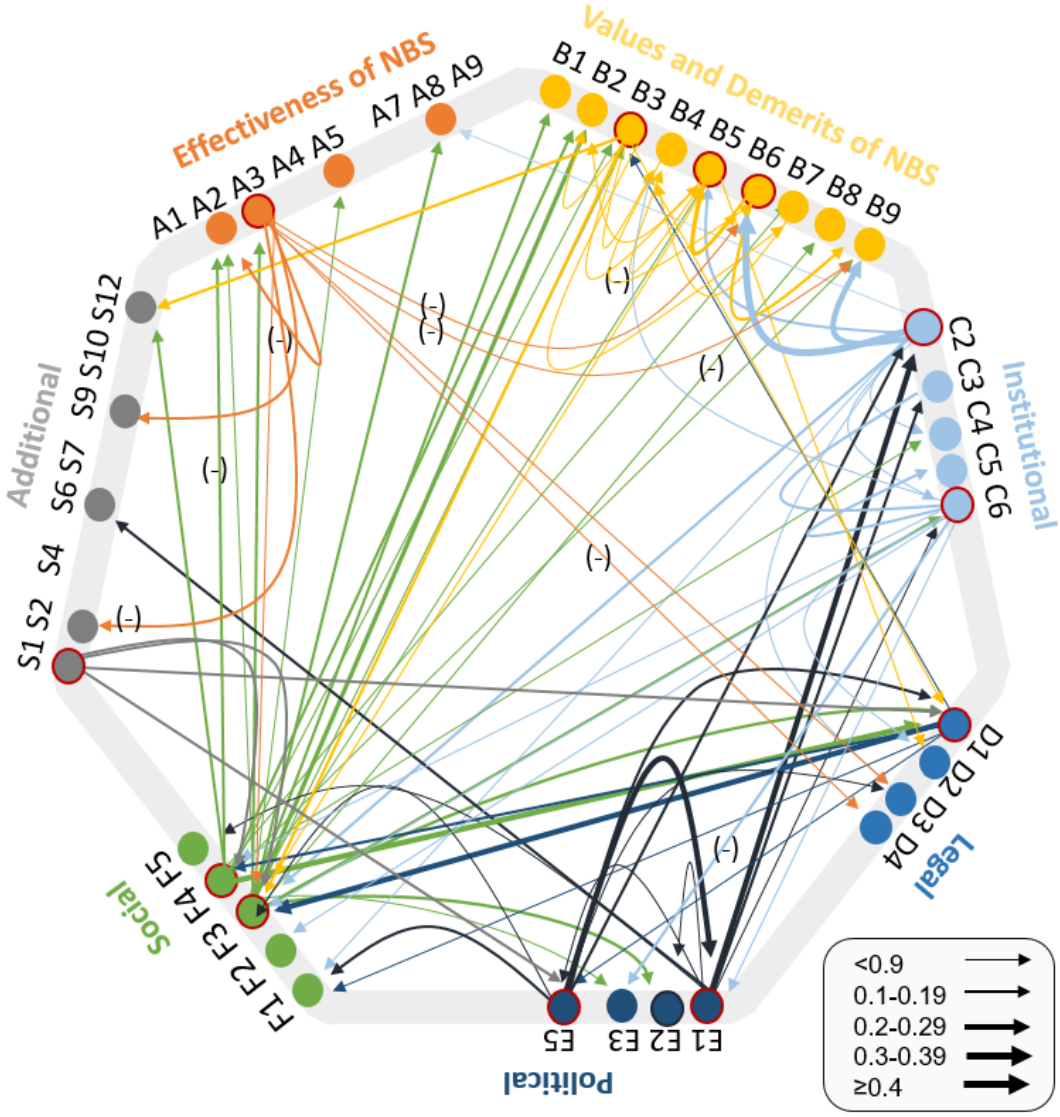
Table 16 Centrality values in the Pilica case study

Component	Indegree	Outdegree	Centrality
F3. Public understanding of nature-based solutions operations	**1.72**	**1.22**	**2.93**
C2. Financial Resources for NBS	**0.98**	**1.25**	**2.23**
E1. Political will and long-term commitment	**0.50**	**0.90**	**1.40**
F4. Knowledge of nature-based solutions	**0.55**	**0.72**	**1.27**
D1. Nature value in the legal system	**0.65**	**0.52**	**1.17**
E5. Awareness of NBS	**0.47**	**0.67**	**1.13**
B5. Impact on residents' quality of life due to the construction of NBS	**0.80**	**0.33**	**1.13**
B6. Compensation mechanism	**0.68**	**0.42**	**1.10**
C6. Silo thinking	**0.43**	**0.55**	**0.98**
B3. "Untouched nature" aspect of nature-based solutions	**0.30**	**0.52**	**0.82**
B9. Land acquisition from private owners	**0.53**	**0.28**	**0.82**
B2. Health benefits	**0.58**	**0.18**	**0.77**
F1. Public participation	0.45	0.32	0.77
A3. Long time scale of NBS implementation/effective operation	0.27	0.40	0.67
C3. Path dependence	0.27	0.37	0.63
F5. Intermediaries and facilitators/knowledge brokers/training programs	0.12	0.48	0.60
B1. Aesthetic and recreational value	0.20	0.35	0.55
S1. Education	0.00	0.47	0.47
A8. Cost-efficiency of NBS	0.25	0.20	0.45
S2. Decision-making	0.43	0.00	0.43
F2. Coalitions and stakeholder groups	0.18	0.25	0.43
A4. Need of more space than traditional flood risk measures	0.10	0.32	0.42
A2. Uncertainty about the effectiveness of NBS	0.40	0.00	0.40
D3. Legal basis for land acquisition, compensation. and incentives	0.18	0.20	0.38
D4. Liability between local governments or within the organizations	0.18	0.20	0.38
D2. Design standards and guidelines for maintenance and monitoring	0.25	0.12	0.37
S3. Uniform message to the public	0.22	0.12	0.33
B4. Accessibility to NBS sites	0.15	0.18	0.33
S4. Enforcement of the law	0.17	0.17	0.33
S5. Legal basis	0.17	0.17	0.33
E3. Populism in nature-based solutions politics	0.20	0.08	0.28
C5. Misalignments between short-term plans and long-term goals	0.12	0.13	0.25
S6. High public awareness and environmental education	0.08	0.12	0.20
S7. Dependence on EU policies and regulations	0.12	0.08	0.20

