Deliverable D2.1 Case study optimisation strategies

www.project-merlin.eu

MERLIN

Imprint

The MERLIN project (https://project-merlin.eu) has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101036337.

Lead contractor: Deltares

Contributors: Aarhus University, Naturstyrelsen, Swedish Forest Agency, Swedish University of Agricultural Sciences, Kampinos National Park, Warsaw University of Life Sciences, WWF Adria, Ponte de Lima municipality, University of Lisbon, Finnish Environment Institute, Tapio, University of the Basque Country, Gipuzkoa Provincial Council, Emschergenossenschaft/Lippeverband, University of Duisburg-Essen, Directorate-General for Agriculture and Rural Development Portugal, AVIV-AMCG, Kishon Drainage and River Authority, Tel Aviv University, Province of East Flanders, Ghent University, Scottish Natural Heritage, UK Centre For Ecology & Hydrology, University of Stirling, Dutch Ministry of Infrastructure and Water Management, University of Natural Resources and Life Sciences Vienna, Via Donau Österreichische Wasserstraßen Gesellschaft MBH, WWF Hungary, National Institute for Research and Development of Marine Geology and Geoecology, WWF Romania, Federal Institute of Hydrology

Due date of deliverable: 30 September 2022

Actual submission date: 15 December 2022

To be cited as: Buijse, A.D., Penning, W.E., Alatalo, I., Andrzejewska, A., Anlauf, A., Anton, C., Baattrup-Pedersen, A., Bañanres, I., Birk, S., Boets, P., Brandao, C., Cerqueira Correia, F.L., Colls, M., de Lange, M., Dias, H., Drexler, S.-S., Ecke, F., Elosegi, A., Ferreira, T., Forio, M.A., Fuchs, E., Funk, A., Geerling, G., Gerisch, M., Gerner, N., Goethals, P., Grossman, M., Gruber, T., Hein, T., Henriques, V., Hering, D., Hershkovitz, Y., Hunter, P., Jägrud, L., Jarak, M., Kajner, P., Karnatz, S., Katz, A., Kempter, I., Mateljak, Z., Meissner, K., Nørgaard, M.N., Pickard, A., Pietilä, K., Portela-Pereira, E., Puiu, I., Rankinen, K., Ratner, T., Rodríguez-González, P.M., Ronkainen, T., Ronkanen, A.-K., Rudziński, J., Sá, L., Samu, A., Schneider, A., Scrieciu, A., Sime, I., Sommerhäuser, M., Streater, H., Tögel, R., Trandziuk, P., Udklit, L., Unzurrunzaga, A., Wijnen, E., Wilińska, A. (2022) MERLIN deliverable 2.1 Case study optimisation strategies. EU H2020 research and innovation project MERLIN. Deltares, Delft. 126 pp.

Acknowledgements: The key messages, summary, and Chapters 1, 2, 4 and 5 have been written by Tom Buijse and Ellis Penning. The individual case studies descriptions in Chapter 3 have been written by the respective case study partners. The authors are mentioned for each case study. Tom Buijse and Ellis Penning have slightly edited these descriptions. The deliverable has been reviewed by Sebastian Birk and Nadine Gerner. Rob St. John edited the key messages and summary.

MERLIN Key messages

1. A SWOT analysis of the IUCN criteria for nature-based solutions to support European Green Deal goals yielded a broad spectrum of information on the MERLIN freshwater restoration case studies.
2. This information provides the necessary ingredients to draft an optimisation strategy for the MERLIN case studies on themes including multiple goals, society, restoration techniques, economy, policy and regulations.
3. This information offers a basis for peer-to-peer learning between the case studies and those in other regions.
4. The optimisation strategies provide new insights and broaden perspectives on restoration actions in individual case studies.
5. Identifying the potential for multiple Green Deal goal achievements will initiate broader dialogues with stakeholders and provide new incentives for restoration with multiple benefits for local people.
6. Capacity building on financial arrangements will create new opportunities for restoration actions.
7. Clear and agile policy arrangements are needed to enhance stakeholder participation in restoration actions.
8. The visioning, planning and evaluation of restoration actions are long-term activities that benefit from adaptive approaches and sound long-term monitoring programs on multiple aspects of biophysical and socio-ecological systems.

MERLIN Executive Summary

The seventeen MERLIN case studies are managed to optimise their potential for upscaling freshwater restoration activities.

Each MERLIN case study performed a structured Strengths-Weakness-Opportunities-Threats (SWOT) analysis based on the potential of nature-based solutions in the IUCN Self Assessment Tool (SAT) criteria to achieve European Green Deal goals.

The results of the SWOT analysis provide clear signposts for optimising restoration efforts beyond current practice.

Based on the SWOT results each case study drafted an optimisation strategy. These strategies addressed five main topics: 1. Multiple goal optimisation; 2. Societal optimisation; 3. Technical optimisation; 4. Economic optimisation; 5. Policy/regulatory optimisation.

This process suggested that multiple goals can be reached within a single case study area, such as a combined biodiversity gain, flood and drought protection, and carbon sequestration. This is important for fostering dialogues with local stakeholders, as it highlights the direct benefits they may gain from restoration.

The analysis showed that carrying out restoration activities needs a strong multi-disciplinary approach to exploit the potential for multiple goal achievement. Integrating expert perspectives from socio-economic, policy and financial domains can bring new views and opportunities for optimising restoration activities.

Specific knowledge development is needed to monitor and quantify greenhouse gas emissions and carbon sequestration potential in new restoration projects. It will be useful to link this knowledge with carbon crediting schemes as potential new financial mechanisms for freshwater ecosystem restoration.

In a number of case studies, the voluntary participation of landowners in land consolidation schemes is a fundamental underlying mechanism to enable freshwater ecosystem restoration. Without such schemes it can become challenging to implement large-scale restoration as without voluntary participation the willingness of local landowners to participate is limited, due to risks of reduced income.

Alternative financial mechanisms such as payment schemes for blue-green services can mitigate reductions in landowner income. However, these can be perceived as unreliable due to the potentially limited time frame in which such regulation or legislation is placed.

The SWOT analysis and optimisation strategies are the building blocks for the restoration measures that will be implemented within the project lifetime of MERLIN (Oct 2021 – Sept 2025). They also support the mid- to long-term plans to upscale restoration in the case study areas.

The MERLIN case studies differ in the extent to which they are already pursuing multiple objectives, collaborating with stakeholders and implementing various restoration measures and nature-based solutions. The overview in this report will help deepen dialogue within, and between, the case studies to support learning from each other.

Key findings for each of the five topics were:

1. Multiple goal optimisation: more attention is needed to address the impact of droughts and the pros and cons of rewetting for biodiversity, natural functioning and economic use.

2. Societal optimisation: more interaction with wider groups of stakeholders is needed from the early stages of restoration projects.

3. Technical optimisation: there is a need for more knowledge on the applicability, transferability for upscaling, costs and benefits of nature-based solutions, alongside their potential ‘disservices’.

4. Economic optimisation: more guidance is needed on undertaking cost-benefit analyses of restoration – particularly the role of nature-based solutions. Guidance should address the complexity of valuing non-monetary services and exploring alternative and/or additional financing options, including carbon crediting and related biodiversity/habitat banking and green bonds.

5. Policy/regulatory optimisation: there is a need to broaden interactions with other policy realms, such as climate change mitigation and adaptation, human well-being and health. This process can also help increase public awareness and support for restoration. The role of clear policy arrangements that encourage stakeholders to participate - for example land consolidation and payment for blue/green services - are identified as crucial instruments to speed up and scale up freshwater ecosystem restoration.

Content

The MERLIN project (https://project-merlin.eu) has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101036337.

1 Introduction

Within MERLIN the ongoing restoration works in the case studies (*Figure 1*; *Figure 2*) are being monitored and evaluated within WP1. WP2 aims to further improve on these efforts by expanding the ideation of these restoration projects, further implementation and improvement towards optimisation strategies and prioritisation of future upscaling in a wider context. As a first step in this process a multi-perspective gap analysis has been made identifying the potential Strengths, Weaknesses, Opportunities and Threats (SWOT-analysis) for improvement, optimisation and prioritisation. This gap-analysis was carried out jointly by the implementation and scientific partners of each case study, in dialogue with relevant stakeholders. The results of the IUCN Self Assessment Tool (WP1) and the list of Green Deal goals formed the basis to structure the SWOT analysis to best connect the activities in WP1 'Demonstration' with WP2 'Implementation'.

To assist each case study individually in their future work, the results of the SWOT analysis were then used to develop optimisation strategies, with a focus on transformational change and accelerating the implementation of restoration efforts in collaboration and co-creation with relevant stakeholders and sectors.

The SWOT and optimisation strategy are steps in the process to come to the regional scalability plans (Deliverable 2.2) and the implementation plans (Deliverable 2.3) for each case study (*Figure 3*).

This report provides the outcome of the multi-perspective gap analysis and optimisation strategies per case study, addressing technological, social and governance topics and including also economic and financial aspects. Next to the reporting per case study (Chapter 3), a summary is provided with common findings and lessons learnt in the process of drafting these optimisation strategies for all case studies categorized into three clusters (peatlands/wetlands, small streams and basins and large rivers) (Chapter 4). These summarized results provide recommendations for future initiatives on freshwater restoration in other areas (Chapter 5).

Figure 1 The MERLIN case studies placed in a hypothetical catchment.

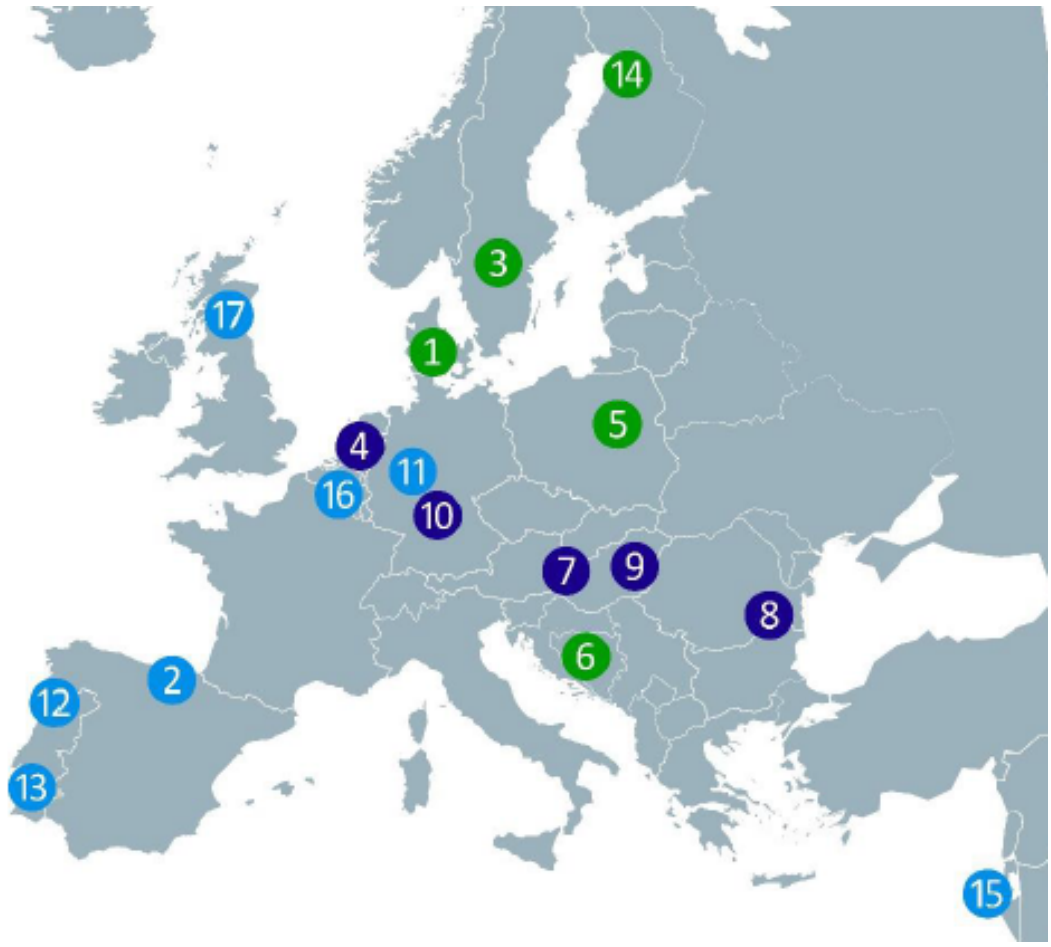

Figure 2 The geographical positions of the MERLIN case studies. Green: peatlands and wetlands; blue: small stream and basins; purple: large transboundary rivers. N.B. CS 12 has been moved to peatlands and wetlands

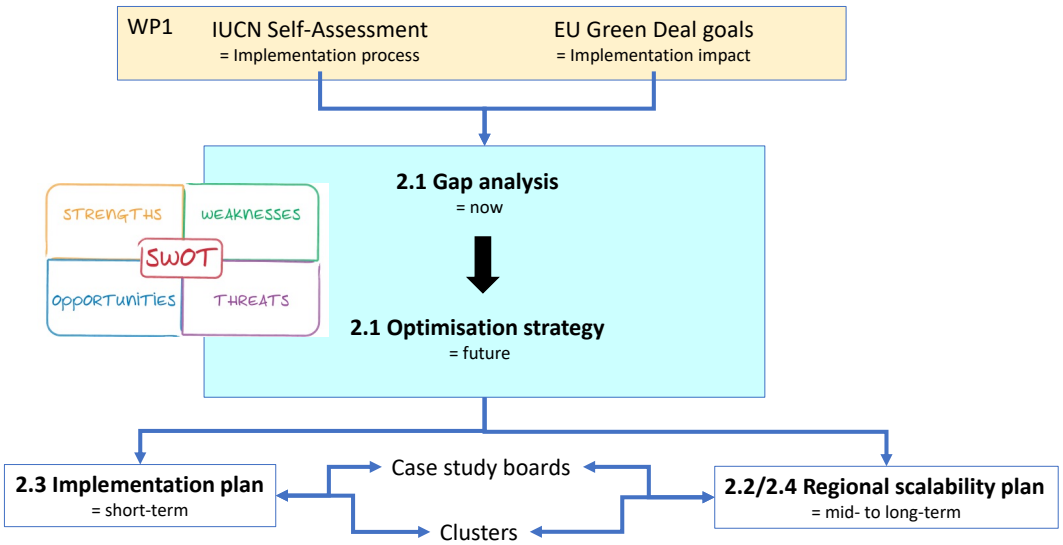

Figure 3 The SWOT and optimisation strategies are steps towards the implementation plans and regional scalability plans for each case study. This figure shows the linkages the WP1 tasks (IUCN SAT and Green Deal goals) and other activities in WP2.

2 Methodology

2.1 Case study template for SWOT analyses

Within WP1 case study partners have been asked to perform a self-assessment of their case study using the IUCN self-assessment tool (SAT) for Nature-based Solutions (NbS) (IUCN 2020a, 2020b) and to draft a monitoring programme for all the Green Deal goals. The SAT predominantly gives an impression how restoration projects are implemented (Table 1). Next to the SAT the list of Green Deal goals is used that provide ambitious goals for Europe initiative to become the first climate-neutral continent. This list gives an overview of the multiple goals that restoration programmes and projects can address (Table 2).

As a follow-up each case study partner was asked to perform a 'Strengths-Weaknesses-Opportunities-Threats' (SWOT) analysis on both the IUCN SAT criteria and Green Deal indicators. Strengths and weaknesses are considered **internal** characteristics of a restoration project itself that give it an advantage or disadvantage over others while opportunities and threats are **external** elements in the surrounding biophysical, social, socio-economic and/or institutional environment that a project could exploit to its advantage or could cause trouble for a project. An EXCEL template was made for each case study to fill in (*Figure 4*).

The scientific and implementation partners of each case study were asked to jointly prepare a first draft. These drafts were then reviewed by the task lead (Deltares). The case study partners were subsequently asked to revise their SWOT and synthesize the main points into a first version of an optimisation strategy with a guidance how to draft this (Chapter 2.2). The draft optimisation strategy of each case study was discussed in bilateral on-line meetings with the task lead (Deltares) and case study partners. The coordinator (UDE) attended several of these meetings. The optimisation strategies were subsequently elaborated, edited for clarity by task lead where needed and included in this deliverable (Chapter 3). The EXCEL files with the SWOT serve as background information and are for internal use only.

In the original plan it was foreseen to perform the gap analysis and drafting of the optimisation strategy immediately together with the stakeholder boards. It was, however, considered better to not involve the stakeholder boards in this initial stage, because to perform the SWOT and draft the optimisation strategy for the first time turned out to be a learning experience and also a time-demanding process by itself. The interim result that is obtained is now suitable for discussing with a wider group and will serve to prepare the draft regional scalability plans (Deliverable 2.2).

As outlined in Figure 3, The SWOT and optimisation strategy are steps in the process to come to the regional scalability plans (Deliverable 2.2) and the implementation plans (Deliverable 2.3) for each case study.

Table 1 Criteria of the IUCN self-assessment tool for nature-based solutions (Source: IUCN 2020a, 2020b)

Criterion	Sub-criteria
1. Societal challenges	1.1 Pressing challenges prioritised
	1.2 Challenges understood and documented
	1.3 Human wellbeing identified, benchmarked and periodically assessed
2. Restoration design at scale	2.1 recognises interactions economy, society and ecosystems
	2.2 integrated with other complementary interventions and seeks synergies across sectors
	2.3 includes risk assessment and management beyond site scale
3. Biodiversity net-gain	3.1 NbS respond to evidence-based assessment of the current state of the ecosystem and prevailing drivers of degradation
	3.2 clear and measurable biodiversity conservation outcomes are identified and periodically assessed
	3.3 monitoring includes periodic assessments for unintended adverse consequences on nature arising from the NbS
	3.4 opportunities to enhance ecosystem integrity and connectivity identified and incorporated in the NbS strategy
4. Economic feasibility	4.1 (in-)direct costs and benefits are identified and documented
	4.2 cost-effectiveness study provides support to the choice of NbS including impact of regulations and subsidies
	4.3 Effectiveness of NbS is justified against available alternatives, accounting for associated externalities
	4.4 NbS design considers a portfolio of resourcing options
5. Inclusive governance	5.1 a feedback and grievance resolution mechanism is available to all stakeholders before an NbS is initiated
	5.2 participation is based on mutual respect and equality of stakeholders
	5.3 stakeholders who are (in-)directly affected by the NbS have been identified and involved in all processes
	5.4 decision-making processes document and respond to rights and interests of all participating and affected stakeholders
	5.5 where the scale of the NbS extends beyond jurisdictional boundaries these are overcome to enable joint decision-making
6. Balance trade-offs	6.1 cost-benefits of associated trade-offs of NbS intervention are acknowledged and inform safeguards and corrective actions
	6.2 the rights, usage and access to land and resources, and responsibilities of stakeholders are acknowledged and respected
	6.3 established safeguards are periodically reviewed to ensure trade off limits are respected
7. Adaptive management	7.1 NbS strategy used for monitoring and evaluation
	7.2 monitoring and evaluation plan for entire intervention life cycle
	7.3 adaptive management is applied throughout the intervention life cycle
8. Sustainability and mainstreaming	8.1 NbS design, implementation and lessons learnt are shared for triggering transformative change
	8.2 NbS inform and enhance policy and regulation frameworks
	8.3 NbS contribute to national and global targets for human wellbeing, climate change and human rights

Table 2 Categories of the Green Deal goals

Category
Biodiversity net gain
Climate regulation
Flood resilience
Drought resilience
Health & well-being
Zero pollution goals
Sustainable food systems (F2F)
Sustainable energy
Sustainable transport
Inclusivity
Circular economy
Financing the transition
Green growth

Filled in by: (name, affiliation, date)						
Filled in by: (name, affiliation, date)						
Filled in by: (name, affiliation, date)						
		Internal factors		**External factors**		**optimization aspects**
		Strengths	**Weaknesses**	**Opportunities**	**Threats**	
focus on process of restoration		characteristics of a project that give it an advantage over others	characteristics that place a project at a disadvantage relative to others	elements in the environment that a project could exploit to its advantage	elements in the environment that could cause trouble for a project	elements that based on the SWOT might be part of the optimization strategy for your case
I. IUCN self-assessment	**Original SAT score**					
1. Societal challenges						
1.1 Pressing challenges prioritised						
1.2 Challenges understood and documented						
1.3 Human wellbeing identified, benchmarked and periodically assessed						
2. Restoration design at scale						
2.1 recognises interactions economy, society and ecosystems						
2.2 integrated with other complementary interventions and seeks synergies across sectors						
2.3 includes risk assessment and management beyond site scale						
3. Biodiversity net-gain						
3.1 NbS respond to evidence-based assessment of the current state of the ecosystem and prevailing drivers of degradation						
3.2 clear and measurabel biodiverstiy conservation outcomes are identified and periodically assessed						
3.3 monitoring includes periodic assessments for unintended adverse consequences on nature arising from the NbS						
3.4 opportunities to enhance ecosystem integrity and connectivity identified and incorporated in the NbS strategy						
4. Economic feasibility						
4.1 (in-)direct costs and benefits are identified and documented						
4.2 cost-effectiveness study provides stupport to choice of NbS including impact of regulations and subsidies						
4.3 Effectiveness of nbS is justified against available alternatives, accounting for associated externalities						
4.4 nbS design considers a portfolio of resourcing options						
5. Inclusive governance						
5.1 a feedback and grievance resolutoin mechanism is available to all stakeholders before an NbS is initated						
5.2 participation is based on mutual respect and equality of stakeholders						
5.3 stakeholders who are (in-)directly affected by the nbS have been identified and involved in all processes						
5.4 decision-making processes document and respond to rights and interests of all participating and affected stakeholders						
5.5 where the scale of the nbs extends beyond jurisdictional boundaries these are overcome to enable joint decision-making						
6. Balance trade-offs						
6.1 cost-benefits of associated trade offs of nbS intervetion are acknolwedged and inform safeguards and corrective actions						
6.2 the rights, usage and acces to land and resources, and responsibilities of stakeholders are acknowledged and respected						
6.3 esteblished safegards are periodically reviewed to enusre trade off limites are respected						
7. Adaptive management						
7.1 nbS strategy used for monitoring and evaluation						
7.2 monitoing and evaluation plan for entire intervention life cycle						
7.3 adaptive management is applied throughout the intervention life cycle						
8. Sustainability and mainstreaming						
8.1 NbS design, implementation and lessons learnt are shared for triggering transformative change						
8.2 NbS inform and enhance policy and regulation frameworks						
8.3 Nbs contribute to national and global targets for human wellbeing, climate change and human rights						
		Strengths	**Weaknesses**	**Opportunities**	**Threats**	
focus on 'technical goal acchievement'		characteristics of a project that give it an advantage over others	characteristics that place a project at a disadvantage relative to others	elements in the environment that a project could exploit to its advantage	elements in the environment that could cause trouble for a project	
II. Green Deal indicators	**Applicable (YES/NO - if no motivate briefly why)**					
Biodiversity net gain						
Climate regulation						
Flood resilience						
Drought resilience						
Health & well-being						
Zero pollution goals						
Sustainable food systems (F2F)						
Sustainable energy						
Sustainable transport						
Inclusivity						
Circular economy						
Financing the transition						
Green growth						
stakeholder analysis						
III. Case study specific aspects						
are you involving the industry sectors? (which ones?)						
are you involving the local residents in your case?						
..						
..						
..						
..						