S8. NBS funding	0.00	0.20	0.20
E2. Sense of urgency	0.13	0.03	0.17
S9. Traditional solutions	0.07	0.10	0.17
S10. Subsidies for agricultural land under agri-environmental measures	0.08	0.08	0.17
S11. Best practices (learning from the best)	0.00	0.17	0.17
B7. Landscape-scale change in the place	0.03	0.10	0.13
S12. Biodiversity	0.12	0.00	0.12
A5. Perception of NBS as having limited and supplemental effectiveness for risk reduction	0.08	0.02	0.10
A1. Natural appearance or features of NBS (compared to technical measures)	0.02	0.08	0.10
A9. Scientific proof for their benefit	0.00	0.10	0.10
B8. Place attachment to the place before NBS implementation	0.02	0.02	0.03
D4. Liability between local governments or within the organizations	0.02	0.02	0.03
S13. Uncertainty of obtaining the expected results	0.00	0.03	0.03
A7. Maintenance cost compared to technical solutions	0.00	0.03	0.03
S14. Strong lobbying group	0.00	0.02	0.02

* Top 25% barriers are presented in bold

Figure 9 shows that no single barrier or category of barriers is shaping the system. There are numerous barriers identified as central, and most of these barriers are reciprocally interlinked.



* The top-25% outdegree barriers are circled in red; thickness of arrows indicates outdegree score.

Figure 9 Impacts of the most influential barriers on other barriers in Pilica case study

From the perspective of stakeholders involved in the barrier analysis, **public understanding of NBS operations** (F3) would have a broad positive impact on many different aspects that currently hinder the realisation of NBS in the Pilica case study. Most importantly if public understanding of NBS were to improve, attitudes towards the **effectiveness** of NBS would improve as would the way in which NBS are **valued**. This includes the following aspects (see **Error! Reference source not found.**): Uncertainty a bout the effectiveness of NBS (A2), long time scale of NBS implementation/effective operation (A3); perception of NBS as having limited and supplemental effectiveness for risk reduction (A5); how NBS are **valued** aesthetically and for recreational purposes (B1), expected health benefits (B2), untouched nature" aspect of NBS (B3), and residents' quality of life (B5).

However, a better understanding of the operation of NBS influences some of the contextual factors, such as silo thinking (C6), indicating that the institutional context does

not yet reflect the requirements (i.e. cross-sectorial cooperation) necessary for realising NBS. The same applies to the legal aspect (D1 Nature value in the legal system). In addition, a better understanding would also increase political sensitivity towards the topic (E2 Sense of urgency; E3 Populism in nature-based solutions politics).

Increasing financial resources for NBS (C2) would also have a positive impact on both the NBS themselves and the wider context. More specifically, it affects the **effectiveness of NBS** (A8 cost-efficiency of NBS) and would also have a positive effect on Values and demerits of NBS (B6 compensation mechanisms; B9 land acquisition from private owners; B5 Impact on residents' quality of life due to the construction of NBS). Increased financial resources would also have a positive impact on the **institutional context** (C4 Incentives for marketability and business environment; C6 Silo thinking), the **legal aspects** (D3 Legal basis for land acquisition, compensation, and incentives) and would also help to improve some of the relevant **social context factors**, including improving F1 public participation and F3 Public understanding of nature-based solutions operations, as both activities would be better supported financially.

Improving political will and long-term commitment to the realisation of NBS (E1) would mainly have a positive impact on the **institutional** (C2 Financial Resources for NBS, C3 Path dependence, and C6 Silo thinking) on legal (D2 Design standards and guidelines for maintenance and monitoring, and D3 Legal basis for land acquisition, compensation, and incentives) and social aspects (F5 Intermediaries and facilitators/knowledge brokers/training programs) but would also increase the sense of urgency (E2) and awareness of NBS (E5) among other politicians, too.

As A.4 (in the Annex) shows, workshop participants emphasise that the links between different barriers are not necessarily unidirectionally interlinked (if A improves, B will improve), but rather circular (if A improves, B improves, which has a positive impact on A, which has a positive impact on B, and so on). Most of the central barriers are bidirectional.

4.2.4.2 Pilica river basin results in a nutshell

In the Pilica case study, 49 barriers were mapped with an exceptionally high number of 170 connections. Based on the comparatively low density and complexity scores, the mapped barriers appear to be sparsely connected and the complexity of their cause-effect relationships is rather low compared to the other sites.

In particular, contextual barriers covering institutional, legal, political and social aspects are of high relevance. Among the most influential barriers for shaping the barrier system at the Pilica site are legal barriers, with a focus on compensation mechanisms (B6) and recognition of nature values in the legal system (D1), political awareness of the NBS (E5), political will and long-term commitment (E1), knowledge (F4) and public understanding of the NBS and its operation (F3), and financial resources (C2). In addition, the impact of the implementation of an NBS on the quality of life of residents (B5) is also a central barrier.

Although many barriers are identified as central, no single barrier or category of barriers dominates the system and, moreover, most barriers are closely interlinked and mutually reinforcing. This means that it is more difficult to identify central entry points for initiating transformative change in Pilica.

Nevertheless, from a stakeholder perspective, significant leverage could be achieved by improving public understanding of NBS and how they work (F3), as well as increasing financial resources (C2) and political will and long-term commitment to their implementation (E1). These improvements are expected to have a broad positive impact on many different aspects currently hindering the implementation of NBS in the Pilica case study - with advances in public understanding of NBS having the highest transformative potential.

4.2.5 Jadar river basin, Serbia

4.2.5.1 Results of FCM

In sum, 24 barriers were identified as relevant by the participants of the workshops. The total interlinkages between the different barriers sum up to 80 connections, which results in an average connection between the different barriers of 3.33. The density score is 0.145 and complexity score of 2.66.

Table 17 provides an overview of how the different barriers influence each other, including information about their outdegree (i.e. how they positively/negatively influence others) and their indegree (i.e. how they are positively/negatively influenced by others) as we as their centrality (i.e. the sum of indegree and outdegree). It also identifies the most central barriers (i.e. the top-25% barriers with regard to the centrality score, bold).

Among the top-25% barriers that characterise the system in the Jadar case study, contextual factors are dominant. **Institutional-legal-political barriers** are seen as the most central ones by workshop participants. In particular, financial resources (C2) is a highly influential barrier with a strong impact on other barriers. In addition, a bundle of political barriers, centred on topics such as political will and long-term commitment (E1) and sense of urgency (E2) have a relatively strong influence on the barrier system. In addition, legal barriers (legal basis for land acquisition, compensation, and incentives, D3) as well as natural value in the legal system (D1) are considered to be most central.

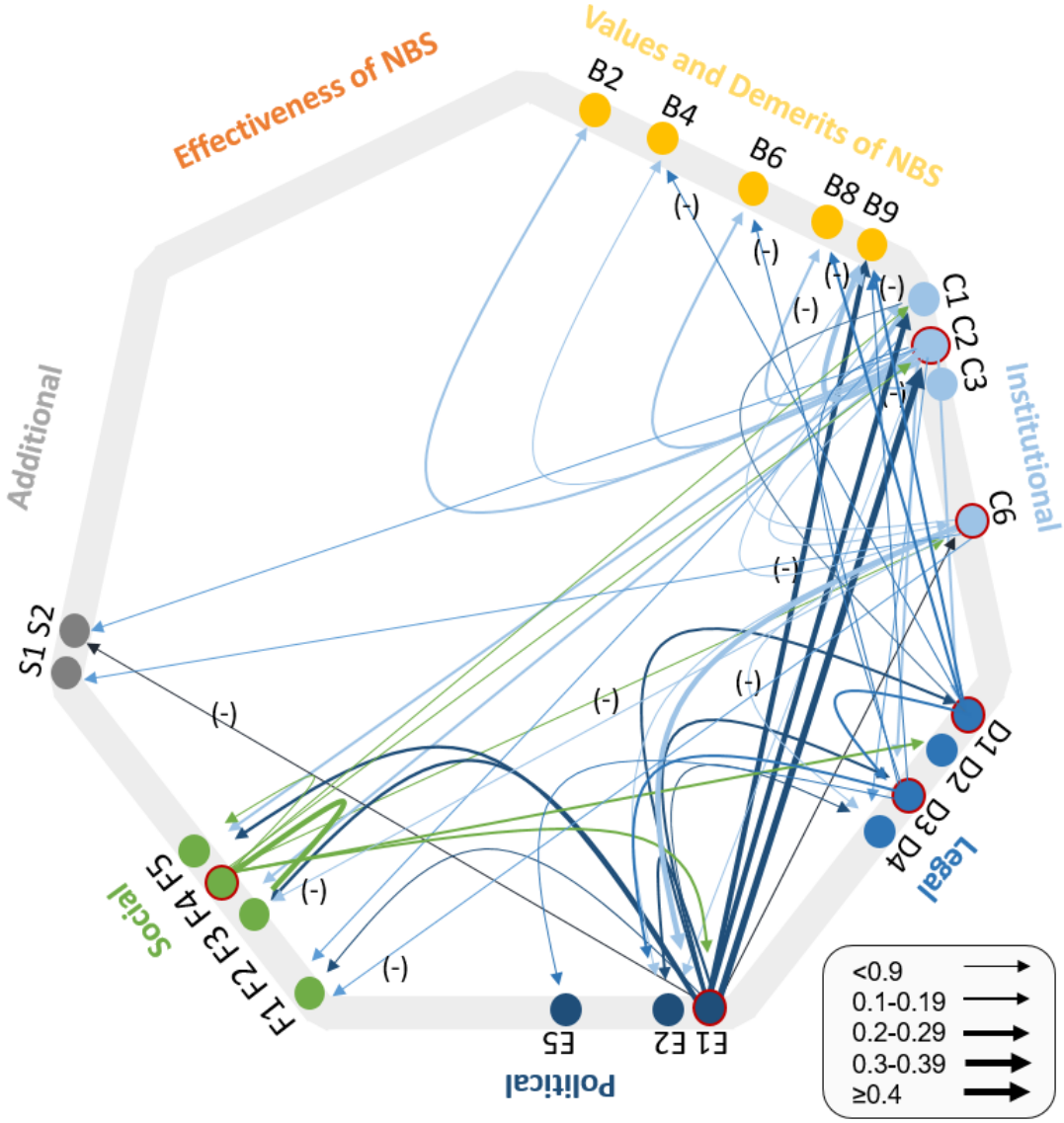
In the following, we present the mean centrality scores for the different domains of barriers. The mean scores underline that **political barriers** (mean: 1.44), as well as **institutional barriers** (mean: 1.33), are considered to be the most central**. Legal** (mean: 0.79) and **social** barriers (mean: 0.52) as well as barriers related to the **value and demerits** of NBS (mean: 0.45) are considered to be of medium centrality. Barriers related to the **effectiveness** of NBS (mean: 0.17) and **additional barriers** are considered to be of low centrality (mean: 0.11).