Figure 4 EXCEL template for the SWOT analysis on the criteria of the IUCN NbS self-assessment tool and the Green Deal goal categories.

2.2 Guidance template for drafting optimisation strategies

To the case study partners the following guidance was sent to prepare their optimisation strategy. The optimisation strategies are structured around 5 main aspects:

1 multiple goal optimisation,
2 societal optimisation,
3 technical optimisation,
4 economic optimisation,
5 policy/regulation optimisation.

For each of these aspects the partners were asked to write a narrative based on the identified strengths, weaknesses, opportunities and threats from the detailed SWOT analysis (see *Figure 4*). Since the 5 aspects of optimization do not one-to-one correspond to the 4 SWOT categories, *Table* was given as assistance to synthesize the information.

It was requested to write each of the above 5 aspects along the following structure:

→ 'the main strengths are …'
→ 'the main weaknesses are …',
→ 'opportunities arise from …',
→ 'perceived threats result from …'.
→ 'based on these SWOT characteristics the way forward for 'multiple goal achievement/societal optimisation/ etc.' is…'

1. Multiple goals optimisation

Identify a wider set of goals (referring to the GD indicators) to be supported with the restoration. E.g. besides floods (what was already done) now also droughts, likewise besides biodiversity (what was already done) now also carbon sequestration/sustainable food systems are supported. Or can farmers optimise their production in a new setting by shifting to different more climate smart cropping strategies?

Answer: …

2. Societal optimisation

The way to involve stakeholders: who and how (see participation ladder). What potential disservices to communities exist (e.g. in terms of health, wellbeing, production reduction etc.) and which measures can help to overcome these?

Answer: …

3. Technical optimisation

Expand the scope of restoration measures (other measures; shift from technical to NbS), combination of different measures in a larger framework strategy that may also include 'soft measures' related to e.g. compensation/education/risk reduction etc

Answer: …

4. Economic optimisation

New financial resources. N.B. identifying new goals to be achieved with restoration may unlock other financial resources. This category can also be added in a later stage, but when you have already ideas.

Answer: …

5. Policy/regulation optimisation

Can new policies help improve upscaling/implementation of measures, or are there EU policies that may be better linked into restoration schemes too to facilitate uptake at larger scale? Or how can those EU policies be better translated to local implementation of those policies? e.g. via blue-green services)

Answer: …

6. Maps of the area on which your SWOT is based

In addition, the following was requested to get insight into the spatial delineation.

Give one or more maps displaying the area on which the SWOT is based. Where needed give a short explanation on the maps.

Table 3 Guidance for combining SWOT information from various categories

Optimisation strategy category	SAT categories to be included	Green Deal categories
Multiple goals	1. societal challenges 2. restoration design at scale 5. inclusive governance	Identify which additional GD goals are relevant to the restoration case
Societal	5. inclusive governance 6. balance trade-offs	Identify how inclusivity and human health and wellbeing are/can be addressed
Technical	3. biodiversity net-gain 7. adaptive management	Identify how combinations of GD goals can be achieved (e.g. combine floods and droughts with biodiversity, but also with sustainable food and zero pollution goals)
Economic	4. economic feasibility 6. balance trade-offs	Which of the goals provide opportunity for additional funding?
Policy regulation	8. sustainability and mainstreaming	

2.3 Synthesis per cluster

In Chapter 4 'Summary findings per cluster' the information is synthesized for each of the five optimisation aspects. Chapter 5 gives the general conclusions and recommendations. These will form input for the regional scalability plans (draft version: Deliverable 2.2 in March 2023; final version: Deliverable 2.4 in September 2024)

3 SWOT synthesis and optimisation strategy per case study

This chapter provides the optimisation plans of each of the individual cases within MERLIN. The contributions are clustered in the three main MERLIN clusters 'peatlands and wetlands, 'small streams and basins' and 'large rivers'.

3.1 Cases within the cluster peatland and wetlands

3.1.1 Case study 1 Kvorning wetland (Denmark)

Authors: Linda Udklit (NST), Annette Baattrup-Pedersen (AU), Martin Nissen Nørgaard (NST)
AU: Aarhus Universitet
NST: Naturstyrelsen

1. Multiple goals optimisation

Climate mitigation

The main goal of the project is reduction of CO2 emissions and carbon sequestration through re-wetting of grasslands and natural areas. This is the focus and the reason for the funding, which is 100% governmental (except for the MERLIN financed cattle passage).

Cost effectiveness needs to be considered and guidelines for this have been developed. Firstly, a CO2 calculation is made, based on a model developed by Aarhus University. The model takes into account:

i) the current use of the areas. Input: area with crops, permanent grass and natural areas. The model applies an estimate of the average use of fertilizer for the respective crops.
ii) Information about current drainage intensity (variation of depth)
iii) Information about content of carbon in the soil – area with 6-12 % peat, area with > 12 % peat and area with mineral soil (<6% peat), based on GIS data.
iv) Information about expected water table following implementation of the restoration measures.

This information with a compared before/after scenario together with a consideration of the carbon content within the soil provides us with a qualified estimate of the expected CO2 effect.

Next a budget for the entire project is made, including thorough pre-investigations, detailed planning, construction works, materials, land distribution/buying- and selling land/properties, man hours, meetings including catering etc.

In order to achieve permission to proceed with a project, cost effectiveness must be within 1.147 €/t CO2. This can be exceeded with up to 2 times, if there is a significant positive effect on nature, environment and/or climate adaptation next to the primary objective of CO2 emission reduction and carbon sequestration.

Inclusivity

Stakeholder engagement ("Inclusivity") is of great importance to us, and is, without a doubt, the key to success in the area, given that it is voluntary for landowners to give up land and engage in the project.

Zero pollution

Biomass has been harvested in the area for a few years, prior to the project being implemented (addressing "Sustainable energy"). Harvesting the biomass is a means to removing nutrients prior to re-wetting, also supporting the "Zero pollution goals".

By re-wetting the area, a reduction of N leakage to the rivers and fjords is also expected. For Kvorning the calculation estimates a reduction of 30 kg N/ha equivalent to nearly 15.000 kg N in total per year, also contributing to "Zero pollution goals".

Other GD goals

The project, together with complementary projects (LIFE IP Natureman) within the area, is supporting farmers who would consider using the areas (and adjacent areas) for grazing/nature preservation ("Biodiversity net gain") and maybe "nature-meat" production upon implementation. I.e. also supporting "Sustainable food production"/"Farm to fork".

1 We anticipate that the project will contribute to mitigate flooding of downstream areas, as closing the drains and ditches allows the area to function as a buffer, retaining water after e.g. heavy downpour.
2 We are unsure if the project will contribute to mitigating the impact of any droughts. Floods seems to be more of a concern – both for farmers/crop production, and for urban communities.
3 We do see droughts as an upcoming issue in DK, but it is not in the foreground of attention yet. It would be a new future line of thinking that may need further attention.

2. Societal optimisation

Stakeholders are involved throughout the entire process (which is still running). Firstly, before anything is carried out in the project area, all possible affected landowners within the project area have been invited to a meeting. In this meeting the landowners were informed about a possible project, why we are interested in carrying out a project, the law and financing behind it, what their possibilities are in terms of compensation, selling and/or land-consolidation and of course underlining, that participating is completely voluntary. Only if the landowners accept, we proceed with pre-investigations in the project area. They do not need to accept a project at this stage, only accepting that we proceed with pre-investigations.

As part of the pre-investigations in the area, besides the technical and biological investigations, also a so-called "proprietary investigation" is being conducted, interviewing all landowners individually. During this interview, we learn more about the individual landowners, their production and future plans (animal production/plant production/expanding/status quo/retirement etc.). We share the provisional results of the technical pre-investigations with them, presenting them with a "consequence map" showing the expected extend of the project and how wet we expect their specific areas to become, according to our models (Figure 5). They share their thoughts on the project, let us know if they are interested, and under what conditions (in regards of compensation) – do they wish to keep the land (with a compensation), sell it entirely, or do they wish compensational land elsewhere in exchange of the land that is being re-wetted and can no longer be tilled, sprayed, fertilized or drained.

Landowners and citizens in the nearby villages and rural areas have given input regarding their wishes for walking tracks in the area. A few dedicated, local users have established a temporary working group to develop the tracks and other recreational measures in- and around the area.

Disservices – e.g. production reduction are overcome by economically compensating landowners for the decrease in value that re-wetting will result in as a one-time compensation.
As participating in the project is voluntary, we will not succeed if any disservices exceed the advantages of the project, to the individual landowners.

Other stakeholders, such as citizens, municipality, NGOs etc. has also been invited and participated in information sharing meetings. NGO's, private stakeholders etc. are also able to give input and objections to the project, as part of the public hearing phase.

Newsletters are sent out in the river valley on a regular basis, with news about the Kvorning project as well as similar projects in the river valley (Figure 6), and other news about work in progress, decisions and plans in regards to the open land in Nørreådalen.

Kvorning has been a case study in Denmark in regards of the 'Land consolidation and lowland projects', hosting several events and meetings with e.g. agricultural organizations and –advisories, politicians and decision makers.

The fact that participating in the project is voluntary can of course be a **weakness**. It seems however difficult to optimise much further on the process of involvement that has been part of the stakeholder engagement in the project area so far.

One tool would be expropriation, but this also has some disadvantages: farmers feeling forced and therefore show local resistance towards the project, or farmers simply denying to engage voluntary with compensation, may instead be waiting for expropriation, as this could be more profitable.

We find that the fact that this project is voluntary is also helpful regarding getting in dialogue with the landowners, as they can hear more and keep an open mind, as they know they will not be forced. Starting the dialogue with "it is completely voluntary" may lower the guards and open some doors and ears.

In Kvorning the project came off to a good start, when a single farmer was willing to sell us almost 400 hectares. This land is now used in the land consolidation process, both as compensational land for other farmers engaging in the project, and some of the land is actual project area which will be re-wetted. We often do rely on land that we can swap – this is what stopped the project in Svoldrup kær (for now at least). The voluntary aspect is thus both a **strength**, and a **weakness**.

3. Technical optimisation

The concept of re-wetting the carbon rich lowlands in Denmark is being rolled out throughout the entire country already. The approach and measures are nearly 1:1 the same as in Kvorning.

The areas chosen for these kinds of projects, are areas with a high content of carbon in the soils (as they are in fact, as earlier mentioned, climate projects with the main purpose of reducing GHG emissions). These areas are often found in the Danish river valleys, and are often more difficult areas for agricultural production, as draining is more and more complicated over the years, as the organic matter in the soils disappear, due to oxidation of the soils, causing the soils to subside to much lower levels.

The project in Kvorning is being optimised with a cattle passage financed by MERLIN. This will allow for grazing animals to browse through the area and/or adjacent areas, optimising the potential for biodiversity net gain.

We see a general need to improve follow-up monitoring in areas that is restored in Denmark. This is not part of the funding and generally, follow-up monitoring is not conducted, which is a **weakness**. This also means that no adaptive management or adjustments are considered after implementation to maximize benefits or to facilitate continuous learning about system-wide processes that could lead to an adaptation of the restoration measure to possible changes.

Thanks to MERLIN, there will be monitoring of Biodiversity net gain and environmental effects (N and P in soils and water) in the Kvorning area

4. Economic optimisation

The Danish projects are 100% financed by the Danish government, as it is part of the Finance Act.

The political ambition is to take 100.000 hectares out of production by 2030. This includes converting 38.000 hectares to extensive management (as a preparation for later taking them out of production permanently), re-wetting 50.500 hectares + 11.500 hectares of adjacent areas. The 100.000 hectares are mainly peat/carbon rich soils + adjacent areas. Taking the adjacent areas out of production as well, supports a diversity of connected habitats in a mosaic (connectivity), and supports grazing thereby improving biodiversity.
This political decision is built upon +20 years of experience with river restoration and especially wetland projects. Previously the aim of the projects were mainly to reduce N loss to aquatic ecosystems, whereas now, the main focus is aimed at CO2 reduction (carbon rich soils). The projects (including Kvorning) are called “Climate-lowland projects” (Figure 6).

Optimising the projects by e.g. conducting follow-up monitoring to verify model calculation of carbon retention and/or to establish short and long-term efficiency of the efficiency as well as establishing grazing upon implementation rely on additional funding. Regarding grazing, however, in some cases, fencing the project areas can be part of the governmental funding if it does not compromise the cost-effectiveness of the project. In other cases, it can be financed via EU funding (if e.g. in N2000) and in a few cases other funding might be needed to succeed. However, in the end it comes down to whether a farmer, or someone else, will take the responsibility for the animals and for grazing the area.

The project is designed so that will need no or very little maintenance after implementation. We do our utmost to avoid introduction of dikes, pumps etc. – i.e. any technical measures that will need maintenance at some point in the future. The aim is to keep it a simple, nature-based solution.
A legal declaration is put on the areas, securing that after implementing the project it is prohibited to drain, till, fertilize and spray the areas, and that these lands must stay as grassland or natural area at all times.

The design and the declarations are to ensure the project sustainability in the long run.

Some use of the areas is allowed: If possible (i.e. not too wet) it is allowed to e.g. graze, do hay cuts, hunt and/or just use the areas for leisure activities. Other income (apart from an extensive production of e.g. hay or meat itself) could be continued direct payment. If the farmer used to receive single payment, but engages in a project that is so called “Directive implementing” (e.g. supporting implementation of the water framework directive), the farmer can continue to apply for the direct payment on the areas, under what we call “article 32”. If the areas on the other hand have high nature value, the farmer might be entitled to apply for subsidies under an eco-scheme, supporting grazing of natural areas. Thus, some income is still possible on the re-wetted areas, under some circumstances.

The landowners have the following 3 options when engaging in the project:

1) One time compensation, depending on the previous use of the land:
   Areas in rotation = approximately 11.090 €/ha
   Permanent grass = approximately 4.770 €/ha
   Natural areas = 630 €/ha
2) Land consolidation. I.e. the **opportunity** to swap land and preferably acquire better land, maybe also closer to their farm, than the land in the project area that is being re-wetted. They can also be offered compensational land without selling the land in the project area.
3) Selling land. Landowners can sell specific plots of land within the project area or sell their entire property. For instance, if a farmer wants to retire, selling the entire farm is possible. In the latter case we can use the areas outside the project area as compensational land for other landowners in the project area.

Naturstyrelsen is allowed to buy land/buildings and take a financial loss. After project implementation, and definition of declarations/restrictions on the land and maybe even establishing public access/tracks (also legally declared on the land) Naturstyrelsen will usually sell any surplus land, building etc., that wasn’t sold in the land consolidation. Naturstyrelsen usually also sells the entire project area – The nature agency is not supposed to own the land after the implementation. By “merging” smaller pieces of land into larger areas before selling, this becomes more attractive for potential buyers as 20 or 50 hectares in connection is usually more attractive to buy, rather than small parcels of e.g. 1-2 hectares each. These are then sold for the highest bid. The (enclosed) bids are sent to Naturstyrelsen before a given deadline, and after the deadline the highest bidder will buy the land. It is not an “auction”, where one can see what the others are bidding. This should ensure the market price. Naturstyrelsen is allowed to refuse the bids though, if for some reason the bids are obviously way to small.

Other financing: We do see an increasing interest for buying and selling carbon credits. However, farmers cannot both sell the credits, and get credit themselves (on their farm or their product) for the same CO2 reduction. We also know that farmers will be facing requirements to reduce emissions. There are no clear guidelines or regulation on this topic yet, which makes it difficult for the farmers to assess if it might be a benefit or not to sell carbon credits. Another question is, if they even can sell the credits, after having a project implemented for free, and also be receiving a compensation for it – i.e. already being paid. As far as we know, the whole matter is currently being discussed in the EU commission.

There is currently a political discussion about implementing a CO2 tax on farm production (actually on industries all together).

5. Policy/regulation optimisation

For the time being, there is some uncertainty in Denmark regarding the compensation for the landowners, for re-wetting protected nature (e.g. meadows). Since the coming into force of a new law (by 1/7/2022) that prohibits to plough, apply fertilizer and spray protected nature, the Minister for Food, Agriculture and Fisheries claimed, that the landowners will not suffer a loss by re-wetting, and declaring that the areas may no longer be drained, sprayed, or fertilized – since it is already prohibited. However, the re-wetting might prevent grazing and hay cuts of currently drained areas, and by participating in a re-wetting project this will lower the value of the area further than just the new law prohibiting spraying, fertilizing and ploughing.

There have been complaints about this (no compensation for re-wetting protected (yet dry/drained) areas/meadows), meaning that the Minister and organizations/sectors are currently discussing this again. This has paused a lot of ongoing projects (since landowners are not satisfied with re-wetting areas without the compensation, that they were promised), and it makes it difficult to start new projects, for the time being, since we cannot promise the landowners compensation for these areas.

The problem revolves around the areas classified as “permanent grassland” that also happens to be protected nature (§3 in the Nature Protection Act). In these areas the compensation went from 4.770 €/ha to 0 €/ha. by July 1st. 2022. The hope is, that the Minister will realize that this is a hurdle to accomplish the national goals of converting 38.000 hectares to a more extensive production (with the aim of later taking them out of production permanently) and re-wetting another 50.500 hectares – all in all taking 88.500 hectares out of production and re-wetting by 2030. Including adjacent areas, the ambition includes 100.000 hectares (page 4: https://fm.dk/media/25215/aftale-om-groen-omstilling-af-dansk-landbrug.pdf).

We are at the beginning of achieving this goal. It takes a long time and a lot of work to complete these projects. New staff has been employed at the government to perform the needed work to reach this goal. The farmers are aware that CO2 taxes for emissions is being considered.

GLM8 (new measure in national regulation of Direct Payment : From 2023 it has been decided, that Danish farmers must dedicate at least 4 % of the area in rotation to “non-productive” areas such as fallow land, ponds and/or shrubs. The goal being increasing biodiversity in the farmland. This, however, causes some farmers to re-consider if it would be wise to engage in wetland projects, or if they should just keep the areas in “rotation” in order to then leave them as fallow land and thereby fulfil the new requirements. This is also a consideration of the landowners, that we now meet more often.

Finally, there is a ”competition” for land these days, with many (often divergent) interests. E.g. production of renewable energy, climate mitigation, carbon sequestration, biodiversity, food production, urbanization, infrastructure etc. We see the need for better national planning of use of the open land (e.g. dedicating some areas for biodiversity, others for production of renewable energy, others for food production etc.). For the time being, some interests are conflicting and there is not necessarily an obvious plan to turn to.

We need to convince politicians to spend more money on the monitoring to really understand if we are achieving the goals we intent to reach.