Table 17 Centrality values in the Jadar case study

Component	Indegree	Outdegree	Centrality
C2. Financial Resources for NBS	**1.00**	**1.99**	**2.99**
E1. Political will and long-term commitment	**0.71**	**1.71**	**2.41**
E2. Sense of urgency	**0.82**	**0.56**	**1.38**
D3. Legal basis for land acquisition, Compensation, and incentives	**0.61**	**0.60**	**1.20**
C6. Silo thinking	**0.37**	**0.76**	**1.13**
D1. Nature value in the legal system	**0.46**	**0.59**	**1.04**
B9. Land acquisition from private owners	1.03	0.00	1.03
F4. Knowledge of nature-based solutions	0.00	0.93	0.93
F3. Public understanding of nature-based solutions operations	0.90	0.00	0.90
C1. Operational capacity	0.49	0.28	0.77
D4. Liability between local governments or within the organizations	0.24	0.51	0.75
E5. Awareness of NBS	0.15	0.39	0.54
B6. Compensation mechanism	0.47	0.00	0.47
C3. Path dependence	0.22	0.19	0.42
F5. Intermediaries and facilitators/knowledge brokers/training programs	0.36	0.06	0.42
B8. Place attachment to the place before NBS implementation	0.32	0.00	0.32
F1. Public participation	0.15	0.09	0.24
B4. Accessibility to NBS sites	0.23	0.00	0.23
B2. Health benefits	0.19	0.00	0.19
A4. Need of more space than traditional flood risk measures	0.00	0.17	0.17
D2. Design standards and guidelines for maintenance and monitoring	0.10	0.06	0.17
S1. Illegal construction	0.15	0.00	0.15
F2. Coalitions and stakeholder groups	0.00	0.13	0.13
S2. Unsettled relations on real estate and property	0.08	0.00	0.08

* Top 25% barriers are presented in bold

Figure 10 shows that three factors are quite influential within this barriers systems, all of them defined by high centrality and outdegree values. These are, E1 Political will and long-term commitment, C2 Financial Resources for NBS, and F4 Knowledge of nature-based solutions. They all shape the institutional-legal-political system and also influence how NBS are valued.



* The top-25% outdegree barriers are circled in red; thickness of arrows indicates outdegree score.

Figure 10 Impacts of the most influential barriers on other barriers in Jadar case study

Increased financial resources for NBS (C2) would also have a relatively strong positive influence on the land acquisition from private owners (B9), which would also be positively influenced if political will and long-term commitment were improved (E1), and on compensation mechanisms (B6). Improving knowledge of NBS (F4) would have a positive impact on public understanding (F3) and would also be beneficial for challenging silo thinking (C6) within the institutional-organisational context.

More detailed information on how the most influential barriers affect other barriers is summarised in A.5 in the Annex.

4.2.5.2 Jadar river basin results in a nutshell

In the Jadar river basin, 24 barriers with 80 connections were mapped. Based on the relatively high density and very high complexity score, the mapped barriers appear to be densely connected and the cause-effect relationships between them very complex.

Here, contextual factors such as institutional, legal and political barriers are identified as central, i.e. they are strongly influenced by others and in turn strongly influence others. Specifically, financial resources (C2) is a highly influential barrier with a strong impact on other barriers. In addition, political barriers such as a lack political will and long-term commitment (E1) and lacking sense of urgency (E2), as well as a legal system that is not yet ready to support the uptake of NBS are considered as relevant barriers. The latter focus on the legal basis for land acquisition, compensation and incentive schemes (D3) and recognition of nature values in the legal system (D1). Overall, political and institutional barriers are central to this case study, followed by legal and social barriers.

The three individual factors that ”ave ’he greatest influence on shaping the barrier system, and also the greatest transformative potential, are political will and long-term commitment (E1), availability of financial resources (C2) and knowledge of NBS (F4). Addressing these three factors seems to be the most promising approach for positive change towards increased use of NBS for hydrometeorological risk management.

4.2.6 Tamnava river basin, Serbia

4.2.6.1 Results of FCM

In sum, 26 barriers were identified as relevant by the participants of the workshops. The total interlinkages between the different barriers sum up to 96 connections, which results in an average connection between the different barriers of 3.69. The density score is 0.148 and the complexity score is 2.66.

Table 18 provides an overview of how the different barriers influence each other, including information about their outdegree (i.e. how they positively/negatively influence others) and their indegree (i.e. how they are positively/negatively influenced by others) as we as their centrality (i.e. the sum of indegree and outdegree). It also identifies the most central barriers (i.e. the top-25% barriers with regard to the centrality score, bold).

Among the top-25% barriers that characterise the system in the Tamnava case study, contextual factors are dominant. **Institutional-legal-political barriers** are considered the most central ones by workshop participants. Within the institutional realm, the availability of financial resources (C2), operational capacity (C1) as well as misalignments between short-term plans and long-term goals (C5) are seen as influential barriers. In addition, a set of political barriers, centred on topics such as political will and long-term commitment (E1) and sense of urgency (E2) have a relatively strong influence on the barrier system. The way in which NBS are valued is also considered as central (land acquisition from private owner (B9) and compensation mechanisms (B6).