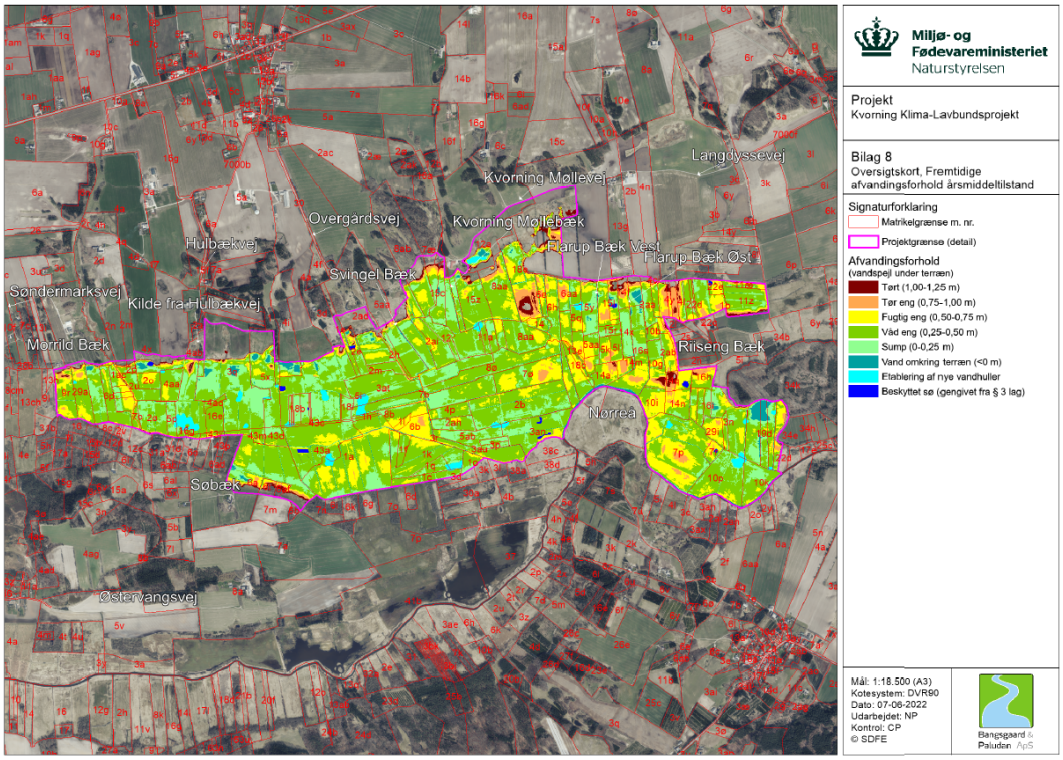

*Figure 5 The expected future water table (average over the year). **Pink**: Project boundary; **Red**: Dry, water table 1-1,25 m below terrain; **Orange**: "Dry meadow", water table 0,75-1 m below terrain; **Yellow**: "Moist meadow", Water table 0,5-0,75 m. below terrain; **Green**: "Wet meadow", Water table 0,25-0,5 m. below terrain; **Light green**: "swamp" Water table 0-0,25 m. below terrain; **Blue/green**: Water table around terrain; **Light blue**: Establishing of new ponds; **Dark blue**: Nature protected lake/pond*

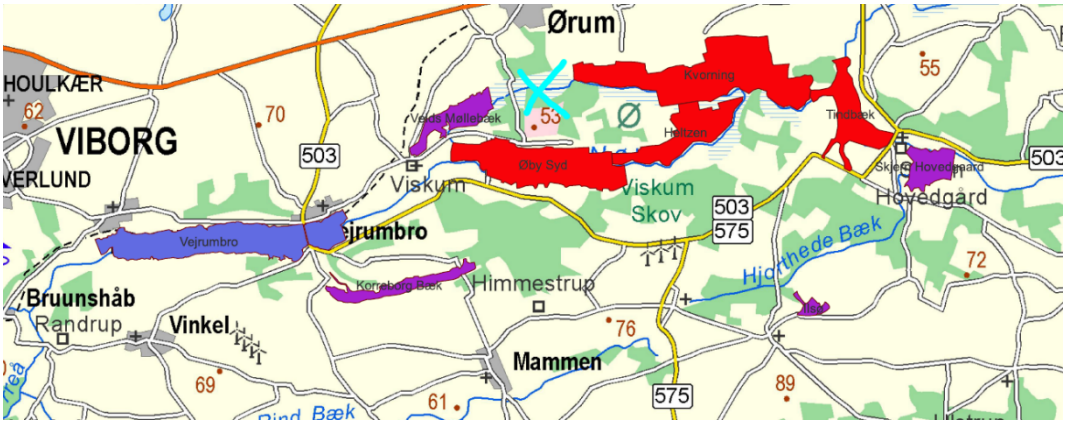

*Figure 6 Overview of projects in the nearby area in Nørreådalen. **Red** is "Climate-lowland projects" (CO2 reduction). **Blue** is "Lowland projects" (Similar to "Climate-lowland"); **Purple** is "Wetland projects" (Reduction of nutrients to the aquatic environment). **X** Pipeline ("Add on" to Kvorning). Established projects: Heltzen (Nature Agency), Velds Møllebæk (Viborg Municipality), Skjern Hovedgaard (Viborg Municipality), Ilsø (Viborg Municipality). Ongoing projects: Kvorning (Nature Agency), Øby (Nature Agency), Vejrumbro (Viborg Municipality), Korreborg Bæk (Viborg Municipality). Planned (expected start in 2023): Tindbæk, Pipeline/"add on to Kvorning"*

3.1.2 Case study 3 Beaver reintroduction (Sweden)

Authors: Linnéa Jägrud (SFA) and Frauke Ecke (SLU)
SFA: Skogsstyrelsen (Swedish Forest Agency)
SLU: Sveriges Lantbruksuniversitet (Swedish University of Agricultural Sciences)

1. Multiple goals optimisation

The main **strengths** are related to the NbS re-introducing beavers is fostering and advancing biodiversity and recreation (incl. beaver safaris, hunting and bird watching). The main **weaknesses** are connected to a) difficulties in calculating the cost effectiveness of the NbS re-introduction of beavers as a restoration measure, b) potential disservices caused by the NbS presence and activities of the beavers (e.g. flooded agricultural fields and production forests), c) limited knowledge on certain ecosystem functions (e.g. GHG emissions, risk originating from zoonotic and vector-borne diseases), and d) the unpredictability of this nature-based NbS solution (NbS) (so far, it is not possible to predict where beaver dams will be build or which beaver dams that will be abandoned where and when), which also affects a)-c). **Opportunities** arise from the very essence of this being a nature-based solution (since it is the beavers that are restoring the ecosystems) and **threats** result from possible changes in legislation connected to landowner structure or beaver population management.

2. Societal optimisation

The current high abundance and spatial distribution of beavers in Sweden offers a significant **strength** for gaining more information regarding so far understudied environmental, ecological and socio-economic effects and hence to gain more knowledge on potential services (biodiversity, recreation [bird watching, hunting], flood and drought mitigation) and disservices (risk [need to look at hazard and exposure] for zoonotic and vector-borne diseases, recreation [impaired canoeing dues to felled trees in the water], economic losses due to flooded production forest and agricultural fields). The main **weaknesses** of the NbS is its unpredictability (see 1.). **Opportunities** arise from the public in Sweden being generally interested in nature and wildlife, making ecotourism – not only to see beavers but to actually experience the environmental impacts that beavers have and to experience and riverine landscape as it likely looked 200 years ago in large parts of Sweden.

Beavers are currently largely absent from southern Sweden but will likely also colonize these areas within the next 50 years (if extension of distribution is not managed). This offers the **opportunity** to learn from the services and disservices induced by the NbS observed in northern Sweden to gain a sustainable beaver management in southern Sweden – an NbS that maximizes services and minimizes disservices.

Another **opportunity** arises from the twin project GRIP on Life (LIFE IP) that builds artificial dams for rewetting degraded peatlands, with the main task to reduce emission of GHG. These dams are largely built in drainage ditches, i.e., systems without fish. The rewetted areas are – so far – unsuitable beaver habitat since they largely lack deciduous trees. Hence, in the current situation, the NbS and the twin project 'rewetting of drained peatlands in Sweden' in areas not suitable as beaver habitat are complementary. However, in the long term, the degree of deciduous trees might increase due to the raise in water level, which in turn could attract beavers.

3. Technical optimisation

The main **strengths** are that the case study is based on a true NbS where beavers recolonize degraded ecosystems and restore them – including associated functions – to pre-industrial status.

The main **weaknesses** are the lack of long-term monitoring and evaluation plans (e.g. for GHG emissions, flood and drought mitigation, pathogen and disease risk), the unpredictability of the NbS (see 1.) and constraints that are not under the influence of the NbS. Here, a major constraint is the low degree of deciduous trees in the Swedish forest landscape, which results in conflicting goals for nature conservation in riparian zones that are rich in deciduous trees. For example, the in Sweden red-listed white-backed woodpecker (*Dendrocopos leucotos*) relies on old and coarse aspen trees for nesting. Due to intense forest management, the abundance and proportion of aspen in the forest landscape is low. This leads to nature conservation conflicts in aspen-rich riparian zones, where beavers fell aspen trees for building up a food cache for winter. To avoid and obviate this conflict a (long-term) transformation is needed in the Swedish forest sector towards cultivation and allowance of natural regrowth of deciduous trees and growth of mixed forests. This transformation needs to account for "multy-purpose forests", where not only monetary values like timber harvest are accounted for, but also where forests are accounted for as for example sinks for carbon thereby reducing GHG emissions and biodiversity net-gain. While the lack of transformation is presently a **weakness**, it can also be regarded as a future **opportunity**.

Opportunities arises from the MERLIN Twin project "rewetting of drained peatlands in Sweden". Both the NbS and the twin project rewet the landscape, with the twin project operating in habitat types that due to habitat degradation are unsuitable for beavers. The NbS and the twin project are hence complementary (see 2.). Currently, there are non-science-based opinions that beaver dams are barriers for fish migration. The current abundance of beavers and their wide distribution range allows – as part of MERLIN and beyond – to address the questions whether beavers create migration barriers or not by studying and monitoring fish migration in multiple beaver dam systems and at various spatial scales, from individual beaver dam to catchment scale. In

this context, it is also important to address beaver dams as potential temporally barriers and to study how such potential barriers can be avoided by for example beaver management (dam removal, hunting) or technical solutions that make beaver dams more permeable (e.g. beaver deceivers that are used in Canada).

Currently, there are no beaver management plans in place. The absence of such plans indicates that there is currently no need for these since the local management by for example hunt or dam removal works sufficiently. However, with the beaver population still expanding, there will be an increased need for such a plan or at least for a toolbox. Here, the NbS and MERLIN can generate and provide empirically based recommendations for beaver management.

The knowledge derived from the current monitoring in MERLIN can be shared wider to other countries where introduction of beavers/presence of beavers is part of the restoration or considered as a future nature restoration measure.

The carbon-sequestration potential related to the artificial rewetting in the twin project versus the potential GHG emissions due to beaver activity induced rewetting requires more studies and monitoring that result in scientific knowledge. To study GHG emissions in both the NbS and the twin project likely enables a large-scale assessment of when, where and how wetlands provide sinks and sources, respectively, for GHGs.

Currently, GHG emissions and carbon sequestration can comparatively easy be translated into the consequences for climate change induced rising temperatures. For services like biodiversity net gain or disservices like disease risk, there are no such translations from species to monetary values. The comprehensive monitoring of the NbS provides an **opportunity** to contribute as part of MERLIN to the development of translational Green Deal indicator values. In this respect, the constant development of new technologies for monitoring provides a great **opportunity**. Various aspects of the NbS including several of its services and disservices can be monitored by eDNA (including monitoring of potential occurrence of American beaver and pathogens) and recent and future developments in real-time remote sensing (drones, satellite).

4. Economic optimisation

The main **strengths** are that the responsibilities and rights of stakeholders are well-defined. The main **weaknesses** are that the balanced trade-offs are only partly known. **Opportunities** arises from the fact that nature-based solutions are trending and are gaining high acknowledgement, and the beaver is a true nature-based solution. The **threats** result from the fact that climate change is occurring at an accelerating pace and legislation and decisions are dangling behind.

The demands for forestry material (timber and pulp) have been stable for many years. The changes in the requirements from the industry is low, and new industrial wood techniques do not promote a forestry with more biodiversity conservation. The demands in the industry for fast growing wood is strong, and the industry is most profitable when coming from a business-as-usual-forestry. Despite these strong economic incitements, there is a growing interest for alternative forestry practices such as continuous cover forestry. Here, beavers can play an important future role when transferring the Swedish forest sector into a sustainable sector.

There is a potential for a compensation mechanism for climate change adaptation to be developed. This could be based upon the flood protection and drought mitigation possibilities that are due to the water holding capacity of beaver ponds. This has not been properly investigated and requires hydrological calculations and a payment for ecosystem services system that does not exist yet.

To increase the acceptance of beaver landscapes even further, economic compensation for the beavers' activities leading to flooding productive forest land or agricultural fields could be provided to landowners. At present, no such compensation is in place, but it could be similar to the compensation provided for livestock losses due to wolf attacks.

At present, there are no professional hunters in Sweden, which also implies that neither meat, fur nor castoreum (used in perfume industry and food production) are commercially exploited. The size of the Swedish beaver population would currently allow for such an exploitation. A transition to commercial hunting would however likely require a national beaver management plan. Overexploitation would otherwise risk a significant reduction in population size comparable to the extinction of beavers in Sweden in the late 19th century.

5. Policy/regulation optimisation:

The main **strengths** are that the nature-based solution aligns well with the habitat directive. The main **weaknesses** are that the beaver population management is regulated on the national level. **Opportunities** arise from the huge potential to link the NbS more and better to the goals identified by IPBES and the SDGs. The **threats** arise from the possible changes of legislation of beaver population management.

From a biodiversity point of view, the ideal forest landscape would consist of heterogenous tree cover in age, height and species composition. This would promote further spread of beavers. The current lack of top predators (especially wolves) is another **weakness** to fully balance the forest system.

The problems caused by beavers in Sweden are minor. They are mainly related to potential damage to infrastructure, and potential flooding of productive forests. There are not many examples where this occurs

(mainly in extremely flat landscapes); the risks are thus very limited. Regarding infectious diseases: the risk is not new and public health interventions including educating people on how to behave and how to avoid getting infected can be put in place. It might be in southern Sweden where agriculture is larger, that beavers might start to feed on sugar beets and reduce harvests. This problem could potentially be avoided by functioning riparian buffer strips.

In Poland, the situation is different because the legislation is very strict, and you cannot remove 'nuisance – beavers'. In Sweden and the Baltic countries, the institutional settings are more relaxed, and it is easier to manage beavers causing damage. This has also made that there are no conflicts (there may be problems, but they can be resolved smoothly). The Swedish approach may be beneficial to other countries, where the approach might be too rigid, and beavers cannot be removed/killed when they are creating too many problems. However, if hunting picks up, Sweden might need new regulations for that (e.g. quota), but currently that is not needed yet (see also above regarding hunting).

To avoid problems, there might a need for more proactive monitoring in areas with a large beaver population and targeting sites where beavers might establish. Such monitoring could for example focus on infrastructure and forests/agricultural fields where beaver dam building should be avoided.

The existing forestry legislation is from 1994. It states that production and nature conservation should be equally important. The balance between them has however switched and the last decade or so, biodiversity considerations have been set behind. Climate change and the substitution principle has further pushed this towards homogeneous plantations with a low degree of deciduous trees. In Sweden this is a question at the highest political levels. It is important to learn good examples from other countries where the balance between production and nature conservation has been successful.

Currently the forest industry is using monocultures of mainly spruce to mitigate climate change. To achieve a transformation of forestry towards a more biodiverse and natural practises negotiations at the highest political level are required. At the same time, education of forest owners (both private and companies) can be incorporated to increase awareness. Here, the MERLIN NbS might be used as a pioneering and showcase example for multiple functional forests and for forestry in the riparian zone. For an overview of the catchment areas focused on in the case study see Figure 7-9.

The achievement of transformative change can be fitted into the scalability plan.

Figure 7 Overview of the catchment areas focused on in CS3. In the north, the Vindelälven catchment (26,815 km2) contains the Krycklan River catchment. The Grannebyån catchment in the southwest is too small to be displayed and is replaced by the blue polygon.

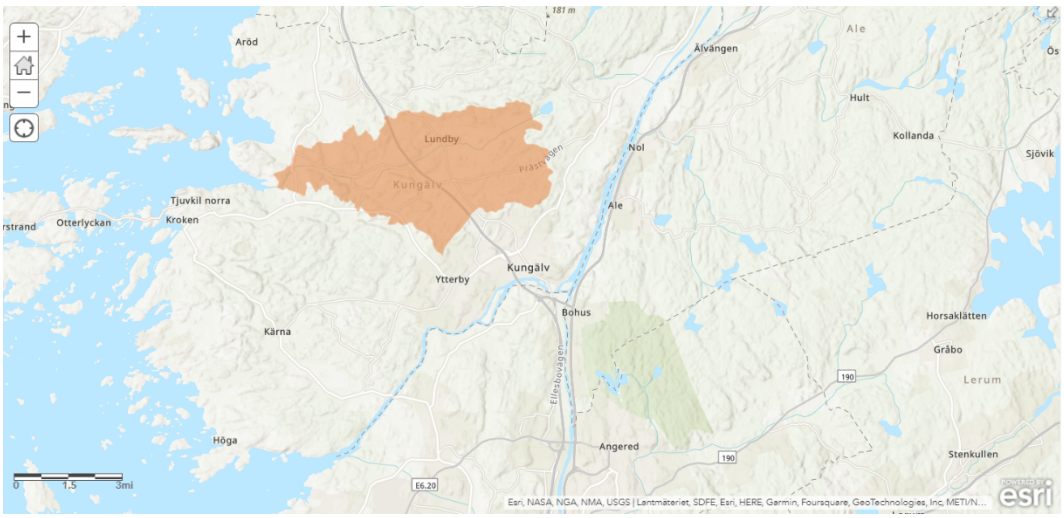

Figure 8 The Grannebyån catchment (45.5 km2) in southwest Sweden north of the city of Gothenburg

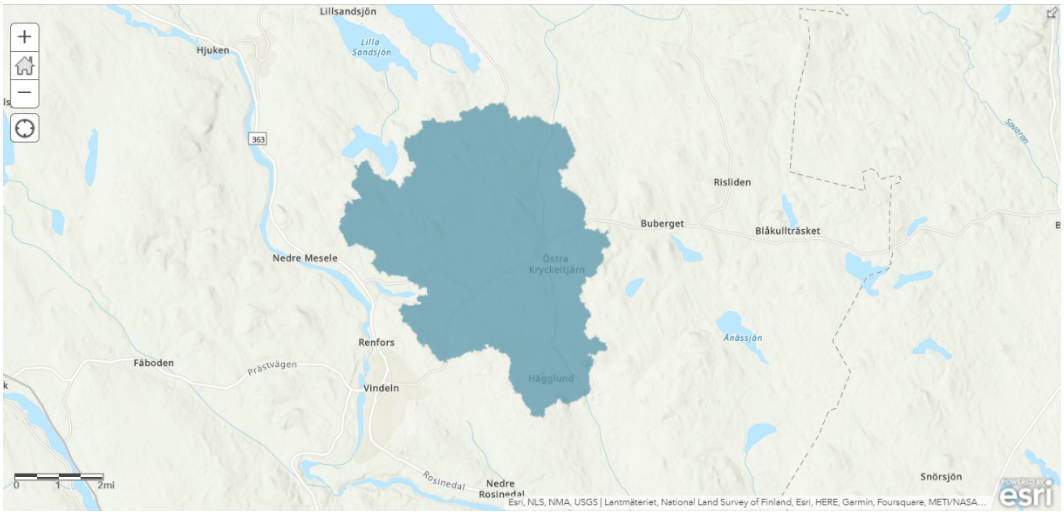

Figure 9 The Krycklan sub-catchment (67.9 km2) in the Vindelälven main catchment.

3.1.3 Case study 5 Kampinos (Poland)

Authors: Anna Wilińska (KPN), Anna Andrzejewska (KPN), Paweł Trandziuk (SGGW), Julian Rudziński (KPN)
KPN: Kampinoski Park Narodowy (Kampinos National Park)
SGGW: Szkola Glowna Gospodarstwa Wiejskiego (Warsaw University of Life Sciences)

1. Multiple goals optimisation

The main strength of wetlands restoration measures in Kampinos by rewetting, channel naturalization and slowing water run-off is that it will positively affect desiccated wetland habitats and enhance biodiversity. Besides that, rewetted wetlands will reduce GHG emission from over-dried wetlands and will improve GHG capturing. These actions will also reduce the effects of extreme weather effects such as drought, heavy rainfalls, (local, flash) floods and heat waves. It will improve resistance of habitats to such extremes and will positively influence local communities' health and wellbeing by mitigating heat weaves, hot summers and drought. Implementing such action will provide as a source of knowledge and experience to be used at other wetland restoration sites in Poland and abroad. Restored wetlands may serve as a scientific research and educational site. It would also improve educational and recreational value of Kampinos wetlands which are adjacent to Warsaw.

Wetland restoration contribute to mitigations of climate change, national goal for counteracting the effects of droughts and floods. Contributes to UN Sustainable Goals and EU Green Deal Goals.

The **strength** is also the existence of Kampinos NP which as a public body has been protecting the nature of Kampinos since 1959 and is going to provide nature protection in future. There is a land acquisition programme for the KPN which has been running since 1975 so today most lands are under KPN's management.

The weaknesses are:

The existing mosaic of land ownership in KPN (Figure 10) hinders nature protection action like limiting alien invasive species, wetland restoration, water retention etc.

The **weakness** is the fact that desiccated wetlands will/might emit green-house gasses when being rewetted.

There are difficulties to create revenue streams for local markets and 'KPN produce' such as local honey, cheese, etc. There are 'too few' farmers with too small farmland areas. Most farmers operate on degraded peat soils.

Although lots of hydrological and biological research were conducted on this area, there is lack of knowledge on influence of rewetted wetlands in KPN on GHG emissions and change in vector borne diseases.

The opportunities arise from:
The number of inhabitants and lands used for agriculture or build-up lands are declining. Through the land acquisition programme KPN manages more and more wetlands area.