In the following, we present the mean centrality scores for the different domains of barriers. The mean scores underline that **institutional** barriers (mean: 1.50) are considered to be the most central barriers in this case study, followed by **political** ones (mean: 1.11). How NBSs are **valued** (mean: 0.82) as well as **social** (mean: 0.51) and **legal** barriers (mean: 0.43) are considered to be of medium centrality. Barriers related to

the **effectiveness** of NBS (mean: 0.39) as well as **additional barriers** are considered less central (mean: 0.37).

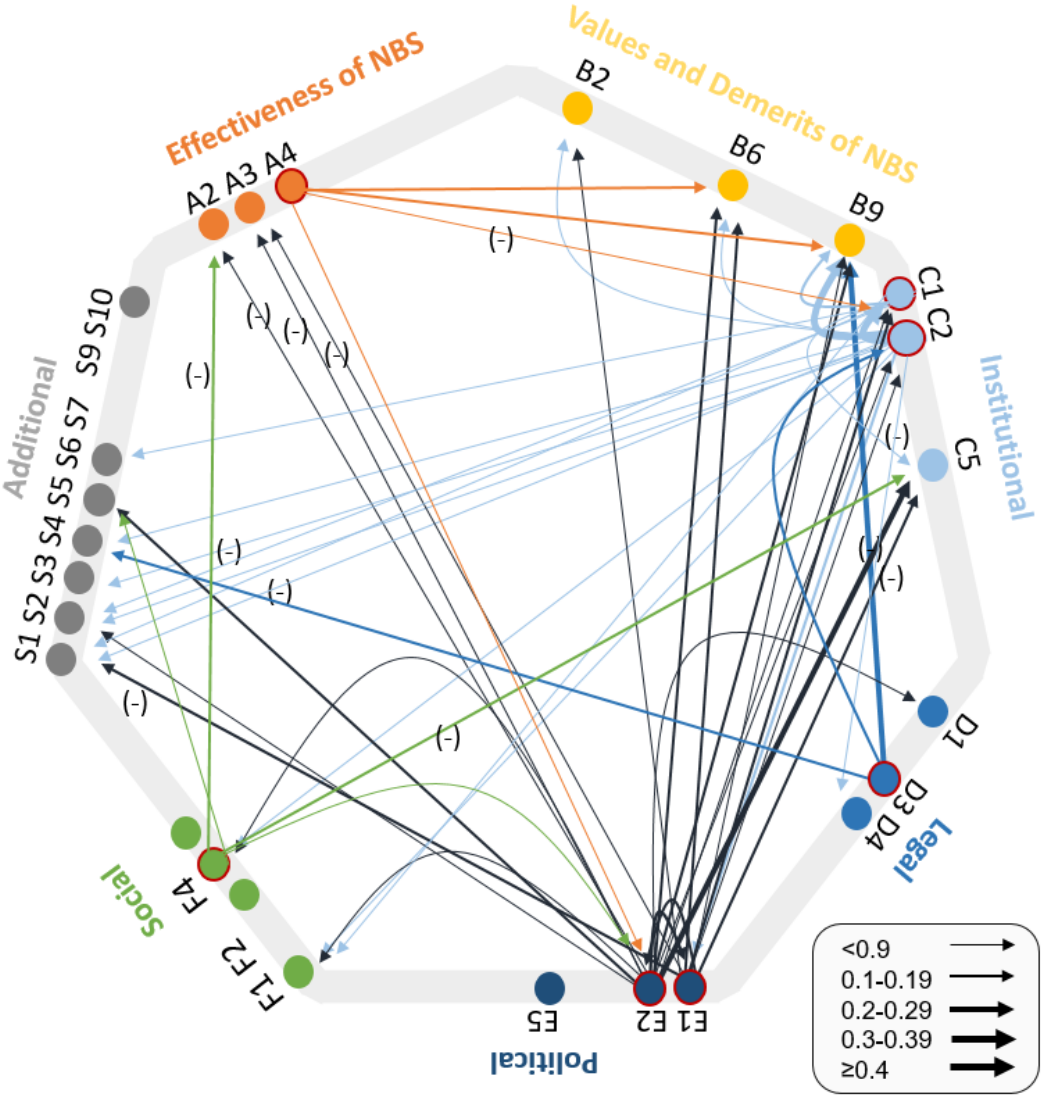
Table 18 Centrality values in the Tamnava case study

Component	Indegree	Outdegree	Centrality
C2. Financial Resources for NBS	**0.67**	**1.26**	**1.92**
E2. Sense of urgency	**0.57**	**1.13**	**1.71**
C1. Operational capacity	**1.10**	**0.57**	**1.67**
B9. Land acquisition from private owners	**1.36**	**0.14**	**1.49**
E1. Political will and long-term commitment	**0.38**	**0.79**	**1.17**
C5. Misalignments between short-term plans and long-term goals	**0.67**	**0.23**	**0.90**
B6. Compensation mechanism	**0.59**	**0.16**	**0.75**
F4. Knowledge of nature-based solutions	0.24	0.42	0.66
D3. Legal basis for land acquisition, compensation, and incentives	0.08	0.47	0.56
S1. Lack of staff. Human Resources	0.28	0.28	0.55
S4. Spatial planning documents	0.25	0.27	0.52
S5. Ecological awareness among citizens	0.28	0.21	0.48
A3. Long time scale of NBS implementation/effective operation	0.38	0.09	0.47
E5. Awareness of NBS	0.10	0.36	0.46
S2. More engagement and training in civil protection services	0.30	0.16	0.45
D4. Liability between local governments or within the organizations	0.19	0.20	0.39
F1. Public participation	0.19	0.18	0.37
A4. Need of more space than traditional flood risk measures	0.00	0.37	0.37
D1. Nature value in the legal system	0.15	0.21	0.35
S6. Lack of awareness of the local population about the collapse of nature (forest cutting, garbage in watercourses).	0.22	0.13	0.35
A2. Uncertainty about the effectiveness of NBS	0.16	0.19	0.34
S7. Illegal construction	0.27	0.04	0.31
S8. Division of watercourses into I and II order. Transferring responsibility to local self-government units without approving financial resources and responsible personnel	0.00	0.29	0.29
S9. No Compliance with legal obligations of competent institutions	0.00	0.24	0.24
B2. Health benefits	0.16	0.05	0.21
S10. Insufficient information on the land owners in order to transfer the land for the needs of the implementation of the PI solution project	0.00	0.15	0.15