Cooperation with scientific institutions, NGO's and realisation of other nature protection projects deepens the knowledge of Kampinos wetlands landform and water regime as well as social aspects.

MERLIN is the 3rd implementation wetlands restoration project in KPN. Before implementation projects there was a research project focused on where in KPN wetlands restoration is most needed and how it should be done. Based on the research project a first LIFE project was implemented focussing mainly on small ditches in KPN. Since 2020 there is the ongoing Kampinos WetLIFE project now focusing on main ditches in KPN. The MERLIN project is planned to supplement and scale up ongoing and previous LIFE projects. KPN is also a case study in the EU project WATERLANDS (Figure 11 and Figure 12). The **opportunity** is coming from merging the aims of all wetland restoration projects in KPN and providing better effects on a wider scale.

Thanks to above mentioned actions/processes there are and will be more **opportunities** for wetland restoration at a wider scale.

In longer term there is an **opportunity** to develop organic farming and paludiculture in a small scale on private lands in KPN.

Threats arise from: climate change caused unpredictable weather events as heavy rains and (flash) flooding which increases the opposition of local communities to wetlands restoration. According to climate change models the risk of heavy rains and flash floods increases.

T**he way forward** for multiple goal achievement is focusing on making the best use from different ongoing wetlands restoration projects (MERLIN, Kampinos WetLIFE, WATERLANDS) on technical issues, inclusivity, financing and merge wetlands restoration effect on wider scale.

The way forward for multiple goal achievement is also installing GHG monitoring and use MERLIN partners knowledge and experience.

We should educate local communities and governors on the values of wetlands for multiple goal achievement.

We should also start discussions on long term agricultural use of wetlands in KPN (including agriculture on degraded peat soils) and look for climate friendly alternatives, i.e. paludiculture.

2. Societal optimisation

The main stakeholder at this site is the Kampinos National Park which aims to protect nature in the whole KNP and manages the majority of lands in the park.

There are several groups of people and institutions who have interest in wetlands restoration in KNP. The most interested and at the same time the most opposing any actions aiming to increase water level are local communities living on or adjacent to the wetlands and farmers. They are also represented by local governments – communes and counties.

The public institution which manages watercourses in KNP is the Polish Water Management Authority. The role of PWMA is water management at this site. They manage watercourses – ditches and hydraulic structures – weirs.

KNP is a point of interest of adjacent Warsaw scientific institutions – WULS, Warsaw University, Cardinal Stefan Wyszynski University and others which conducts research there.

Also interested in wetlands restoration actions in Kampinos are NGO's already cooperating with KNP and realising EU funded projects – REC Polska, CMok.

The main **strengths** are:

KPN as a stable and long-lasting public institution has established relationships with local and regional stakeholders, realises meetings and discussions, and needs and problems of local communities are well recognised.

All of the stakeholders are recognised and relationships established. All above-mentioned stakeholders are included in the consultation process, and they may attend organised meetings and discussions. Materials and documents are widely available to the public through projects and KNP websites. All these groups and institutions are members of working groups and the MERLIN case study board.

KPN manages most lands so KPN can plan wetlands restoration actions in a way to avoid influence on private lands. KPN is capable to handle negotiations and implementation of alternative solutions to fulfil needs of all stakeholders.

Weaknesses:

Conflicts of interests between wetlands restoration and agriculture and urbanization on private lands are a main weakness in this case study. Because of the existing mosaic of private and KNP managed lands and small parcel surface areas (Figure 10) the risk of flooding private lands hinders wetlands restoration. Farmers are not interested in land consolidation and swapping, also as in KPN there are bad experiences with land swapping in the past. The lack of direct benefits for local communities coming from wetlands restoration is a weakness. There is also lack of sufficient social monitoring and research of inhabitants and tourist in KPN and its buffer zone around the park.

There is a lack of a park policy oriented to individual owners and their needs.

There is also a difficulty in realising social research because of small research groups and lack of social experts in KPN.

The influence of wetlands restoration on vector-borne diseases (VBD) is not recognised in KNP due to lack of expertise for monitoring. In Poland the only recorded VBD are lime disease and tick-borne meningitis. There are no records of harmful diseases related to mosquitoes in Poland. In KPN there are already many mosquitoes as a natural part of the system, and there is no change in abundance of mosquitoes due to the wetland restoration activities observed.

The weirs on Łasica ditch in KPN are managed by the Polish Water Management Authority based on agreements signed by PWMA, communes and KPN. The instructions set in agreements are not sufficient for proper management of the weirs. Also, the PWMA response to requests for closing or opening weirs is very slow. Because these weirs are conflicts points they cannot be used properly to serve both local communities and wetlands.

Farmers don't experience drought as a **threat** for agriculture, so they are not interested in water retention and rewetting of wetlands.

The upstream /outside the park stakeholders are influencing the water management in the national park. Residents of the park buffer zone mistakenly associate the flash floods affecting them with the lack of drainage channel dredging in the Park. They fail to see the connection with the change in land use that they themselves are the cause of: turning farmland into housing development areas.

Opportunities:
The land acquisition programme and decline of number of inhabitants and agriculture reduces conflicts between nature protection and agriculture and urbanization. Often it is also an **opportunity** for landowners to get money from lands which are not used and are difficult or impossible to sell at the market. The land acquisition programme creates possibilities for wetlands restoration in new sites and/or on broader scale.

Ongoing cooperation with NGO's is a chance for better communication with local communities.

Thanks to MERLIN's activities, a different approach is being used to work with individual landowners. Made-to-measure solutions tailored to the needs of individual farmers are discussed and prepared.

Wetland landscapes adjacent to tourist trails will be improved/more attractive/more natural.

Threats:

Conflict of interests and local communities' opposition make it difficult to cooperate with communes and obtain necessary permissions for wetland restoration actions.

Torrential rains and inundations which are not connected with implemented measures are seen as caused by wetlands restoration by local communities and increase their opposition.

The way forward for societal optimisation is focusing on farmers and local communities. We have to improve or create relationships with local farmers, establish small working groups for every case and conduct a set of meetings. Work out together the best possible implementation measures aligned to the local community's needs (tailor made solutions). We have to train ourselves and KPN terrain workers on communication and conflicts solving. If there will be a need, we should integrate independent expert opinion and use professional mediations.

Start discussions and meetings with local communities on alternatives and possibilities for more wetlands friendly agriculture (paludiculture).

It is necessary to make local farmers aware that the management of peat soils in past years has led to their degradation (through the drainage system). Their further drainage will not improve the fertility of these soils, on the contrary, the process of mucking up and further degradation will continue. The only possible solution is to raise the water level, ensuring a proper soil moisture content and introducing other management methods, such as grazing.

Use of MERLIN partners to discuss and recognize solutions for agricultural use of wetlands.

Education of local communities and officials on the need of wetlands restoration, their role as flood buffer, mitigation of droughts etc. and about **threats** of urbanization of open lands and wetlands.

Additional dialogue with PWMA is needed to find new solutions for the weir management.

3. Technical optimisation

The main strength of this case study is the large experience in implementation of NbS solutions. The activities are based on the recognition of the current state of nature in KPN. NbS realised in previous projects and their impact were assessed before, during and after the implementation.

Regular monitoring (in the field) has been carried out for many years, both as part of KPN nature monitoring and the additional monitoring of implementation of other projects. Scientific knowledge is considered (SGGW was a partner in the previous projects as well as in ongoing LIFE and MERLIN projects).

Threats and possible negative impacts are identified and monitored. Monitoring is carried out (hydrological, including chemical, wildlife) and models have been developed to simulate possible effects of activities. Ecosystem integrity and connectivity are considered in the planned NbS. Monitoring is carried out throughout the life of the Wetlands project, and conclusions and possible adjustments are being implemented on an ongoing basis.

KPN as a long-lasting public institution assures long term nature monitoring.

The weaknesses are lack of sufficient funds to meet all needs (lands acquisition, GHG monitoring using advanced equipment). The other **weakness** is that main ditches and the technical facilities are managed by Polish Water Management Authority not KPN. Any actions planned on the main ditches have to be agreed by the PWMA, which creates more bureaucracy and is more time consuming. There are also difficulties in management of weirs as mentioned in chapter 2.

The opportunities arise from long lasting and well thoughtful nature and hydrological monitoring. The continuation of biodiversity monitoring is provided and funded by the Kampinos National Park and the State Environmental Monitoring Programme. KPN also has experience from previously implemented wetland restoration activities both in monitoring and in implementation of technical actions.

The main threats come from unpredictable weather events. During drought, ecosystem integrity and continuity cannot be maintained (lack of water). Difficulties in assessing the effectiveness of NbS may arise due to extreme weather events. Effects of drought and flash rains can be higher/ more visible than effects of NbS in a specific year, so monitoring data after one or two years after launching of NbS may not yet be sufficiently representative to draw definite conclusions.

Because GHG monitoring isn't well recognized and implemented in Poland there is a **threat** that newly established GHG monitoring in KNP will not bring adequate and sufficient conclusions.

The way forward: Signalling the impact of barriers on watercourses and seeking solutions with stakeholders. Evaluating in cooperation with local communities rewetting options to address future droughts and describing

the effects of extreme weather events related to climate change to explain how private land can contribute to resilience. In the long-term perspective taking over by the Park the management of the main ditches and the technical facilities currently managed by Polish Water Management Authority.

Slowing water runoff to maintain ecosystem integrity and continuity during droughts.

Learn about GHG monitoring from MERLIN partners and use of their knowledge and experience to establish such monitoring in KNP. Additionally, this provides an **opportunity** to assess the role of water quality in GHG emissions. Realization and conclusions from GHG monitoring will be innovative in Poland.

4. Economic optimisation

The main strength are activities which were undertaken in MERLIN project so far: there are selected technical activities with alternative solutions, predetermined costs are estimated. Funding KPN **opportunities** for activities are well-recognized since KPN as a public entity conducts many projects financed from various foreign and domestic sources and has a portfolio of possible funding mechanisms.

The weaknesses consist of detailed documentation (technical projects of measures and administrative permissions/agreements with Polish Water Management Authority, communes and districts, Regional Directorate for Environmental Protection, which has to be prepared prior to the launch of activities: the full documentation necessary for the implementation of technical measures has not yet been done, the participation of other institutions in the implementation of measures is being determined. A detailed cost effectiveness study of the measures has not yet been prepared. Design, technical projects and cost-effectiveness study will be done soon by external expert chosen through public procurement.

The other recognised **weakness** is lack of funding for land acquisition and lack of private sector funding.

The only economic activity at Kampinos wetland is agriculture which is in decline. Farmers (landowners) are changing into housing developers and in some places inside and around KPN there is a pressure of urbanization which is a strong **threat**.

There is not a lot of market for 'KPN produce' such as local honey, cheese, etc. and there are 'too few' farmers with too small farmland areas. The number of farmers is declining due to the land acquisition programme and because some farmers are turning into housing developers.

It is necessary to make local farmers aware that the management of peat soils in past years has led to their degradation (through the drainage system). Their further drainage will not improve the fertility of these soils, rather on the contrary it will continue the process of mucking up and further degrading the soil structure. The only possible solution is to raise the groundwater level and introduce other management methods, such as grazing. Unfortunately, such solutions will never bring landowners as much income as the change of land use from agricultural to construction/housing areas (near Warsaw).

Carbon crediting as financing instrument for wetlands restoration is not yet developed/established in Poland.

Possibilities which are to be recognised are ability to raise funds based on GHG credits or increase of financing options through green deal financial schemes.

The main threats to economic optimisation relate to the present world economic crises, which is also present in Poland: lack of staff, shortage of materials, rapid and unpredictable changes in prices of materials and labour, declining interest in the nature conservation issues in the face of the war in Ukraine and the general energy crisis.

Optimisation will consist of further discussions with MERLIN financial experts to assess if private/international donors may help provide necessary funding. Conducting GHG monitoring and use of knowledge from MERLIN partners and financial experts to recognise potentials of GHG capturing in KPN as a new funding mechanism for restoration measures, e.g. carbon credits. Conducting a cost effectiveness study by specialists and conducting ex-ante and ex-post analyses.

5. Policy/regulation optimisation

The identified **strengths** come from the fact that KPN is long lasting public institution. Policies both on national and European level are recognised, acknowledged and used in implementation of measures on KPN area.

While national policies on nature restoration are being prepared, KPN consults and gives opinions to those policies and other legal documents.

Weaknesses: There is no policy for carbon crediting from wetlands in Poland. There is a lack of legal and political support for wetlands restoration in Poland and agri-environmental subsidies for water retention.

Threats come from insufficient support for NbS and wetlands restoration in national policies.
The vicinity of the Warsaw city causes a strong urbanization pressure in both the areas surrounding KPN and also inside the Park. The communes' visions of spatial planning often assume building in wetlands or open areas which is in conflict with wetlands restoration and nature protection. As a result, farmers are turning their

agricultural lands into building lands. Unfortunately, there are weak law regulations in Poland which allows building up open and agricultural lands.

The water permits for weirs on Łasica ditch are going to finish in 2027, just after MERLIN.

National policies do not support efficiently nature restoration. Private property and industrialization, technical infrastructure are prioritised.

The way forward for policy/regulation optimisation is to use of MERLIN outcomes and MERLIN partners knowledge/experience on upscaling, mainstreaming wetland restoration and sharing information.

There is a strong EU pressure on the Polish government to use NbS for water restoration, flood and drought risk management and control of EU money spend in Poland on such projects in accordance with NbS and nature restoration/protection.

New legal aspects which free implementation of infrastructure in ditches from obtaining permits would make it easier to develop wetlands restoration.

Discussions with Polish Water Management Authority on the future of weirs and implementing new solutions for weirs management are to be started up. In the long-term perspective the management of the main ditches and the technical facilities currently managed by Polish Water Management Authority are ideally taking over by the Park .

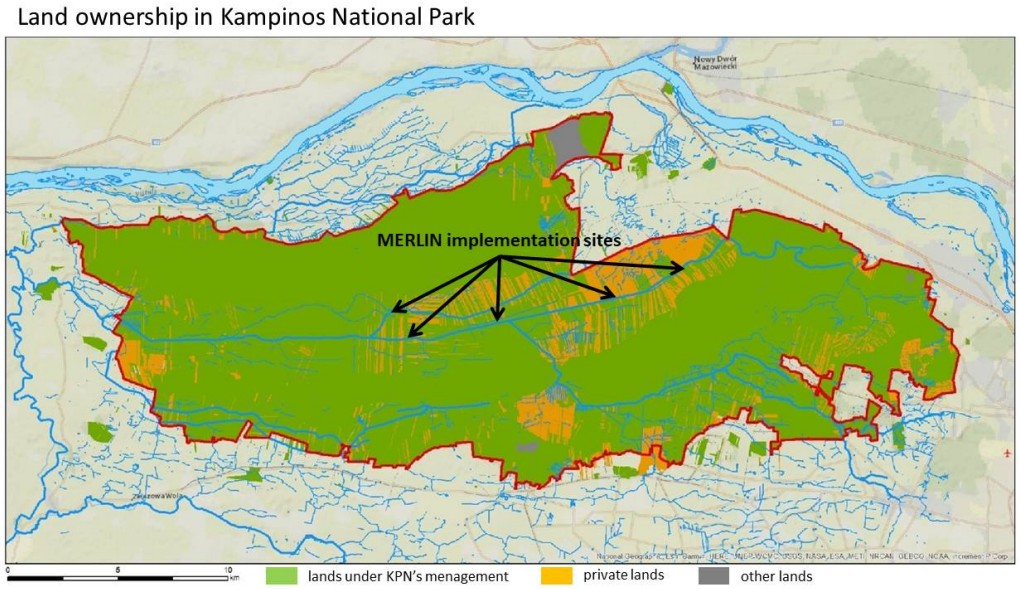

Figure 10 Land ownership in Kampinos National Park

General map of Kampinos National Park

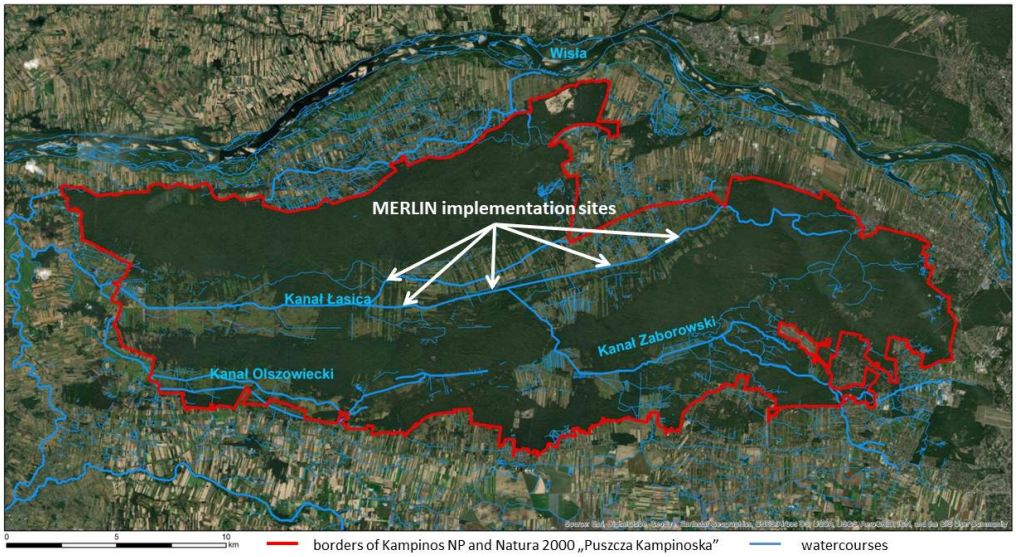

Figure 11 General map of Kampinos National Park

Landform

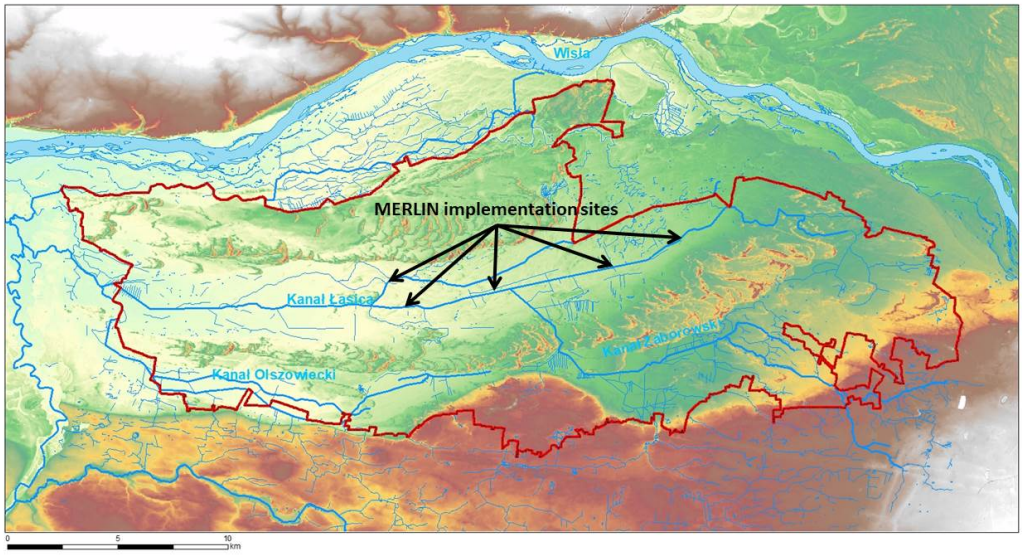

Figure 12 Landforms in Kampinos National Park

3.1.4 Case study 6 Hutovo Blato peatland (Bosnia-Herzegovina)

Authors: Zoran Mateljak (WWF Adria) & Matea Jarak (WWF Adria)
WWF Adria: WWF Adria -Udruga Za Zastitu Prirode I Ocuvanje Bioloske Raznolikosti (WWF Adria)

1. Multiple goals optimisation

The main **strengths** are:

Hutovo Blato nature park is in the territory of Bosnia and Herzegovina, in the south-eastern part of the Federation of Bosnia and Herzegovina, on the territory of the municipalities of Čapljina and Stolac Herzegovina-Neretva County/Canton. It is 20 km from the state border with Republic of Croatia and is located on the eastern bank of the river Neretva, that is, on the eastern side of the Neretva Delta, which partly also belongs to Bosnia and Herzegovina. It occupies an area of approx. 7,400 ha, and its greater part is under some form of anthropogenic influence. As part of this area, there are hilly parts, Londža and Koščela, with the highest elevation of 588 m ASL. (Budisavina), and the water part consists of six larger lakes: Deransko, Svitavsko, Jelim, Orah, Drijen and Škrka (with elevations of 1.5 - 2.5 m ASL), with some deep sources down to about 15 m below sea level sea, and the Krupa River, through which Hutovo Blato is directly connected to the lower course Neretva. Water occupies the largest area of the Hutovo Blato Nature Park - 39 % of the total area. The park consists of two separate geomorphological units: Deran Lake or Gornje Blato and Svitava Lake or Donje Blato. Gornje Blato is composed of 5 smaller lakes: Deran, Orah, Drijen, Jelim and Škrka are interconnected by ravines, while Donje Blato and lake Svitava were transformed into reservoirs for the needs of the reversible hydropower plant "Čapljina" during the 60s of the 20th century. The wetland is supplied with water through numerous karst springs (the total number of springs in Hutovo Blato is more than 70, and vast majority of them are temporal), and also the Neretva, which connects the wetland via the Krupa River with Lake Deran (Figure 13). Proposed measures (transition in land use, re-wetting, and channel restoration) would benefit local biodiversity and habitat restoration, as well as water retention, carbon-storing, and flood and drought control.