* Top 25% barriers are presented in bold

Figure 11 shows that two factors are quite influential within this barrier system, all of them defined by high centrality and outdegree values. These are C2 Financial Resources for

NBS, as well as E2 Sense of Urgency. They have a strong influence on institutional-legal-political system and also influence how NBS are valued.



* The top-25% outdegree barriers are circled in red; thickness of arrows indicates outdegree score.

Figure 11 Impacts of the most influential barriers on other barriers in the Tamnava case study

More detailed information on how the most influential barriers affect other barriers is summarised in A.6 in the Annex.

4.2.6.2 Tamnava river basin results in a nutshell

In the Tamnava river basin, 26 barriers with 96 connections were mapped. Based on the relatively high density and very high complexity score, the mapped barriers appear to be densely interconnected and the cause-effect relationships between them very complex.

In this context, institutional, legal and political barriers are recognised as central, i.e. they are strongly influenced by other barriers and in turn have a significant impact on other barriers. Among the institutional barriers, the following three are the most influential: financial resources (C2), operational capacity (C1) and mismatches between short-term plans and long-term goals (C5). In addition, political barriers such as political will and long-term commitment (E1) and sense of urgency (E2) also have a strong influence on the barrier system. Among the factors that fall within the scope of the NBS assessment, compensation mechanisms (B6) and land acquisition from private owners (B9) are also considered central. Overall, institutional and political barriers are the most central barrier areas.

The barriers identified as having the greatest transformative potential for the entire barrier system, and overcoming which could be expected to have major positive effects, are financial resources (C2) and sense of urgency (E2).

5 Summary and implications for RECONECT

This report provided insights into the key factors hampering the realisation of NBS in European Collaborator sites. The report is based on a multi-method approach and includes the following steps:

- Ranking
- Fuzzy Cognitive Mapping (FCM)

This multi-method approach to address barriers to implementing NBS is both dynamic and inclusive. Firstly, ranking is employed to identify and prioritise significant barriers and drivers. By employing traditional methods of identifying barriers in combination with an innovative use of FCM, a holistic and interconnected representation is achieved. Consensus building and ranking allowed for the attainment of collective agreement rather than individual biases. Using pre-established barriers and enablers, FCM activity visualises and models causal connections between system components, improving understanding of intricate relationships among barriers and enablers. This methodology is unique due to its explicit inclusion of 'enablers' in the system representation.

5.1 Summary of key findings concerning the barrier analysis

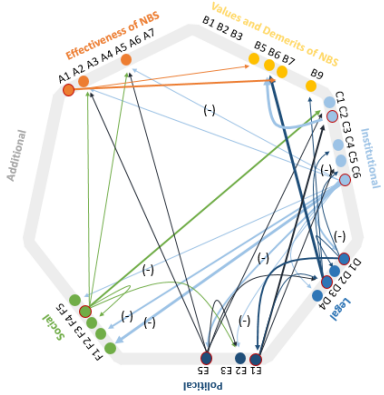
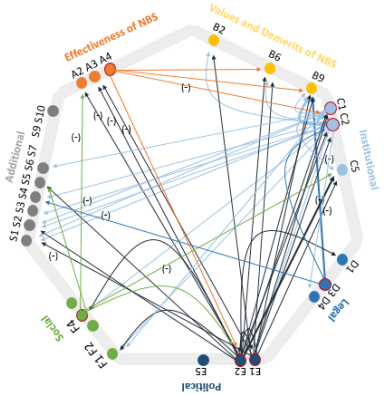
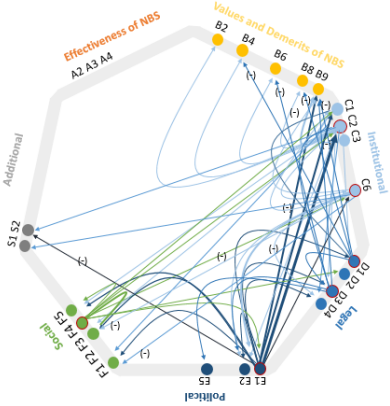
Instead of focusing on single barriers, this analysis was guided by the idea of identifying interrelated bundles of barriers that are shaping an entire system.

Generally, our analysis reveals that contextual factors are more relevant than barriers centring on the NBS more narrowly (e.g. their effectiveness in contrast to technical solutions). Furthermore, we were able to identify three ideal types of such barrier bundles (Figure 12).

- **Ideal type 1 - Barrier systems dominated by institutional-legal-political factors. This is the most dominant type of barrier bundles in our analysis.** Examples include the case of Kamchia, Tamnava, Jadar, and to a certain extent Bregana. Key factors identified are, among others, the lack of resources for financing NBS, Silo thinking, a lack of political interest and thematic commitment as well as lacking legal frameworks for enforcing land acquisition and compensation and for generating incentives for the uptake of NBS. These barriers have a strong influence on other barriers. They are at the same time a key lever for transforming the institutional-legal-political system to enforce the uptake of NBS more effectively (see also Table 19). A “special case” among these ideal types is Bregana as the dominant barriers are identified within the political realm, which results in a more explicit accountability for initiating transformative processes among politicians.

- **Ideal type II - Barrier systems dominated by a lack of knowledge and awareness.** This ideal type is represented by the Vrbanja case study. Most dominant factors include a lack of scientific evidence on the benefits of NBS, a lack of knowledge about and understanding of how NBS operate and why they are beneficial as well as a lack of awareness both among the general public as well as among politicians and decision-makers. Again, overcoming these barriers would have a positive impact on many other barriers currently hampering the realisation of NBS.

- **Ideal type III - Barrier systems dominated by a tightly coupled net of various barriers.** This ideal type is neither dominated by a bundle of barriers nor by a strong set of barriers. It is rather defined by the reciprocal interrelatedness of a tight net of different barriers. This ideal type is represented by the Pilica case study. As most of the barriers are tightly interlinked and reinforcing each other circularly (if A improves, B improves, which feeds back positively on A, which then again influences B positively, etc.), there are hardly any barriers that stand out as the more influential ones, which implies it is more challenging to identify central entry points for initiating transformative change.

	1. Kamchia (Bulgaria) - **Central categories of barriers:** Institutional, legal, and political barriers as well as social barriers; - **High outdegree values:** Natural appearance of NBS (A1), Financial Resources (C2), Silo Thinking (C6), Nature values in the legal system (D1), Legal Basis for Land acquisition, compensation and incentives (D3), Political will and long-term commitment (E1), Awareness of NBS (E5); - **Highest transformative potential**: Silo thinking (C6) and Knowledge of NBS (F4).
	2. Tamnava (Serbia) - **Most central categories of barriers:** Institutional and political barriers; - **High outdegree values:** Need for more space than traditional flood risk measures (A4), Operational capacity (C1). Financial Resources for NBS (C2), Legal basis for land acquisition, compensation and incentives (D3), Political will and long-term commitment (E1), Sense of Urgency(E2), Knowledge of NBS (F4); - **Highest transformative potential**: Financial Resources (C2) and Sense of Urgency (E2).
	3. Jadar (Serbia) - **Most central categories of barriers:** Political and institutional barriers; - **High outdegree values:** Financial Resources for NBS (C2), Silo thinking (C6), Nature values in the legal system (D1), Legal basis for land acquisition, compensation and incentives (D3), Political will and long-term commitment (E1), Knowledge of NBS (F4); - **Highest transformative potential**: Financial resources for NBS (C2), Political will and long-term commitment (E1), and Knowledge of NBS (F4).

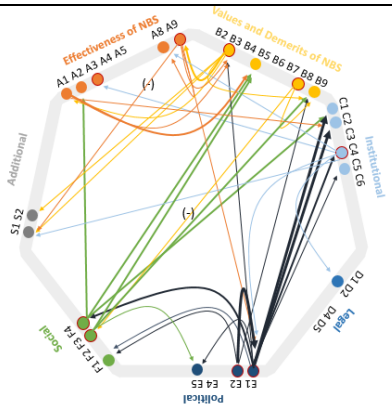
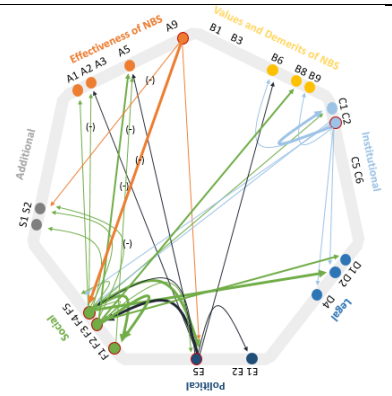
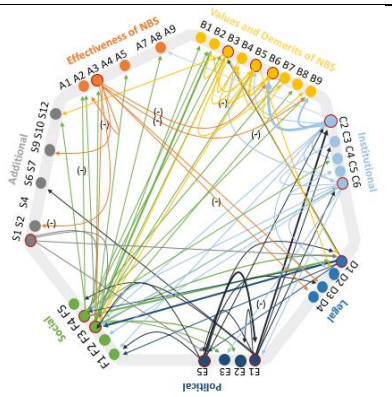
	4. Bregana (Croatia) - **Most central categories of barriers:** Political barriers; - **High outdegree values:** Natural appearance of NBS (A1), Scientific proof for their benefit (A9), "Untouched nature' aspects of NBS (B3), Land acquisition from private land owners (B8), Incentives for marketability and business (C4), Political will and long-term commitment (E1), Sense of urgency (E2), Public understanding of NBS (F3), Knowledge of NBS (F4); - **Highest transformative potential**: Political will and long-term commitment (E1) and Sense of Urgency (E2).
	5. Vrbanja (Bosnia-Herzigovina) - **Most central categories of barriers:** Social and political barriers; - **High outdegree values:** Scientific proof for their benefit (A9), Political will and long-term commitment (E1), Awareness of NBS (E5), Public participation (F1), Public understanding of NBS (F3), Knowledge of NBS (F4); - **Highest transformative potential**: Scientific proof for their benefits (A9), Financial resources for NBS (C2), Political will and long-term commitment (E1), Awareness of NBS, and Knowledge of NBS (F4).
	6. Pilica (Poland) - **Most central categories of barriers:** Social and institutional barriers; - **High outdegree values:** Long time scale of NBS implementation/ effective operation (A3), "Untouched nature" aspect of nature-based solutions (B3), Compensation mechanism (B6), Financial Resources for NBS (C2), Silo thinking (C6), Nature value in the legal system (D1), Public understanding of nature-based solutions operations (F3), Knowledge of nature-based solutions (F4), Political will and long-term commitment (E1), Awareness of NBS (E5), Intermediaries and facilitators/knowledge brokers/training programs (F5), Education (S1); - **Highest transformative potential**: Public understanding (F3).