One of the first benefits would be biodiversity recovery. It is expected that after the restoration a number of species will return and/or increases in existing populations will be observed. . The Neretva Basin is characterized by several endemic and threatened species. More than half of the Adriatic river basin species inhabit the Neretva Basin and more than 30 of them are indigenous. The Neretva Delta hosts more than 20 endemic species. Amongst them salmonids, with three endemic varieties of Neretva trout: Neretvan softmouth trout (*Salmo obtusirostris*), toothtrout (*Salmo dentex*), and marble trout (*Salmo marmoratus*). A great number of cyprinids are endemic to the Neretva Basin, in particular Adriatic minnow (*Phoxinellus alepidotus*) and Dalmatian minnow (*Delminichthys ghetaldii*). The downstream section of the Neretva is inhabited by 20 endemic species, among which Neretvan spined loach (*Cobitis nerentana*) which is strictly protected in Croatia. Some iconic species require more space to return such as the Dalmatian pelican. Biodiversity can recover relatively quickly. The area has been degraded in the last 40 years and experts expect that as soon as natural conditions are back biodiversity will recover.

A second benefit of the restoration will be that the retention capacities of Hutovo Blato will be increased, therefore floods resilience will be increased. Water from the area of the Hutovo Blato flows through the Krupa River into the Neretva, and during high tides, the water level of the Neretva flows in the opposite direction into the Hutovo Blato, flooding the entire Hutovo and Svitava mudflats. With a higher water retention capacity in Hutovo Blato, more water from Neretva can be taken in. Also, the local microclimate could benefit, and water retention could improve resilience to extreme weather conditions seen in the last decade (summer temperatures in the nearby town of Mostar can reach up to 42 ℃ and with last few summers have been extremely dry). *NB_Eds. Note: It should be noted that the impact of letting in more water from the Neretva for resilience to droughts is to be further detailed for its' impacts on water quality and resulting response of the ecosystem in Hutovo Blato)* . During extremely rainy seasons there is a risk of substances entering the wetland due to soil erosion, bringing nutrients as well as pesticides used in agriculture into the watershed, and those are accumulated in peatlands such as Hutovo Blato.

Lastly, as part of the restoration plans the spring zone will be unblocked (by overgrown vegetation and sedimented mud) which will positively address drought problems. Although there will be some vegetation extraction, new growth that will be managed will still contribute to carbon sequestration. Channel clearing will help with water retention and distribution. The problem is the reduction of water inflow in the Deran Lake area. Under such conditions, ravines and lakes become overgrown, i.e. swamp vegetation dries up and causes build-up of organic debris. To improve the water regime at the springs, water circulation and recharging the lake in the Deran area, it is necessary to clean overgrown sources and ravines. Also, new habitats for aquatic species will be made. By applying an adequate scientific methodology, it was determined that the mitigation potential of the surface layer of peat in the Hutovo Blato Nature Park amounts to 1.3764 mil. t C. Further research within the project estimated that the thickness of the peat of the investigated area of Hutovo Blato is several meters, which indicates the conclusion that the mitigation potential of this carbon landfill is many times higher than this and can amount to 3 mil. t C, which is about 7% of the total estimated mitigation potentials in the Federation of Bosnia and Herzegovina.

The main **weaknesses** are: It is not certain how to secure funding for the maintenance of the area once the restoration has taken place. The state of the habitats of Hutovo Blato is dependent on the operations of the

hydropower plant Čapljina. Based on currently available data, Hutovo Blato has a water demand of at least 10 m3/s, but according to the last measurements the wetland is only receiving 5 m3/s because of the HPP. Hydropower projects and hydrological alterations are the main **threat** to biodiversity, mainly due to the Upper Horizon projects as well as the HPP Ulog which is currently under construction upstream from Hutovo Blato. The Upper Horizons project refers to the construction of three hydroelectric power plants (the Dabar, Nevesinje, and Bileća power plants). Hydropower plants are altering water regimes and drain or reduce water availability in important peatlands such as Nature Park Hutovo Blato. Large-scale non-sustainable agriculture is present in the area and represents another environmental problem.

The Hutovo Blato National Park wants to clear the springs and the gullies for the tourist boat operation and restore the habitats, especially for birdwatching activities within a touristic scope. The bottom of the lake is under succession and is slowly filling up. Despite this being a natural process, it still should be managed for conservation purposes. Water hydrology is complex, and the scientific data available is not sufficient. It is known where water originates from, but not how much exactly and from which sources in which quantities. For that reason, continuous monitoring should be done, and additional data should be collected.

Given that the hydromorphological state affects the final evaluation of the ecological state, that is of the overall water condition, it is estimated that certain measures related to inter-entity impacts of Deran Lake and after the planned changes in the Trebišnjica basin could lead to conditions that would keep the ecological or overall condition in good condition. By building a series of constructions and technical facilities in the bed of the Neretva river since 1953, then also in the Trebišnjica basin, the ecological system of this area is already quite burdened. In the coming period, the construction of the new hydroelectric power plants with accompanying reservoirs is planned in the Gornja Neretva area and in the Trebišnjica basin. In principle, the accumulations of these power plants should contribute to a more balanced flow of the Neretva on the profiles in the middle and lower part of its flow, as well as balancing the regime of Trebišnjica. However, the problem may arise due to the inadequate operating regime of these hydropower systems, which can cause further reduction of spring flow in the area of Hutovo Blato in the period of low water and salt intrusion water towards the upstream parts of the stream. The big problem of these salt intrusions can also be of influence in the protected areas of Hutova Blato, which might cause destruction or alteration of the entire flora and fauna in this protected area. Salinization of the soil, lowering of groundwater and surface water levels, transfer of water, draining karst areas, and the decrease in the flow of fresh water is already evident in the Neretva delta downstream of Čapljina, with a tendency for further deterioration.

Opportunities arise from wetlands restoration and conservation taking a more prominent position in the national environmental strategies as awareness of their role in addressing climate change issues is becoming more evident. Restoration will enable the development of other environmental activities such as bird watching. Investments in the park are directly linked with the benefits for the local people. The restoration area is potentially small. It is 10% of the delta of river Neretva. Some iconic species require more space to return such as the Dalmatian pelican. Making it a keystone species, the restoration area could be expanded in the future and also based on bird-watching activities be financed from additional sources. The restoration of the wetlands may prevent wildfires, and tourism development opens possibilities for bed and breakfasts offered by local residents, but also may provide new sustainable tourism activities in the surrounding areas such as nature walks, heritage and tradition, etc.

Perceived **threats** result from:

Hydropower is the main **threat** to Hutovo Blato and is getting promoted especially in the current context of energy security in Europe. Locals, in the absence of another stable financial influx, choose non-regenerative agriculture, investing in hydropower, or unsustainable tourism (over-exploitation of resources, pollution, and urbanisation).

Based on these SWOT characteristics **the way forward** is**:**

Biodiversity recovery will increase the resilience of the whole area to climate changes. Also, there is a **threat** of climate change-caused unpredictable weather events such as heavy rains and flooding or droughts which could make the involvement of local communities in wetlands restoration even stronger and needed, as their livelihood is under pressure. Restoring Hutovo Blato, especially the water retention capacity, could improve the safety of locals, mainly because of the floods and droughts. Considering local safety is a way to engage them as stakeholders, paving the path to potential co-management of the Park. Engaging with energy companies is the key. Without full cooperation and support from local hydropower operators the wetlands of Hutovo Blato cannot be saved in the long-term.

2. Societal optimisation

The main **strength** is that the importance to protect Hutovo Blato is recognized by the Federal government as the government signed the Ramsar convention and proposed Hutovo Blato as the first Ramsar site in Bosnia and Herzegovina (BiH). The Cantonal government proclaimed Hutovo Blato as Nature Park and devoted certain financial support to this operation. Local stakeholders are also getting involved in Hutovo Blato as they are more aware of the benefits that restored nature has for their business and wellbeing, and stakeholder participation has a major role in the planning and implementation process. The local municipalities Čapljina and Stolac are strongly connected to Hutovo Blato traditionally. For example, Čapljina got its name after the stork “čaplja” in the local language, and Hutovo Blato is stork habitat. So, there is a high chance for their involvement

in the stakeholder process if there is a good communication strategy made. Locals are using Hutovo Blato as a place to visit for healthy, relaxing, and recreational reasons, making it the centre for those activities in those municipalities.

The main **weaknesses** are**:** Environmental protection is quite low at the governmental agendas. BiH is a poor country with several other priorities. The government is not very transparent and does not include the local communities in their work, especially in granting permits. In cases when some projects are financed by international donors it is obligatory to organize public hearings regarding the issuance of permits and usually, locals come and do share their opinions, but more often that is not the case. More often, as seen especially during the COVID-19 pandemic, a ban on public assembly was an excuse for not organizing public hearings. There is low or no information on public hearings, etc. However, NGOs and EU standards are a safeguard for this kind of obscure behaviour. Citizens often do not trust the justice systems and security providers. Law enforcement is weak, as well as complaint mechanisms in the country, which often discourages individuals and communities to seek justice. Freedom of expression remains restricted while in recent years only limited progress was made to ensure an enabling environment for civil society.

Opportunities arise from the civil sector in BiH which is becoming stronger, through access to information and educating the public. The environmentalists have succeeded to achieve some key goals such as stopping governmental subsidies for hydropower. Public pressure and awareness to protect nature, especially waters in BiH, is getting higher. Discussing pressing challenges through stakeholder engagement and explaining the importance of the conservation of Hutovo Blato for the region through the provision of ecosystem services is of uttermost relevance for engaging local stakeholders. New perspectives and job **opportunities** could be the biggest initiator for local engagement.

There are several protected wetland areas in neighbouring countries such as Croatia (e.g. Lonjsko polje and Vransko jezero) where knowledge transfer to Hutovo Blato can be made through study visits, as they are branding themselves as water retaining systems that are keeping the downstream farms and locals safe.

Perceived **threats** result from:

Political instability and poverty prevail, so local communities, civil society, and governments just leave environmental issues behind. Local communities do not recognize the benefits of conservation of the area and would rather engage with unsustainable but profitable activities such as hunting, land reclamation, intensive agriculture, and hydropower. Land flooding, droughts and low buy-out prices are reasons for the conflict of interest between wetlands restoration and agriculture and urbanization on private lands.

Based on these SWOT characteristics **the way forward** is:

Keep on campaigning and promoting the importance of environmental (wetland) protection as a healthy environment breeds a healthy society. Democratization and law enforcement are keystones for successful nature protection. The capacities of the local NGOs, governments, and communities can be engaged to expand the scope of restoration measures until the Park is able to overtake all responsibilities with its own capacities. The Government must be pushed toward recognizing the benefits Hutovo Blato has for the region. Possibly broadening the stakeholder board with diverse stakeholders would be a functional base layer for developing co-management of the Park, defining the needs and **opportunities** of the Park based on stakeholder input through the development of a good business plan, involving educational and touristic activities in the Park. A financial analysis should be done on how the hydropower central and the Park can co-exist, with the Park having the needed water flow and the HPP being profitable. For that, extensive collaboration with the HPP should be done and a new financial influx in the Park has to be developed.

3. Technical optimisation

The main **strengths** are:

Hutovo Blato plays a crucial role in the reduction of the risk of floods. It has a great retention potential that has been degraded by hydropower operations. Hutovo Blato can contribute to the local economy through tourism development (birdwatching, educational visits). Also, it has great potential to become an educational and/or even scientific centre. Local schools and universities have already expressed interest in and are visiting Hutovo Blato. There is already some infrastructure that can be used in the development of new programmes that could add to Nature Parks' value. As Hutovo Blato is part of the big karstic area, known for numerous endemic species, there is already some research done, but there is a big capacity for further research to be done and monetized in the area, specifically related to hydrology and biodiversity monitoring.

The main **weaknesses** are:

Public Enterprise "Nature Park Hutovo Blato" is in charge of managing the Park. The Enterprise does not have capacities. There is only a director, ranger service, and some administration who are struggling to provide just basic and very modest income to the Enterprise. The public enterprise "Nature Park Hutovo Blato" does not have a developed conservation department. They need qualified nature conservation experts. The Government keeps on ignoring calls for the protection of Hutovo Blato. Ramsar convention removed Hutovo Blato from the list of important wetlands. Therefore, there are no sufficient scientific data for the are collected over time.

Opportunities arise from:

Recently, Hutovo Blato has attracted EU-funded projects. Besides MERLIN, there is an Interreg project on tourism development in the Park. Using natural resources found in Hutovo Blato and its close surroundings to develop new infrastructure, a circular economy system could be developed. As the old Action Plan is valid till 2023 a new Action Plan will be defined in the coming period. The Public Entity NP Hutovo Blato could invest in developing a better Action Plan, especially a business plan and financial sustainability plan, using EU funding that is available for BiH.

Water sampling in Hutovo Blato is under the jurisdiction of the AVP of the Adriatic Sea Institute for Public Health of the Federation of Bosnia and Herzegovina. General physical-chemical parameters, nutrients, heavy metals, microbiology, etc. are measured parameters, but systematic monitoring of biological elements of quality (fish, macrozoobenthos, phytobenthos, phytoplankton, and macrophytes) has not been established. Measurements have been carried out since 2007, and the results of the sample tests show that the water quality meets the requirements of the Regulation on water classification ("Official Gazette of the SRBiH", no. 19/80), i.e. the prescribed class of water (I and II) in physical sense and from a chemical point of view. There are low levels of chlorophyll, which is characteristic of the wetlands area, and in the summer period, there is an evident increase in conductivity, which indicates an increased salinity in the water. However, the general conclusion is that the water meets the prescribed quality criteria. Federal Water Management Agencies possess capacities and mandates to develop and support the implementation of NbS-restoration measures and Nature-based Solutions (NbS). There are no real experiences in implementing NbS in BiH. The project in Hutovo Blato can be considered a pilot. A good partnership between FWMA and the Public Entity NP Hutovo Blato could result in the strengthening and capacity building of Hutovo Blato. Bringing Hutovo Blato back on Ramsars' map could improve their capacities and bring financial stability.

Perceived **threats** result from:

In the current capacities of the Public Enterprise “Nature Park Hutovo Blato,” it is not possible to expand the scope of restoration measures. Therefore, it is a priority to enable the Park to use the full potential of the Park. Also, if Government persists in ignoring the value of Hutovo Blato not only for that Canton but for the whole region, the Public Entity could lose all available finances.

Based on these SWOT characteristics **the way forward** is:

The most urgent problem in Hutovo Blato is the reduced water inflow in the Deran Lake area. Under these current conditions, ravines and lakes become overgrown with vegetation. To improve the water regime at the springs, water circulation and recharging of the lake in the Deran area it is necessary to clean overgrown sources and ravines. Unlike Deran Lake, water sampling is not performed in the Svitava Lake area systematically. However, there are data on one-year monitoring of nutrients (in 2011) at the outlet of HPP Čapljina. The sampling results indicate a somewhat increased presence of phosphorus, which is probably the result of agricultural activity in this area. In addition to agriculture, many landfills were recorded in this area during a field visit focussing on identifying locations of solid waste, which also contributes to the water pollution of Svitava Lake. Additional sampling and monitoring should be done on Svitava Lake and also communal monitoring for landfills should be done on regular basis.

4. Economic optimisation

The main **strengths** are that peatlands have greater GHG sequestration capacities than rainforests. Peat is one of the main soil characteristics of Hutovo Blato. Stakeholders and governments are becoming fully aware of the necessity of the trade-offs. Legislation in BiH supports balanced economic development. Local communities from Čapljina and Stolac municipalities are strongly connected to Hutovo Blato and are strong stakeholders. Because of that connection to Hutovo Blato, there is a communication **opportunity**, new visuals, and a brand for Hutovo Blato to develop to engage those communities more.

The main **weaknesses** are:

There is no relevant example, neither knowledge nor skills available on how Hutovo Blato can approach the carbon crediting market in BiH or internationally. The public enterprise “Nature Park Hutovo Blato” does not have a developed conservation department. They need qualified nature conservation experts. Restoration does not bring immediate economic gains to the area. It is a long-term investment. NbS in national policies and also carbon crediting as a financing instrument for wetlands restoration is not yet recognized in BiH.

Opportunities arise from:

Projects like MERLIN and/or relevant international organizations that can provide the necessary “know-how” to fully explore Hutovo Blato’s carbon sequestration potential and connect it to the carbon market. Also, knowledge transfer from the MERLIN network could define business opportunities for locals to monetize their products and services in a sustainable way. WWF Adria has experience in developing sustainable business models for marine areas and could transfer that knowledge to wetland areas for blue-green services, such as Hutovo Blato.

Hutovo Blato contributes to sustainable agriculture through the provisioning of ecosystem services (pollination, water supply, clean water, etc.) and also can be a sponge to store water, downsizing the repercussions of flooding to downstream areas. Through stakeholder engagement, new information on how farmers are dealing with climate change and how it impacts their lives, we could develop a new approach to resilient agriculture for them to use, including less environmental impact and higher income for them.

Perceived **threats** result from:

Hutovo Blato is losing its peatlands, and soon the "point of no return" can be reached that would make all efforts that restoration unlocks and other financial resources irrelevant. The cantonal government has financial issues due to which they might stop financing the park as they have already great pressure for additional funding from health and education as priority sectors. 80 % of the total income to the municipality of Čapljina comes from a hydropower plant located in their territory. Therefore, hydropower has a great influence on the municipality's decisions. Restoration means less water for electricity generation which could bring additional problems in dealing with energy companies.

Based on these SWOT characteristics **the way forward** is:

The potential to develop a carbon-crediting pilot project for the restoration of Hutovo Blato wetlands should be analysed and technical support to initiate its implementation is to be provided.

Hutovo Blato is recognized as a touristic and educational locality. Local schools are visiting Hutovo Blato for educational reasons, so that could represent the added value to the locality and add to the capacity of the public institution governing it (educational programmes, materials, equipment, etc) as a new means of financing. Local communities can finally see the benefits of wetlands conservation as restoration can increase demand for local products as more eco-tourists will be coming to the area. The Cantonal government recognizes that Hutovo Blato contributes to the attractiveness of the Canton and enriches its touristic offer.

Carbon crediting is probably not going to solve the lack of water in the area, but Hutovo Blato may be a carbon sink when managed well. There is an assessment of the amount of carbon that may be released if not managed well, but there is no proof to validate this theoretical analysis yet. Habitat/biodiversity banking also be a method to get more attention and financial incentives for the management of Hutovo Blato. Restoration will decrease the water risk that agriculture is facing within the delta of river Neretva. Using the knowledge gained from the MERLIN project on the bankability of carbon crediting could improve the financial status of, not only Hutovo Blato but the whole area around it. As almost half of the Park is private land, establishing a fund for local owners could be one of the mechanisms to use for the Parks' sustainability.

5. Policy/regulation optimisation

The main **strengths** are: There is a political consensus and the majority of people's opinion is that BiH must accomplish all necessary requirements for EU membership. Thus, EU legislation is already being incorporated into the national legislation. Aarhus centres in BiH are very active and support different organizations in access to information on public interest in the field of environmental protection. Water ecosystems are protected through nature protection legislation. The restoration of Hutovo Blato is fully in line with national and local strategies and legislation. The federal government incorporated the protection of wetlands into national legislation. In the Federation of Bosnia and Herzegovina, since both Federation- and canton-level institutions share the competence in nature protection, the legislation is enacted on both federal and cantonal levels. Municipalities are on the Park's Board which enables them to participate in the decision-making process.

The main **weaknesses** are: BiH is not EU Member State. Therefore, BiH is not obliged to implement EU policies. Corruption in the country is high and it often happens that certain individual interests prevail over public and national interests. In BiH, the law is not harmonized on the national, cantonal, and local levels and citizens still need strong administrative knowledge to access information. Still, only 35 % of citizens in BiH have had experience in participating in local decision-making, mostly through local community offices and 81 % of them consider local community councils' meetings as the best way to participate. Law on nature protection in Article 14 defines informing, data collection, and monitoring mechanisms that will be later defined by additional acts. These special acts are still not adopted. The transboundary cooperation between the countries in the region is weak when it comes to the effective management of the river basins. Bosnia and Herzegovina suffer from a high degree of political instability with some of the political actors within the country advocating for the country's dissolution. The possible succession (dissolvement of federal entities) of the parts of the country would further disable the framework for nature protection on the transboundary level.

Opportunities arise from: Presently, BiH has the status of a potential candidate for EU membership. BiH applied for candidate status 4 years ago and the main political parties recognize it as their priority to get the candidate status as soon as possible, so it is in their strategies to follow EU policies. Hutovo Blato is a protected area on the cantonal level, so most of the money comes from cantonal funding. The park is developing new projects and is trying to secure funding for the future. Future EU funds will be available once BiH is a member, which will bring more **opportunities** for the park to develop and be financially sustainable. Also, becoming an EU member state will impose an aligning to a new set of rules to abide by, which will ensure better monitoring processes and the possibility to revise water balances defined currently by HPP Čapljina.

The current park director will be retiring soon (has been a director for a long time). Recently there is some activities to improve the Hutovo Blato (e.g. via Interreg). New management may help refresh the management strategy for the park, yet it might also be a **threat** if the ideas of such new management are not in line with the perceived best strategy and this can it be harmful to the Park. As an opportunity e.g. Hutovo Blato park could evolve to national-level protection, as such status brings new possibilities for better implementation of management ambitions.