Figure 12 Summary of the main findings from the case studies

Table 19 summarizes the drivers with the **highest transformative potential**. They are defined by a high outdegree score as well as by a low indegree score (i.e. they are not strongly influenced by any of other barriers). Such barriers are thus not only operating relatively independently in the system, but they offer also a great potential for overcoming barriers linked to them. If such barriers are lowered they may support a more effective uptake of NBS in the case-study regions.

The analysis revealed that the availability of financial resources for realising NBS, establishing political will and long-term commitment as well as providing knowledge about NBS are considered as highly influential and relatively independent drivers in the case study. In addition, generating a sense of urgency enhancing public understanding

of NBS, and generating scientific proof for their benefits are also highly influential drivers in selected case studies.

Table 19 Barriers with the highest transformative potential across case studies

Level 3. Used in FCM	Pilica	Bregana	Jadar	Kam-chia	Tam-nava	Vrba-nja
A9. Scientific Proof for their benefits						0.65
C2. Financial Resources for NBS			1.00		0.59	0.81
C6. Silo Thinking				1.62		
E1. Political will and long-term commitment		0.50	1.00			0.64
E2. Sense of urgency		0.86			0.56	
E5. Awareness of NBS						0.50
F4. Knowledge of NBS			0.93	0.61		0.96
F3. Public understanding	0.50					

*Influence calculated as a result of the difference between outdedgree and indegree, only barriers with a difference of greater/equal to 0.5 are included.

Barriers can become enablers and vice versa. Whether a factor identified as relevant for the realisation of NBS hampers or amplifies depends on its position and connectedness within the wider institutional-political-legal-social and perceptual system. As our analysis reveals, if a central barrier with a high impact on other barriers is systematically addressed and overcome, it will very likely have positive effects on other barriers and will hence serve as an enabler. In this view, it is more relevant to understand the centrality/connectedness of a "barrier" and whether it is a barrier influencing other barriers (or being influenced by other barriers) than to statically juxtapose barriers and enablers.

The results of the barrier analysis confirm our previous analyses in the case studies. In our report on "Local acceptance, institutional and political feasibility in Collaborators Sites" (D4.5) we have highlighted three aspects that are very much in line with the findings of the barrier analysis. First, we stated that in the perspective of stakeholders, "**process-related factors** play a central role in shaping acceptability of NBS" (D4.5, page 102). Across all case study sites process-related factors are perceived as having the strongest influence on the acceptability of NBS to reduce hydro-meteorological risks, this includes a fair land acquisitions process, proper compensation schemes, an open and transparent decision-making process, a properly designed and implemented participatory process, and trusted public authorities in flood risk management. Most of these factors are embedded in and defined by institutional-legal-political governance frameworks.

Second, the analysis conducted for this report confirms our review of available policy information on institutional frameworks. Through this review, it became evident that the current **legal, administrative, and policy systems** are still in their early stages when it comes to considering NBS in the risk management process. The existing frameworks, processes, and funding systems are predominantly centred on traditional hard infrastructure measures. The primary challenges to embracing NBS involve the absence of appropriate legal provisions, complex administrative and legal protocols, unclear assignment of responsibilities, inadequate allocated budgets for NBS planning, implementation, and maintenance, and a limited institutional capacity to effectively incorporate NBS into mainstream practices. The barrier analysis confirms this policy-based analysis.

Third, despite the existence of a multitude of EU policies and directives that provide a solid legal basis for the use of NBS, **political support** for mainstreaming of NBS falls short of expectations at the RECONECT Collaborator sites. Political actors are generally seen as observers whose actions are often considered more symbolic than practical. At best, political actors might endorse the inclusion of NBS in relevant policy documents, but their commitment to actively supporting the execution of these policies is viewed as somewhat lacking. Nevertheless, numerous local experts underscore the importance of persuading political actors to establish the necessary legal foundation for mainstreaming NBS and to ensure the availability of required resources for successful implementation.

Outlook and next steps

Looking ahead to the near future, it is anticipated that the persistent demand for reform driven by EU legislative frameworks will yield a favourable impact on the establishment of NBS. This impact will extend beyond mere inclusion in strategic policy documents to encompass enforceable legal regulations. Consequently, this will positively influence the primary type of barrier systems identified, namely those influenced by institutional, legal, and political factors.

However, the influence of the European level extends further. The gradual rise (albeit at a modest rate) of local best-practice examples, frequently co-financed by the European Union, is also poised to enhance the knowledge and awareness of NBS within the realms of politics and society. This enhancement will be achieved through accompanying benefit monitoring and informational campaigns. Thus, the focus will also be on addressing the barrier systems predominantly dominated by a lack of knowledge and awareness.

In the upcoming D4.7 report, a strategic focus will be placed on the development of comprehensive methodologies aimed at mainstreaming and upscaling NBS. The content and conclusions derived from D4.5 and D4.6 will serve as primary reference points, further supplemented by detailed summaries of relevant policies and management plans as well as the view and expertise of stakeholders on the national level. The report provides a forum with collaborative discussions around the identification and formulation of tailored strategies to counteract and overcome barriers.

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