Perceived **threats** result from: Political instability is the greatest threat for Hutovo Blato. Quite frequently, BiH is stuck and unable to make decisions because of the disagreements of the main political parties (representing three constituent nations in BiH) over key political issues. There is a long-term management plan for the park. This plan is made without stakeholder involvement (local stakeholders) so the plan is not very feasible. No stakeholders were involved in the management of the park, so making the stakeholders part of the action/management plan for the protected area is the only way to get a secure longer-term vision without extreme changes due to changes in the higher management in the Park. Therefore, getting a better understanding of the current status of the management plan and how we can guarantee long-term safety of the process of the management of the area is needed.

Restoration means less water for electricity generation which could bring additional problems in dealing with energy companies.

Based on these SWOT characteristics **the way forward** is: Promoting EU standards and policies, advocating for the democratization of the country and rule of law, and having direct and open communication with BiH officials can contribute to the effective implementation of EU policies in BiH. Engaging the federal government in stakeholder dialogue would be beneficial, both from the optimisation side and also for the potential financial stability of the Park.

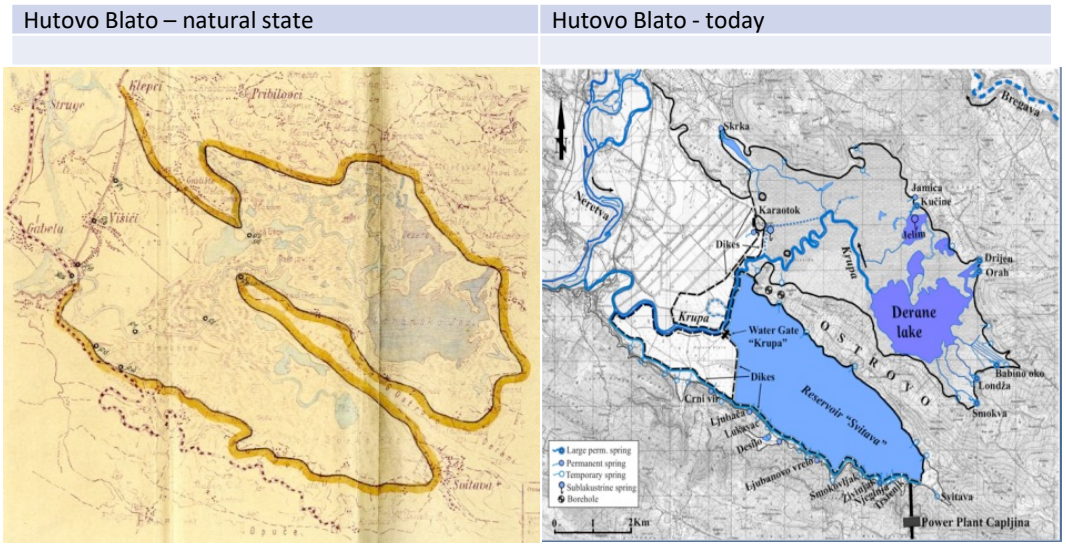

Figure 13 The natural and present state of Hutovo Blato

3.1.5 Case study 12 Lima (Portugal)

Authors: Patricia María Rodríguez-González (ISA-ULisboa), Estevão Portela-Pereira (ISA-ULisboa), Francisco Lourenço Cerqueira Correia (CPML), Vera Henriques (CPML)
CMPL: Municipio De Ponte De Lima (Ponte de Lima municipality)
ISA-ULisboa: Instituto Superior De Agronomia Universidade de Lisboa (School of Agronomy – University of Lisbon)

1. Multiple goals optimisation

The major **strengths** of the Lima restoration actions referring to the Green Deal indicators are potential contributions to: Biodiversity net gain, Climate regulation, Flood regulation, Health and wellbeing, Zero pollution goals, and Sustainable Food Systems. **Strengths** referring to these indicators rely, at least in part, on lessons learned during the development of the demonstration project LIFE FLUVIAL; 2017-2022. The LIFE FLUVIAL and its After-LIFE programme of measures (during 5 years, 2023-2027) include a coordinated transnational strategy for the conservation of fluvial corridors in the Iberian Atlantic biogeographical region. This strategy is developed by the international consortium of the LIFE FLUVIAL project (8 partners from Spain and Portugal including different type of stakeholders). The LIFE FLUVIAL has been focused on recovery of a priority habitat (91E0*) for conservation at European level, notably a type of wetland forests that represent the basis for the ecosystem functioning and host wildlife communities in the floodplains of Lima. Thus, recovering this habitat will contribute to sustain multiple organisms (e.g. fauna, microbiota) and to the whole ecosystem functioning as basis of the trophic food chain (Ferreira et al 2015). This type of habitat is especially rare in Portugal, endangered not only by widespread drainage and fragmentation along fluvial corridors (Rodríguez González et al 2008), but also by biotic **threats** with reported impacts at European level for stream ecosystems (the disease *Phytophthora xalni*, Bjelke et al 2016, invasive exotic species, Ferreira et al 2021).

The natural habitats and ecosystem in the area help in connectivity, thermal regulation and in water storage, improving groundwater tables for agriculture that dominate in surrounding alluvial terrains (the so-called "veigas"), both upstream and downstream of the intervention area. The wetland ecosystem restoration is expected to improve buffer capacity to pollutants (Bogas 2012) as it has been reported for similar ecosystems in Portugal (Rodríguez González, et al 2008). The restoration of certain habitats is expected to contribute to a diversity of floral resources with potential to contribute to other GD goals. Synergies are addressed with local cattle breed production and management of natural succession in the target forest habitats, which might help improving the diversity of habitats conserved (e.g. Natura2000 habitats) while other GD goals are achieved (F2F).

The major **weaknesses** of the Lima CS referring to the GD goals, are mainly related with Financing the transition and Green Growth. The small scale of restoration projects previously implemented in this floodplain may limit, at least in the short term, the level of achievement of multiple goal optimisation and consequent upscaling of restoration effort. The fact that a local authority is in charge of protected area management may impose administrative limitations due to both reduced financial availability and due to difficulties in the integration of scales and sectors linked to deficient coordination of competences of different entities at national, regional, basin, or local level. While the implementation partner (CMPL) had a permanent and fruitful dialogue with stakeholders during the development of the demonstration project, it was not a partner of the LIFE FLUVIAL consortium so this will slow its involvement and it will require additional effort of coordination for a total involvement in the full development of MERLIN activities in the area. This includes several transversal challenges such as language barriers that slows down the full incorporation of the different dimensions of the project and might affect the speed of achievement of multiple goal optimisation. The demonstration project was focused on habitat improvements sensa Habitats Directive, so that focused mostly on vegetation plant communities, this might limit the multiple goal optimisation as MERLIN will build on existing knowledge and experience.

The main **opportunities** of the Lima case study referring to the Green Deal goals are related with potential improvement at the level of Inclusivity, Biodiversity net gain, Flood resilience, Drought resilience, Health and human wellbeing, Sustainable food systems, Green Growth and potentially Financing the transition. A new upcoming National Strategy for the Rehabilitation of Rivers and Streams (EN3R) and the upcoming EU restoration law, both under development, may provide a positive legal framework if effectively applied. In the first case, the EN3R may help to improve evidence-based procedures (monitoring and assessment) in restoration. In the second case, a global restoration framework may help to improve coordination of the restoration efforts among small restoration projects or neighbouring regions. It might also provide monetary support depending on how a future national strategy establishes priorities on restoration, potentially facilitating conditions to enlarge the Green Deal goals achievement. The demonstration effect resulting from an increase on the area of natural habitats, through previous elimination of plantations dominated by exotic species (partly used to drain land in the past e.g. Eucalyptus plantations), may also benefit other dimensions of diversity (pollinators) and indirectly foster other Green Deal goals such as Health and Wellbeing or Sustainable food systems (e.g. there is production of honey in the area that may benefit from the general improvement of the ecosystem recovery and especially its floristic diversity). The integration of the implementation area in a Protected Area may increase its visibility, so that Green Growth can be promoted. There is limited experience in using private funding in conservation or restoration in the area. Yet this can be explored as an **opportunity** upon the establishment of a diverse representation in the Case Study Board and establishing/reinforcing contacts with private companies. This might help in the Green Deal goal Financing the transition.

The main **threats** at the level of Biodiversity net gain result from the prevalence of biological invasions in the basin (both invasive species and exotic diseases) potentially leading to modifications in canopy cover in the wetland communities and less shade as other species substitutes alder. These changes might be exacerbated by climate change (effect on drought resilience if more intense and frequent droughts occur). The traditional silos in public administration are known to be a barrier to effective implementation of restoration (Cortina et al 2021). A good integration of Green Deal/EU Biodiversity Strategy for 2030 and the future EU restoration law require to overcome deficient integration of floodplain conservation/management with existing legislation. Competing sectors that coincide in the same floodplain wetlands may generate conflict of interests challenging a prioritization that addresses a holistic Green Deal approach.

Based on these SWOT characteristics **the way forward** for 'multiple goal achievement/societal optimisation/ etc.' includes the development of a progressive strategy to finally achieve an upscaling level that is aligned to the spatial planning at the basin(sub catchment) scale. During the MERLIN projects' life time, the improvement of stakeholders involvement is increased, following stakeholder mapping and considers not only a larger but also more diversified type of stakeholders involved. This is expected to contribute to several Green Deal goals, either directly (e.g. contribute to inclusivity), or indirectly through a demonstration effect contributing to Biodiversity net gain, Flood resilience (e.g. surrounding landowners including sustainable management practices), or Sustainable food systems (e.g. conciliate biodiversity conservation with farming using local cattle breeds). At a medium/long term, an integrative study of the whole Estorãos Basin including both biophysical (e.g. different aspects of the basin that is not yet sufficiently studied) and socioeconomic interactions (land use- water cycle) may help to improve the restoration strategy towards upscaling of the restoration effort. Another important aspect is the incorporation of a systematic assessment and monitoring in the regular management of target ecosystems, to allow an evidence-based adaptive decision-making.

2. Societal optimisation

A major **strength** in terms of societal optimisation includes the good basis that has been created during the demonstration project though a regular dialogue with the principal stakeholder (CMPL). This dialogue that was established during the implementation of LIFE FLUVIAL will serve to enlarge and reinforce societal involvement during the development of the MERLIN project activities. The CMPL, in its quality of a local authority, is a privileged interlocutor with different societal entities in the territory. Thus, there are already highly interested stakeholders such as the cattle breed producers, that have already showed support to the conciliation of ecosystem and productive goals. These may serve as an example for other stakeholders. Considering a longer timescale, there is a good establishment of environmental issues awareness by CMPL within local society through long term experience in developing environmental education programmes, especially with children (schools of the region).

Weaknesses: not all stakeholders (e.g. private companies were generally missing) were involved in the previous demonstration project LIFE FLUVIAL. With the typical small landholdings in the area, some conflicts may arise between private owners and project interests. For example, related with cutting or controlling of exotic species in lands neighbouring the target restoration areas of the MERLIN implementation activities, where private owners may decide to keep exotic plantations for economic purposes. In Portugal species legally classified as invasive are prohibited (e.g. all Acacia species). However, the landowners, many of them old, do not know/may misunderstand this legislation and such interventions, given the type of ownership of private property that is traditionally accepted in Portugal. In the past this has always generated many conflicts. Currently with agricultural abandonment and the aging of the population and detachment of the youngest from the land this scenario has changed, but other conflicts may arise, mainly due to lack of knowledge. Even so, the implementation partner, which is a local administration and so close to the territory, has already developed this type of interventions in a pilot mode and collaborated with some landowners, so any problem can potentially be solved with continuing dialogue and communication of project actions.

Threats: The small private property size, and not completely identified landownership (which is a problem of the region, in North Portugal) is a threat to the project. The identification of private owners of rural areas in Portugal is a deep structural problem. Although there is an accurate mapping of the land parcels (sometimes very small, less than a hundred square meters, with a good part less than 1 hectare) not even the local administration can identify all the owners, as often these have emigrated in the past to other countries looking for jobs. Even so, specific programmes are being developed in this sense at the national level and being applied locally (E.g. BUPI programme, largely resulting from the problems related to forest fires in Portugal and their prevention). Even so, there may be some conflicts, but they can be resolved, given the role of the local administration (implementation partner) in this project.

Opportunities: Under the frame of MERLIN there is the possibility to increase the connection between the Regional Protected Landscape (CMPL, the implementation partner, is responsible for the management of this protected area) and the owners of surrounding private lands in the basin and enhance this relationship. The Regional Protected Landscape is recognized nationally, and the other classifications of the area (RAMSAR site 1613, and Natura2000 PTCON0020) are recognized internationally. This implies that the site attracts visitors and tourists, who will be able to enjoy new areas with recovered natural habitats and may advertise the project/area so that more society groups can enjoy it. In order to increase public awareness, the project plans to promote volunteer actions to engage people in the restoration activities such as the control of invasions.

Based on these SWOT characteristics the way forward for societal optimisation involves as a first step in the optimisation to identify the landowners who are responsible for the management of the land. This will enable to involve all the stakeholders interested or affected by the restoration actions, integrate them and co-working in a concerted way to achieve effective restoration. One **opportunity** that may pave **the way forward** to optimisation is the fact that the dialogue with stakeholders has been already started and builds on long term relationships and close knowledge of the territory. Among previous activities, the demonstration project, LIFE FLUVIAL included the development of a robust Dissemination plan, on which MERLIN can build. A stronger involvement of stakeholders, by building an extended Case Study board, will set the first steps for the upscaling and transformative change that underlies MERLIN. By attracting their interest in the MERLIN project, the CMPL will try to align them with the restoration goals and alert them to the urgency of maintaining and improving ecosystems like the one we target, to the dangers associated for example with climate change, for which the implementation partner will seek their help in all aspects.

3. Technical optimisation

One **strength** regarding technical optimisation, relies on the lessons learned about the demonstration project LIFE FLUVIAL especially in what concerns environmental challenges (e.g. invasive species, natural habitats restoration, tree diseases, invasive plant species dispersion). Assessment of the target priority EU Habitats conservation status was performed in the context of LIFE FLUVIAL, including cartography, field sampling and consultation of stakeholders. The MERLIN project will provide for the continuation of this monitoring in the coming years. The existence of previous characterization, and studies developed in the context of the LIFE FLUVIAL project, plus the cartography and reports developed for the implementation of Habitat Directive and several reports are available from the local authority. Specifically, fine resolution UAV maps, and field data together before the MERLIN implementation will help for the understanding of the status and help decision making for the technical implementation. Also, the ongoing development of a 5 year After-Life programme (2023-2027) which is being prepared in coordination with LIFE FLUVIAL partners in the Ibero-Atlantic fluvial corridors (Galicia and Asturias regions in Spain) will be articulated with MERLIN and so contribute to the upscaling at the transnational level.

One major **weakness** regarding the technical optimisation includes the insufficient knowledge of the overall water balance at sub-catchment level which is required for a deep understanding of the functioning of the basin. One challenge is the long history of land use which includes long term alterations in the hydrographic network such as the drainage of lagoons and ponds and the deepening and straightening of the Estorãos river channel. One **weakness** relies on the fact that previous work in the demonstration phase has been focused on implementation of Habitat directive (LIFE FLUVIAL), so this was mostly focused in effects on biodiversity and specifically plant communities (species and habitats). As a result, other biodiversity groups are less addressed. There is a lack of experience/equipment for certain Green Deal indicators such as Greenhouse Gases measurement and assessment techniques. While monitoring and assessment of restoration measures have been developed during the LIFE FLUVIAL project (Figure 14), there is a lack of systematic monitoring in the regular activities of the implementation partner.

Threats: In terms of Environmental Challenges: while past drivers of some the exotic species presence are identified (e.g. Eucalyptus plantation was linked to paper production demand), others are not fully understood yet (e.g. emerging diseases such as *Phytophthora xalni* expansion probably linked to a mix of natural spread and human intervention, such as negligence in the use of nursery plants in bad sanitary status, Jung et al 2016). The use of fertilizers, herbicides is extensive among local communities, which may hamper achievement of certain Green Deal goals (Zero pollution). Climate change will lead to longer, more frequent and more intensive drought periods as well as flood events, potentially challenging the achievement of restoration goals. Disease of alder in the region may imply modifications in the canopy cover on the riparian zone, leading to a reduced capacity of climate regulation in the aquatic ecosystem (less shade).

Opportunities: The involvement of project scientific partners in parallel projects focused on investigating resistance and resilience of alder populations (dominating a rare and endangered type of forest in Portugal) which may help anticipating risks to mitigate the devastating effects of the disease in the larger scale. Links established during LIFE FLUVIAL with regional Higher Education institutions (e.g. Escola Superior Agrária de Ponte de Lima) may enhance possibilities to enlarge the strategy in the educational component. Some assessments of other indicators related with Green Deal goals (societal, contingency survey on ecosystem services) have been performed in coordination with LIFE FLUVIAL partners in the Ibero-Atlantic area through surveys to local communities but with relatively low participation in the Lima area, yet the methodologies are established and could be used in MERLIN.

Based on these SWOT characteristics **the way forward** for technical optimisation starts by building on the previous characterization and experiences gained during LIFE FLUVIAL. In our Measure “M4. Stakeholder agreements for rewetting and rewilding”, we will develop a pilot NbS approach for reconnection with the floodplain of river Estorãos, where formerly (in the 90´s), hard measurements were implemented to stabilize river margins under river incision and reduced connectivity of river channel and riparian zone. While relatively localized, this measure is intended to serve as a pioneer demonstration to be replicated in other parts of the basin. In this case study, relatively localized interventions will contribute to the control of non-native vegetation (measure “M1. Removal and control of invasive plants”) which had been planted in former times mostly to stimulate land drainage, such as Eucalyptus spp., and in the assisting of river meandering and lateral

connectivity between riverbed and floodplain (M4.). While these localized actions will not solve the structural problem, they can stimulate different actions in the future in broader areas of the ZEC Rio Lima, (Figure 15).

To overcome the lack of experience/equipment for certain Green Deal indicators such as Greenhouse Gases emissions b(both measurement and assessment techniques), we will seek exchange of knowledge and experiences with MERLIN partners to explore possibilities for their direct or indirect assessment.

One point to a way forward refers to the incorporation of systematic procedures of assessment and monitoring in the regular management measures that are conducted on site. While monitoring and assessment of restoration measures has been developed during the LIFE FLUVIAL project, there is a lack of systematic monitoring, namely for the whole set of Green Deal goals, so this requires to be established in the regular activities of the implementation partner. Therefore, MERLIN should serve the way to improve procedures and incorporate the need of them for the effectiveness of restoration.

Previous links established during LIFE FLUVIAL with regional Higher Education institutions (e.g. Escola Superior Agrária de Ponte de Lima will explore the educational dimension of MERLIN. This will be explored in the form of training activities linked to the restoration plan (e.g. a training course on best practices for bio-engineering linked with the implementation of nature-based solutions for rewetting/reconnecting with floodplain, planned to be done in the context of M1 and M4).

4. Economic optimisation

Among the **strengths** related to economic optimisation we could cite the potential conciliation of environmental goals and sustainable economic activities (production of honey, native cattle breeds production). Budget of MERLIN allows for continuity and reinforcement of measures established during the LIFE FLUVIAL project, allowing for some economical optimisation as capitalizing on previous effort, while creating some (even temporary) economic dynamics such as jobs created for the restoration actions implementation. The forest companies already involved during demonstration project become more familiar with best practices in restoration. Also, the effort in enlarging the target area of restoration actions to neighbouring properties is envisaged as it will allow a more consistent management of the different land uses, resulting in better land use effect.

Weaknesses: The available MERLIN implementation budget for this case study is relatively low and thus this implementation can only be carried out on a relatively reduced area. Private funding has not been common practice in the region to upscale implementation actions. The restoration has been funded by public funding and it may be difficult to opening up to other funding options.

Threats: More attractive and accessible wetland areas might result in pressure from recreation, so a way forward to improve optimisation is to discuss with local authorities and scientist how to establish a carrying capacity for the area.

Opportunities: Big private companies have not been traditionally involved in conservation of ecosystems in the area, yet it could be a possibility to be explored considering exploring carbon credits. By including these types of entities in the Case Study Board they might be engaged for future private funding. The target area to be restored is integrated in a Protected Area (Ramsar Site, Natura 2000) that already has visitors (increased potential for Nature tourism and Birdwatching). Exchange and help of MERLIN partners (e.g. WP3) may be of help in considering a larger range of resourcing options and might help upscaling.

Based on these SWOT characteristics **the way forward** for ‘economic optimisation” might include actions to analyse if carbon credits could be an option provided that the experience of MERLIN partners could help in gaining some expertise. To find potential funders, also the interaction with MERLIN partners would be required as for the way on exploring private funding **opportunities**. There is not a lot of tradition of private funding in this type of projects, but a few examples exist (e.g. projects leaded by WWF in South of Portugal are supported by private companies), to be learned from. We plan to involve a big wine company that is using irrigation and is located in the upstream area. There are **opportunities** of linking existing economic activities with environmental conservation as the cattle breed production, a link that can be reinforced in the implementation of our measure M2. Passive restoration through cattle exclusion. In this measure, target areas will be excluded, and others will be allowed for cattle grazing as to keep a diversity of habitats (also herbaceous). This measure is expected to contribute indirectly to other economic activities such as honey production (diversification of floral sources). There are some companies in the area working in organic production, that do integrated protection, using more sustainable and environmentally friendly solutions and they can be an example for other companies.

5. Policy/regulation optimisation

A **strength** regarding policies is that there is a good knowledge on the current instruments, after a thorough review of EU, national and local policies affecting the target area. This review was included in the LIFE FLUVIAL Restoration plan and in the reports produced as preparatory actions (A). A specific contribution to the improvement of Habitat Directive was conducted. This included a revision of 91E0* Habitat mapping at National level in Portugal, which was previously incomplete and gives a clearer scope of the importance of the floodplains of the Lima basin, for conservation at the national scale. Implementation of local policies is

facilitated by the in-depth knowledge of the territory that results from the fact that the implementation partner is also a local authority, which is responsible for the management of the protected area (Protected Landscape).

Weaknesses: Previous work during LIFE has identified landowners surrounding the intervention area (limiting parcels besides the intervention area). Even so, there may be some conflicts related to this e.g. heirs of older owners who die may have different "sensitivities" and it can easily be the case that there are several owners of a small plot of land. These conflicts may be resolved, given the role of the local administration in this project, which is responsible for the management of the protected area (Protected Landscape). the fact that the implementation partner is also a local authority, may however also be a weakness when political priorities might affect the environmental decisions

Threats: Traditional silos among different public administrations operating in wetland/riparian zones in Portugal may hamper proper coordination of different rules operating at the floodplain/riparian zone, which showed limited progress in the application to some key policies (e.g. WFD) to the floodplain/wetland ecosystems. This may also limit the effectiveness of new policies such as the Green Deal/Biodiversity Strategy or the future EU Restoration law.

Opportunities: The strong involvement of the scientific partner within the Portuguese Network of Ecological Restoration (and SERE) is expected to facilitate links to the process of implementation of the upcoming EU Restoration Law in Portugal and may help improving upscaling/implementation of measures in the context of the approval of this new regulation.

Based on these SWOT characteristics **the way forward** for 'policy/regulation implementation' may be to continue increasing awareness to policy makers on the importance of restoration and the implementation of new policies that align with the sustainability of these efforts. In particular, an **opportunity** at the EU level could come from the upcoming implementation of the EU Restoration Law, mandatory for all Member States. At the national scale, another strategy focused on rivers is under development by the Portuguese Environmental Agency: the National Strategy for the Rehabilitation of Rivers and Streams (EN3R), is intended to create a new figure of protection specifically for rivers, "Fluvial reserves", which are intended to be implemented at the local level (municipalities), and that include as a new feature the need to develop specific conservation plans including mandatory monitoring plans.

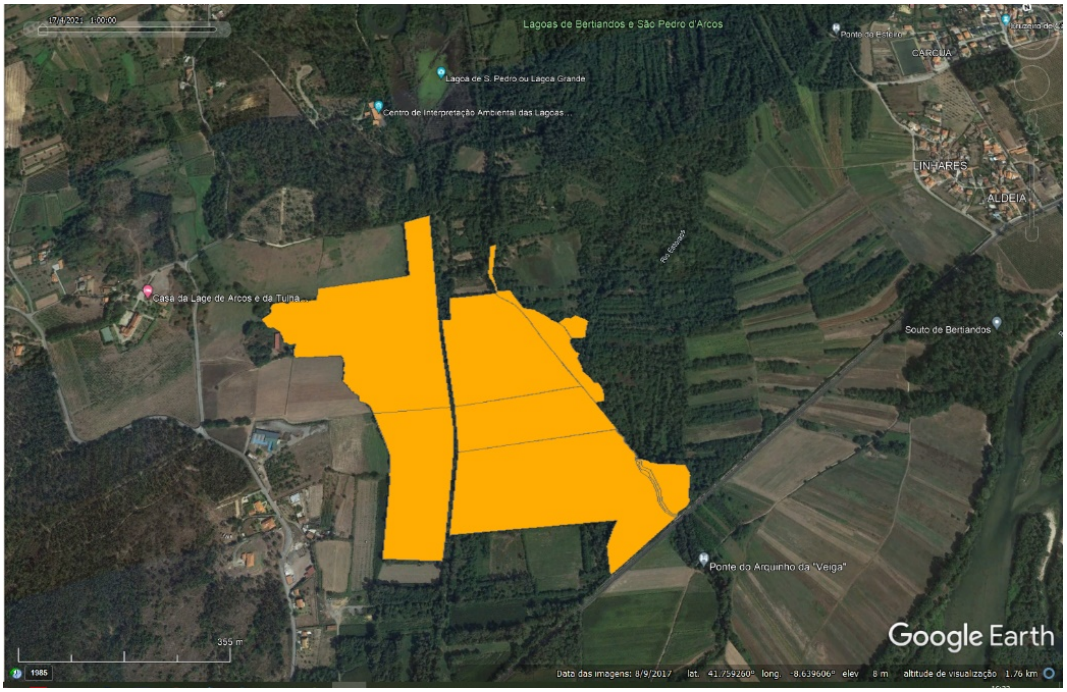

Figure 14 Implementation plots where specific restoration measures are planned (orange polygons).

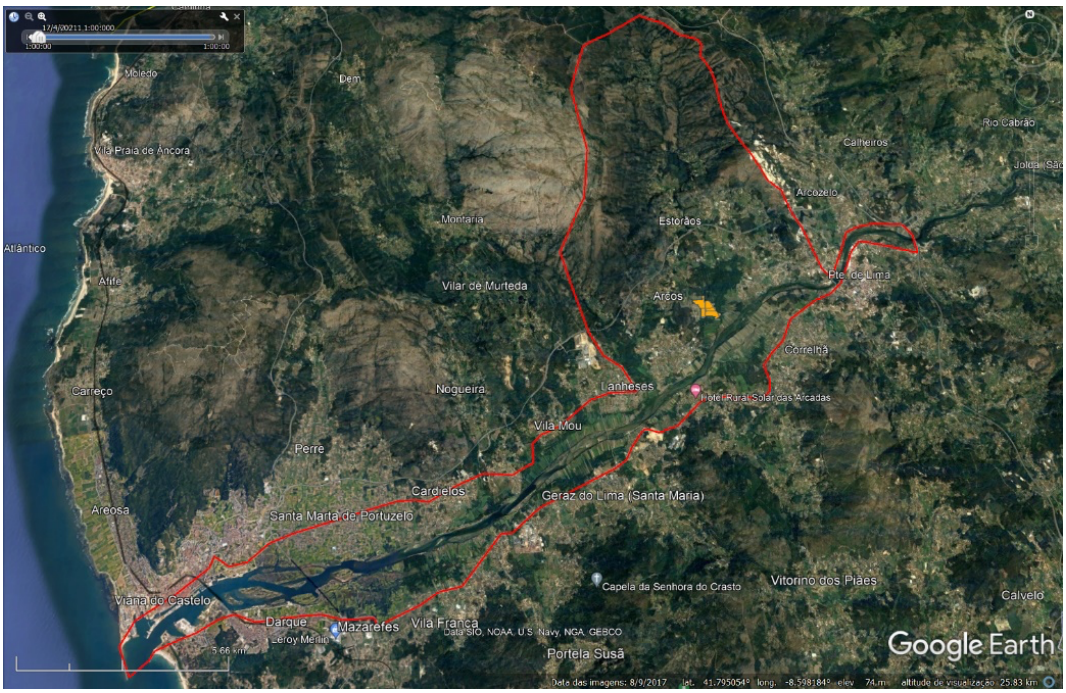

Figure 15 Portion of Lima basin and Estorãos River basin that could potentially affect or involve effects of MERLIN restoration plan (red line)

3.1.6 Case study 14 Oulujoki (Finland)

Authors: Katri Rankinen (SYKE), Kristian Meissner (SYKE), Anna-Kaisa Ronkanen (SYKE) Kaisa Pietilä (SYKE), Tiina Ronkainen (Tapio) and Isra Alatalo (Tapio)
SYKE: Suomen Ymparistokeskus (Finnish Environment Institute)
Tapio: Forestry consultant

1. Multiple goals optimisation

The main **strengths** of restoring peatlands are:

- Restoration of a balanced river discharge by decreasing floods and low (or no) flow periods
- Restoration is likely to have positive climate regulation impacts by decreasing GHG emissions

The main **opportunities** are

- Restoration creates **opportunities** for eco-tourisms and paludiculture
- Restoration influences biodiversity by providing habitats to peatland species and migratory birds

Perceived **weaknesses** are that

- Case specific climate regulation and emissions are depending on water table variation
- It is unknown how large the nutrient, suspended solids and carbon loads are and will be to water bodies

Perceived **threat** is that

- The water treatment will be stopped after peat extraction has ended

NARRATIVE: The Komppasuo peat extraction site is located in the Kivijoki sub basin (1136 km^2) of the Kuivajoki river which flows directly into the Baltic Sea. The catchment is characterized by organic soils. The main land cover types are peatland forests (36% of the basin area) and forests on mineral soils (34%). Peatbogs cover 25% of the area. Forest ditches are common in the area, and 39% of the peatland forests are drained by ditches for forestry. Forests are mainly coniferous; the area of mixed forests is around 5% of the forest area. There are in total 7 peat extraction sites containing 3224 ha in the basin area. Common water protection measures like treatment wetlands, sedimentation basins and buffer zones are already included into current forestry and peat extraction practices. However, their implementation can still be improved.

The main **strengths** are that restoration of peatland balances river discharge by decreasing the intensity of floods and low (or no) flow periods. Kuivajoki river is not recognized to be a specific flood-risk prone area. Spring floods due to snow melt and low-flow periods in mid-summer and mid-winter are characteristic for this area.

Restoration also increases local biodiversity by providing habitats to species primarily associated with peatland and meadows. The NATURA2000 peatbog area Litokaira (30384 ha) is partly located within the Kuivajoki river basin. Another protected area is the southern part of the Lake Oijärvi located nearby. Restoration may benefit the water birds there. There are no other recognized biodiversity hot-spot areas. Further, restoration is likely to have a decreasing long-term effect on climate emissions (Figure 16 and Figure 17).

The old forests are well known to have comparatively larger biodiversity, C-sequestration, and water quality. Only 2% of the forest area in the Kivijoki basin is covered by old forests (>120 years), but the area of 'over-aged' economical forests (80-120 years) is about 18% of the forest area, which potentially provides **opportunities** to restoration of peatland forests. Restoration can include filling the forest ditches and rewetting peatland forests, in addition to restoring the peat extraction sites.

Perceived **weaknesses** of restoration result from the fact that the positive effect on climate regulation may depend on the depth of the water table and therefore be case-specific and hard to manage. Moreover, impacts on water bodies after restoration of peat extraction sites are unknown and highly depending on specific land use in future (e.g. forestry, wetland, restored peatland). Even rewetting may increase carbon and nutrient losses especially in the beginning of restoration. The most common after-use options include rewetting of the area, but also afforestation of agricultural fields and paludiculture. Windmill or solar panel parks can provide **opportunities** to produce sustainable energy and may gain in popularity due to the current political climate.

Based on these SWOT characteristics **the way forward** for multiple goal optimisation is to devise clear decision guidelines and other advice for peatland owners that include the case specific multiple aspects (biodiversity, hydrology, and impacts on carbon balance) of their specific peatlands and provide clear impact scenarios of the different after-use options in relation to these aspects.

We recognize a potential trade-off situation with regards to the regulation of the water table. The best water depth for water quality is not necessarily the best for carbon sequestration.

2. Societal optimisation

NARRATIVE

The main **strengths** are that local stakeholders are often interested in developments taking place in their region. The number of stakeholders is also relatively small because the site is remote. Another **strength** improving optimisation is that the effects of more natural habitats have been shown to have clear health benefits for people, making the project justifiable also from a human health and wellbeing point of view.

Opportunities arise from the health benefits being related to improved ecosystem services of restored areas, which in turn are related to increase in recreational value, which manifests in increased potential for berry picking, hunting, bird watching or hiking. Litokaira NATURA area located nearby may attract tourists interested in nature. There are also several natural fish species (pike, perch, roach, bream, burbot) and an introduced trout stock.

The main **weaknesses** are related to production and income losses for local landowners from phasing out peat production. Peat extraction can locally be an important source of income and can be difficult to substitute by alternative sources of income. Further differences in opinions on which after-use strategies to pursue may create tensions between local stakeholders. There is trade-off as different stakeholder and user groups may have different ideas what they want out of the areas.

Perceived **threats** result from the increasing energy price, as it makes it less attractive to give up peat extraction. In general, Komppasuo is not a very accessible area for nature tourism and considering that there are multiple nature attractions that are more accessible and in better condition, **opportunities** for nature tourism may take a long time to materialize. It would require careful thinking and marketing to turn the site into a successful/economically sustainable nature tourism attraction.

Based on these SWOT characteristics, **the way forward** for societal optimisation is to

1) encourage the foundation of regional interest groups comprised of related stakeholders to reduce adverse societal effects of different after-use practices

2) to mediate potential tensions between different stakeholder interest groups. To be more attractive and encourage overall participation, such regional interest groups should be subsidized by regional authorities and could include outreach activities, joint voluntary action etc.

3. Technical optimisation

Main **strengths** are that

- restoration has in general several positive effects on water and climate regulation and biodiversity

Main **weakness** is that

- there is a trade-off between water and climate regulation, a high groundwater table is good for water regulation but may increase carbon emissions

Perceived **threats** result from

- how well the regulation of water table will succeed

NARRATIVE : the main **strengths** of case specific tailored technical optimisation is in the improved positive effects on water and climate regulation and biodiversity over a one-size-fits-all technical solution. Effects are monitored before and after measures on different land use sites at Komppasuo (wetland, restored peatland, afforested area, control area).

However, the main **weakness** is related to the inherent trade-off between optimisation for either water or climate regulation, since optimisation of high (ground)water tables is good for water regulation but can have adverse effects and result in increased carbon emissions.

A perceived **threat** is related to the water table level. It affects all the measures at Komppasuo: how well wetland will be formed, how well peatland vegetation survives, how well trees will grow. Also, water table level at all different land use options affects the greenhouse gas fluxes and carbon sequestration. Therefore, there is a need to find a pareto optimal technical solution. Other **threats**, while largely speculatory for Finland, could be national or regulatory practices that limit the application of truly effective solutions.

Consequently, the **opportunities** lie in the possibility of identifying the most cost-effective combinations of technical optimisations that result in pareto optimal effects. This will require government funds and national initiatives from both the Ministry of Agriculture and forestry as well as the Ministry of the Environment.

Based on these SWOT characteristics **the way forward** for technical optimisation is to build small dams to block drainage ditches inside the peat extraction area. The dams will be built in a way that they don't need any

maintenance in future. The number and location of dams is optimised by recognizing and utilizing the topography and hydrology of the extraction area and areas in close vicinity of the area, in a way that the natural flow of water is mimicked within the area. This allows restored land use forms to thrive: wetlands on the areas where water level will be higher, forests on areas which will stay dry, re-growing and spreading of peatland vegetation on areas where moisture conditions are optimal. While planning and conducting measures the surrounding areas, mainly commercial forests and peatlands, has to be considered so that measures at the restored area won't have an unwanted effect on them (wetting of forests or drying of the peatlands).

The thickness of the remaining peat layer varies within the peat extraction area, which also has to be considered while optimising the after-use. For example, optimal peat thickness for afforestation as well as wetlands is approx. 30 cm. Peat extraction is declining fast in Finland and many sites are closing earlier than originally anticipated, and thicker peat layers are left on site (over 1 m). Currently it is unknown what is the best after-use for such areas. Rewetting is a good option as the carbon will not degrade anymore with rising water level. At Komppasuo site peat thickness varies between 0.3 – 2 m. Parts where the peat layer is thin and topography and hydrology is optimal, areas are afforested. Parts where peat layer is thicker and topography and hydrology is optimal, areas are restored as wetlands or peatland. Zones in between will be vegetated naturally.

Ash fertilization will be used on the area to facilitate forest and vegetation growth, which results as increase of biodiversity on the area. Afforestation will be done by seeding and by natural seeds from surrounding forests. Wetland formation will be facilitated with seeding the wetland areas. For optimising forest growth other forest management measures are needed in the future.

By the measures conducted in the Komppasuo area we optimise the improvement of the water quality in the catchment, carbon sequestration and biodiversity. To optimise water quality the construction works (building dams, modifications of the soil) will be planned and conducted in a way that effects are minimized. This includes precise planning of the timing and spatial arrangement of the works at the Komppasuo site.

The restoration methods and peat extraction areas are versatile so that a copy paste approach is not possible for restoring different sites. However, the main concepts and actions to be taken are similar in different sites. A **strength** is that there are good examples of different after use options already available from peat extraction sites that have been restored or taken into another use.

4. Economic optimisation

Main **strengths** include:

- **opportunities** for nature tourism – bird watching
- wild berry and mushroom picking/hunting for bird and moose may be locally important source of income
- possible carbon credits or nature compensation? For this the case study may benefit from the knowledge develop within MERLIN's WP3
- The MERLIN project has a good connection with the environmental authorities to further discuss the guidance for after-use options

The main **weakness** is that

- We are lacking on the economic knowledge, which we need to strengthen during MERLIN.

The main **threats** are that

- The future land use may have harmful effects on biodiversity, climate or water quality

The main **opportunities** are that

- During MERLIN we will gain knowledge about costs of different after-use and restoration options, which will in future help landowners to evaluate different options more accurately.
- Can we state the value of the berries and mushrooms picking and hunting? How to scale national level values to the local situations?

NARRATIVE:

Peat extraction areas are mainly privately owned by the extraction company or private landowners. The owner needs to change peat fields to another land-use after the extraction. There is quite a good set of rules of what they must do after peat extraction in terms of not leaving in bare.

The main aim usually is to gain income. This may result mainly in afforestation of the areas or solar/wind power fields. Other after-use options should be made more appealing income-wise for landowners, e.g. wetlands as bird hunting areas. Sometimes hunters buy the area together as a group. In worst case it is bought by agricultural companies. Farming on peatlands is very harmful (30% of the greenhouse emissions is from farming on peatlands, due to the draining of peat and the resulting oxidations).

For compensation C-sequestration may not be the best idea, but biodiversity and nature compensation could be more suitable options at peat extraction areas. During MERLIN we will gain information on the effects. The main issue is how to start up a money flow for compensations. Within Finland there is probably not enough demand for such compensation and cooperation should be sought from the EU level for sources of investing/funding.

5. Policy/regulation optimisation:

Main **strengths** are that

- there is strong political interest in national policy in stopping peat extraction
- this change is currently happening faster than planned and expected
- Several EU policies are directly or indirectly connected to the impacts of peatland restoration (e.g., biodiversity)

Perceived **threats** result from

- change in Europe's political situation, which has increased the need for self-sufficiency in energy

NARRATIVE: The main **strengths** of policy regulation and optimisation lie in the strong current European political will expressed in the European Green Deal objectives and supporting EU policy that are directly or indirectly connected to peatland restoration. The aim to stop the use of peat for energy production is further accelerated by current global (enviro)political events and proceeds faster than was planned or expected.

However, the same political events also create the **threat** of a transitory winding back of previously decided upon decisions to restrict peatland use. This could be an outcome of future increased political pressure from possible future energy shortages and the aim to achieve national and European independency from Russian fossil energy. On the other hand, there are ongoing public discussion on use of agricultural peat fields, peat extraction sites and restoration of peatland forests.

Opportunities lie in the identification of combinatory peatland after-use management options that increase both national energy self-sufficiency (e.g. wind power) without compromising the aim of national carbon neutrality or set biodiversity goals.

Based on these SWOT characteristics **the way forward** for political optimisation lies in creating flexible regulatory systems at administrative level that are agile enough to permit for shifts in priorities without compromising the timetable and goals of the European Green Deal.

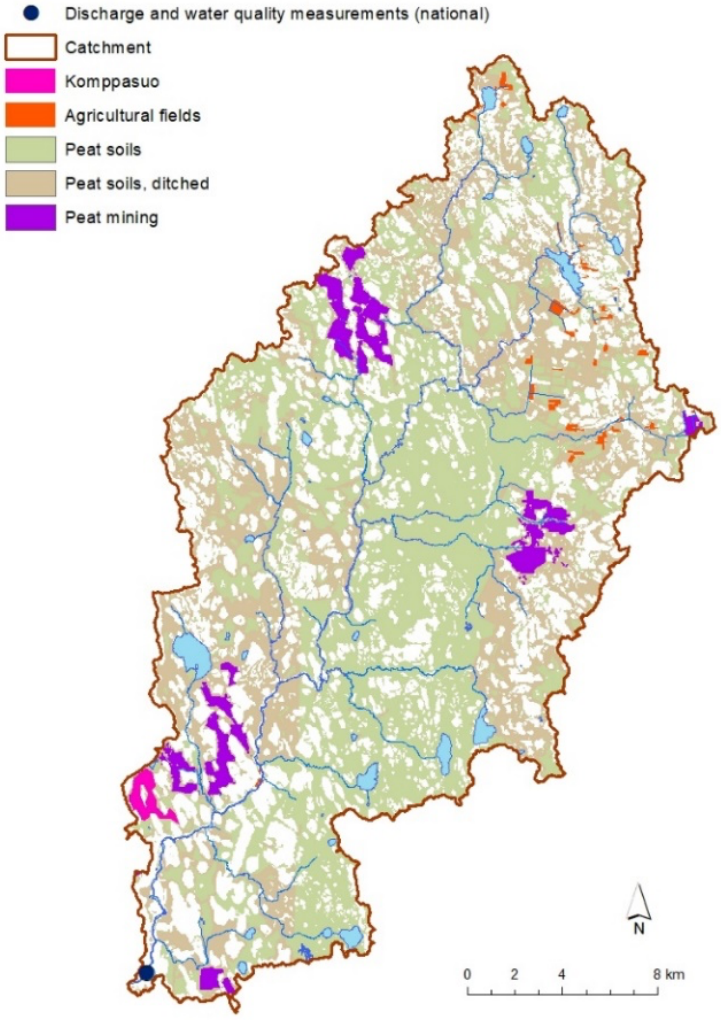

Figure 16 Study site Komppasuo and its location in sub catchment above the national water quality observation gauges (black dot). White areas are coniferous soils on mineral soil. Green is peatland without ditches and peatland forest.

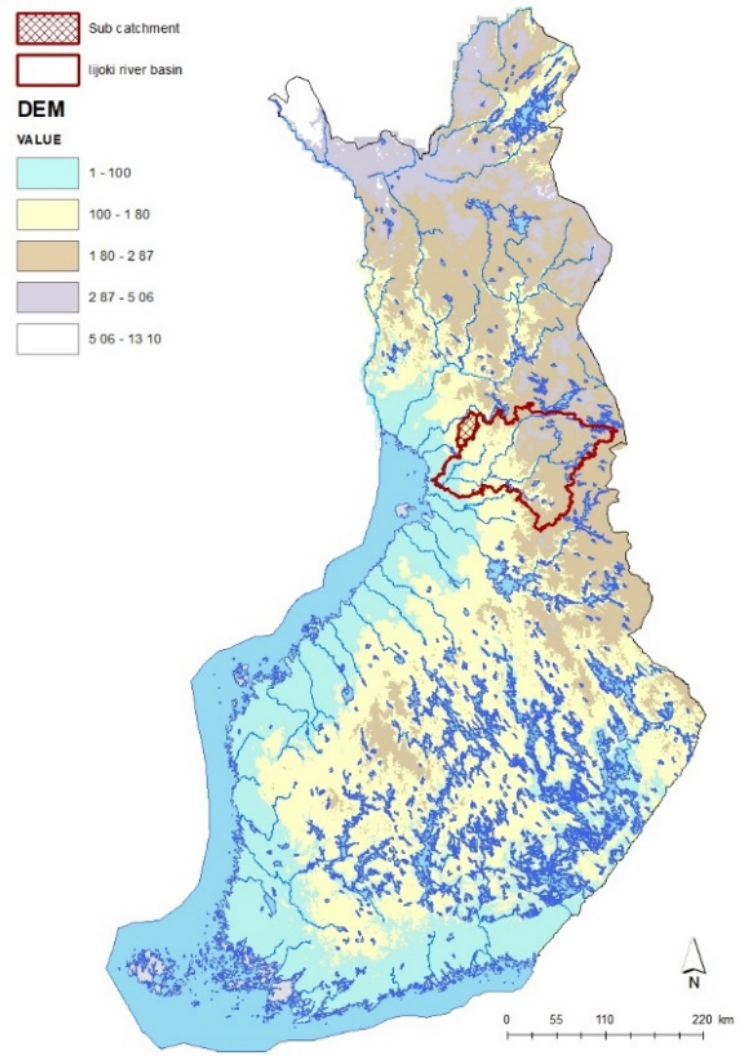

Figure 17 Location of the Iijoki river basin and Komppasuo subcatchment in Finland

3.2 Cases per cluster small streams and basins

3.2.1 Case study 2 Deba River – Basque country (Spain)

Authors: Miriam Colls (UPVEHU), Arturo Elosegi (UPVEHU), Iñaki Bañanres (UPVEHU) and Arantxa Unzurrunzaga (DFG)
UPVEHU: Universidad Del Pais Vasco/Euskal Herriko Unibertsitatea (University of the Basque Country)
DFG: Gipuzkoako Foru Aldundia (Gipuzkoa Provincial Council)

1. Multiple goals optimisation

The main **strengths** of Deba River restoration actions (Figure 18)referring to the GD indicators are:

i) the potential contribution on climate regulation and green growth by means of the reduction of CO2 and CH4 emissions from the impounded areas (replaced by lotic ecosystems). This expectation is based on the increasing number of studies documenting the role of reservoirs as greenhouse gas (GHG) sources (Deemer et al., 2016). Despite size and, consequently, retention time differences between large dams and small weirs organic matter stored on the latter, together with nutrients derived from human activities, fuel microbial decomposition, which in the often-anoxic conditions found in depositional areas, result in GHG emissions. Although these impounded areas are small, their number at the basin level makes changes in GHG emission significant.
ii) The improvement of flood resilience through the removal of obstacles (dams) that now increase the water level and thus flooding risk.
iii) The contribution to the zero-pollution goal, sustainable energy, and green growth by the improvement of the river's self-purification capacity, because of increasing hydro-morphologic heterogeneity, which contributes to reduce the pollution.
iv) The contribution to the biodiversity caused by improved ecological quality of the river ecosystem and by increased habitat heterogeneity.
v) The improvement of health and well-being by reducing the presence of stagnant ecosystems and, consequently, unpleasant smell and mosquitoes.
vi) Improved inclusivity through workshops organization and participation, which will favour different stakeholders' involvement in the restoration process (municipalities, local authorities, citizens, scientists, etc.).

The main **weaknesses** of the restoration are related to the presence of other anthropogenic impacts in the area, which may limit the expected improvements. The multiple stressors in the area include a diverse array of pollutants derived from WWTP effluents, point-source pollution coming from leaking or un-connected sewers, illegal, but still occurring releases of industrial pollutants, high loads of suspended solids derived from erosion in intensive tree plantations, and morphological alterations beyond small dams, mainly bank reinforcements and canalization through most reaches of the Deba River. Flood risk mitigation may also be compromised or less evident because of the presence of bridge piers in the stream. To achieve flood risk reduction, the Basque Water Agency foresees the replacement of the bridge piers once the dams have been removed. However, such replacement is not included in the restoration budget and, therefore, depends on other public funding. In terms of inclusivity, there is a bias in relation to the people attending the workshops, which mostly consists of retired men, whereas a group such as migrant women rarely attend.

Derived from the workshops and social inclusion, there is the **opportunity** to develop greater social awareness and ecological knowledge among the local population. This can help to demand and promote improvements in all other aspects of the green deal. In addition, improving the biodiversity and ecological status of the Deba River can increase its conservation status / degree of protection. Finally, the implementing partner Gipuzkoa Provincial Council has a long experience in dam removal in the catchments of the region (>100 dams, also close to the monitoring sites) and is working on the removal of many others where the knowledge and experiences derived from MERLIN may be applied.

Dam removal is just a part of the restoration since Deba River is a multi-stressed system. Erosion from forestry, exotic species, lack of lateral connectivity, or high pollution levels from the current and historical industrial activities in the area are other important stressors. These stressors suppose a **threat** to achieve the restoration objectives. However, dam removal may put the spotlight on the other stressors and the involvement of local and strategic stakeholders may contribute to address these as well. For the long term and the regional scalability plan, Deba River restoration experience is valuable to show how to approach restoration in such complicated situation, being a **threat** and **opportunity** at the same time.

2. Societal optimisation

The main **strengths** of the Deba River restoration actions to society are related to increasing inclusivity and improving health and well-being. In terms of inclusivity, local and strategic stakeholders have been contacted and the reasons for dam removal have been presented and discussed with them during workshops and talks. Citizens appreciated this approach and contributes to their willingness to change. It must be taken in account that for some people, especially in the town of Soraluze, the stagnant waters created by three dams downtown

are a very special feature that shapes the image they have on their town and on themselves. In addition, we (scientists and implementers) are constantly in contact with local and strategic stakeholders, who can communicate to us complaints or doubts that may arise throughout the project. In relation to the health and well-being of citizens, Deba restoration actions focus on i) flood risk reduction, ii) reduce the exposure of people to vector-borne diseases (mosquitos), and iii) improve urban ecosystems (green spaces) and so human health.

The main **weaknesses** of the restoration are related to the short timeframe of the MERLIN project and the balance between being inclusive and executing the restoration action. Explaining what the restoration action consists of and the motivation of the project is very time consuming, and limits the time that can be spent on other tasks. This fact forces decisions to be made with less discussion and probably less consensus than ideal. Within the framework of the oncoming municipal elections in 2023, the reluctance of some citizens, especially older people who are particularly reticent to change, puts the implementation of the project at risk. Moreover, it is not always easy to discern between claims that are feasible and important and those that are not, especially since there are other factors that also affect the social challenges addressed and their improvement (i.e., multiple stressors). Overall, the improvement of societal challenges may be less than expected because of multiple stressors on the ecosystem or may be felt outside the municipalities where the demolitions are carried out due to river continuous flow. Mobilising citizens is another **weakness** since only about 20 out of the 4000 inhabitants attend the meetings.

Opportunities arise from the modernisation of the Deba River, a largely suburban catchment area. Thus, digital literacy (achieved through workshops and organised activities) even among older people can increase awareness of the importance of a healthy environment for a sustainable way of life. This translates, for example, into greater acceptance of restoration actions due to their better conceptualisation. Moreover, being part of a large European project makes people think that it may be a good idea after all, which can build trust between local communities and administrations. On a local scale, the Deba is one of the rivers with the worst ecological status in Gipuzkoa. The demolition of the dam can draw attention to other problems that will force public-private entities to invest in its improvement, improving the health and well-being of the population. In addition, our implementing partner Provincial Council of Gipuzkoa is the public body responsible for the management of river ecosystems. This fact favours the extension of the restoration actions applied in the Deba to other river basins in Gipuzkoa. Outside the provincial boundaries, our sister project is the Catalan Water Agency (ACA), and they and other water managers have contacted us to explain the problems they have with the demolition of dams (due to public opposition). They all came to visit our case study and exchange views and experiences, which could help to develop effective strategies. Contacts between the institutions are constant. Finally, some partnerships with larger industry companies within the basin may help restoration.

Perceived **threats** result from digitalisation and global change. Digital social networks can spread disinformation against the project, creating controversies. Politicians, thinking on the next election, can prefer to postpone potentially conflicting issues, such as dam removal. Additionally, the Basque society has known deep trenches dividing the society in the past (from political violence to management of solid waste), and there is always the possibility of a new trench-forming debate. In relation to global change, dam removal decreases floods for the 50-year return period, but climate change is increasing the frequency of extreme events and may therefore mask improvements from dam removal. Finally, dam removal is being hijacked by political parties, generating supporters and detractors depending on which political party you vote for. This does not seem to be a problem at present, but it could happen as has happened on other issues such as municipal solid waste management.

3. Technical optimisation

The main **strengths** of the Deba River restoration lie in the current and historical information on the state of the river ecosystem. There is information about their ecological status from more than 20 years ago. Nowadays, the gauging stations located along the basin provide real-time information on water quantity and quality, five times per year water quality and abiotic variables (e.g., heavy metals, nutrients, and chlorophyll) are monitored, twice per year macroinvertebrate community, and fish once a year. The maintenance of the gauging stations, periodic monitoring of the ecological status, and generally the management and conservation is the responsibility of the Gipuzkoa Provincial Council, the implementation partner of Deba River restoration.

The main **weaknesses** of the restoration are the multiple stressors present in Deba basin, and the fact that dam removal does not put an end to them. For instance, despite most WWTPs are done, there are still some leaking sewers. The flood plain is occupied by cities or industry, resulting in the river canalization. The physical habitat is very poor due to canalization and the physical improvement is limited due to the lack of space and within the main channel there are three dams still operating. The MERLIN implementation measures may help to identify or highlight this and other aspects that also need to be tackled.

Opportunities arise from local managers (including Province Council, WWTP managers, Basque Water Agency, and others) willing to collaborate for any additional aspect that might be considered interesting. Additionally, new regulations (Basque law of Climate Change, Basque law of Soil Conservation) tend to value nature more than previous legislation. This undoubtedly represents a great **opportunity** to carry out further improvement actions on the river.

Perceived **threats** result from many potentially confounding factors as multiple human activities occur in the basin, some of them (e.g., building the bullet trainway) with a strong temporal signal. Also, multiple-stressors

and their potential legacy effects, e.g., sediment pollution or invasive species, may have unknown effects on restored river ecosystems, thus limiting the prospects for improvement. Finally, nature conservation usually loses priority under "emergency" situations (COVID, financial crises or Ukraine war). Although MERLIN restoration actions are not compromised, “emergency” situations may prolong the time to solve Deba pressures.

4. Economic optimisation

The main **strengths** of the restoration of the Deba River in terms of (in-)direct costs and benefits lie in the benefits derived from the potential improvement of self-purification performance, the reduction of GHG emissions and the control of the mosquito population. In terms of effectiveness, the Obstacle Demolition Plan of the Provincial Council of Gipuzkoa highlights dam removal as the most effective alternative to restore fish movement and habitat quality in the province rivers. As far as the trade-offs are concerned, it should be borne in mind that the dams are currently not used, abandoned and clogged. For this reason, there is no benefit from their maintenance.

The main **weaknesses** of restoration in terms of (in-)direct costs and benefits are because, despite the key value of cultural ecosystem services, it is yet not known how the provision of ecosystem services from dam removal can be quantified nor is it known when these benefits will be significant. This fact derives from the scarce number of studies assessing dam removal and associated ecosystem services. Collaboration with institutions within MERLIN gives us the possibility to address this issue and attempt to quantify these ecosystem services. In terms of effectiveness, it is not only dams that affect flooding, but bridge piers also increase flood risk. Therefore, the effectiveness of restoration action may be less evident due to the presence of bridges. In addition, political fragmentation and focus on local issues make it difficult to apply a theoretically ideal prioritisation between large areas. Actions are mainly based on timing.

Opportunities arise from the indirect benefits derived from the restoration action. Potentially, self-purification reduces economic water purification costs. Additionally, some ES such as GHG emission reduction can have a higher value in the future. The same with self-purification if water downstream is used (urban cleaning, industrial uses, etc.). In terms of effectiveness and in the face of the global change scenarios, successful management of MERLIN's restoration actions may lead other nearby municipalities to also opt for these NbS to reduce, for example, the flooding risk and consequent economic impacts. Additionally, UPV/EHU (scientific partner) works closely with public administration agents, who have accurate information on the managerial costs currently incurred. The details of these costs can be the primary source of information to estimate potential savings from the dam removal.

The main **weaknesses** of (in)direct costs and benefits are related to the fact that the way nature is perceived is strongly linked to cultural ecosystem services. People's perceptions are changing, but it may be at a very slow pace. Earlier this year, a published law decreed natural heritage to lay above cultural heritage. A few weeks ago, a judge decreed that cultural heritage should be above natural heritage. Some of our dams have a certain cultural value (in the Basque Country there are 3 categories of cultural protection); which value (cultural or natural) prevails can affect the type of demolition (total or partial) and, consequently, the benefits of such demolition. In terms of effectiveness, the non-success of MERLIN project restoration actions due to external factors such as bridges or pollution may lead other nearby municipalities to discard NbS actions. Instead, non-NbS solutions could be chosen, which are often used by regional managers as there is little room for nature.

5. Policy/regulation optimisation:

The main **strengths** of the Deba River restoration in terms of NbS design and learnt lessons and related to enhance policy and regulation frameworks lie in the fact that the public administration is the executing partner and is responsible for the management and conservation of the river ecosystems. In addition, all agents involved in the project are responsible for disseminating the progress achieved so that all interested parties can learn about it. As the public administration is one of those involved, this dissemination can have a wider scope. Finally, according to their contribution to national and global targets for human well-being, dam removal is mainly focused on improving four major societal challenges: a) disaster risk reduction, b) environmental degradation and biodiversity loss, c) human health, d) climate change mitigation and adaptation.

Opportunities arise from our twin project. Catalan Water Agency (ACA) is our twin project and they and other water managers have contacted us explaining the problems they have with the dam demolition (due to citizen opposition). All of them attended the field visit to see our case study and exchange point of views as well as experiences. They are currently in permanent contact with scientific and implementing partner to keep up to date with the progress of the project and our experiences. This will help to implement restoration strategies more effectively.

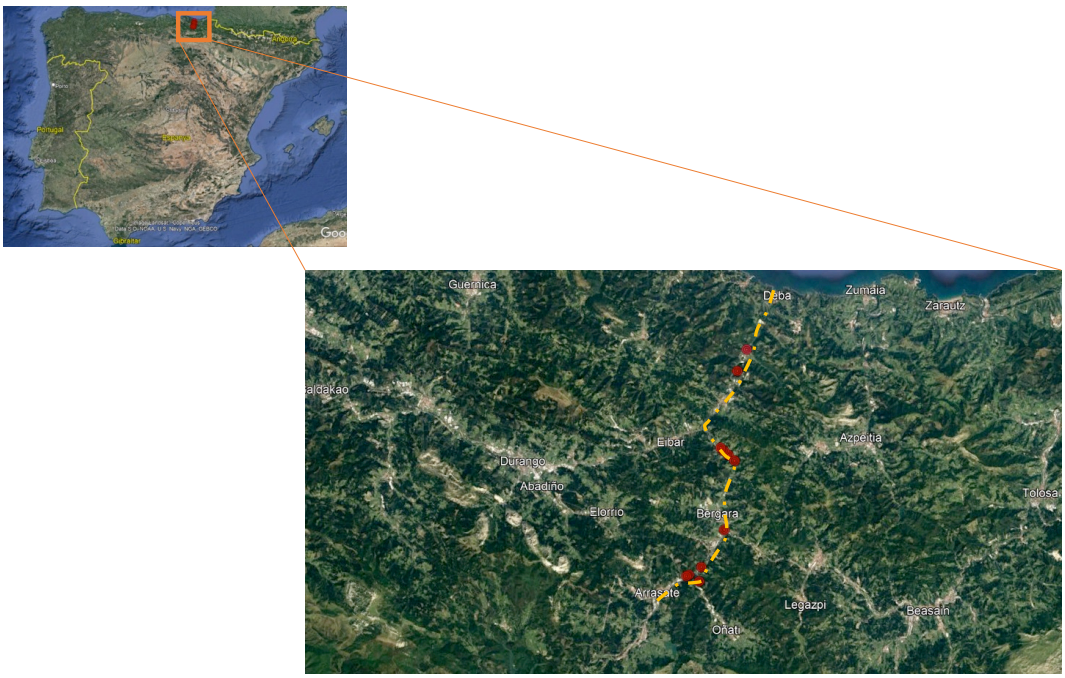

Figure 18 The restoration project consists of the demolition of 10 dams (red dots) located along the Deba River (yellow dashed line). We treat the removal of these 10 dams as a single restoration project and are working with the effects at the basin scale (main channel).

3.2.2 Case study 11 Emscher (Germany)

Authors: Nadine Gerner (EGLV), Svenja Karnatz (EGLV), Mario Sommerhäuser (EGLV), Daniel Hering (UDE), Sebastian Birk (UDE), Andrea Schneider (UDE)
EGLV: Emschergenossenschaft Lippeverband
UDE: Universitaet Duisburg-Essen (University of Duisburg-Essen)

In the IUCN SAT and the SWOT, the Emscher case study focuses on the demo case “Emscher restoration”, while in in the Optimisation strategy, also implementation aspects were included. The majority of the text refers to the **demo case** and its temporal and spatial scale. When indicated with (I) the text is indented and refers to the **implementation measures** and their temporal and spatial scale.

1. Multiple goals optimisation

The main **strength** is that Emschergenossenschaft (EG) has gained many years of experience with this large-scale project since the restoration of the river Emscher started 30 years ago and is continued ever since. The project is multidisciplinary by its nature and embedded into urban development programmes.

The river basin restoration is not only a part of the structural change in the Ruhr Metropolitan Area (Figure 19, but also played a major role in triggering and shaping urban development. Societal needs addressed include shaping water infrastructure, sanitation and flood protection and were included into a long-term strategic programme (Gerner et al. 2018). From the very beginning, synergies with regional planning and the development plans of the individual municipalities were sought. The planning by the EG is conducted at the basin level and is therefore integrating large-scale processes and goals (e.g. flood risk management).

Flood retention areas are usually designed to meet several goals in addition to the retention functions: habitats for biodiversity, safe infrastructure for recreation, attractive river-landscape. River restoration measures also serve various goals: resilience to floods and drought and creating habitats for aquatic and terrestrial organism groups. Since climate change impacts became more apparent, EG assessed risks and developed plans for adaptation towards extreme events, i.e. the “Roadmap Krisenhochwasser (Flood crises)” and “Dürremanagement-Aktionsplan (Drought management action plan)”. Further, a funding programme for decentralized rainwater management (“Zukunftsinitiative Klima.Werk”) is in place in cooperation with the municipalities in the Emscher region: It aims to store rainwater and enhance infiltration of rainwater into the groundwater or lead rainwater into nearby streams rather than into the combined sewage system; these measures minimize combined sewer overflow into streams and therefore improves water quality. It also enhances the minimum water flow into streams during periods of drought and decreases flood waves during heavy rain events. Furthermore, it enhances evaporation to counteract heat islands.

Aspects of sustainable mobility are addressed by the construction of bike paths next to restored water ways.

Main **weaknesses** include little cooperation with agriculture and forestry. Engagement of these economic sectors is mostly informative, but in the Emscher region agriculture and forestry do not play a major role, as the catchment is mainly urban.

The three pillars of sustainability (economic, environmental and social) have only recently been explicitly considered in the implementation of each single measure (i.e. via the sustainability check).

CO_2 emissions due to the heavy constructions works in the process of the Emscher restoration, both in the construction of sewers and in the hydromorphological restoration of streams, cannot be avoided. This adds up to the carbon budget.

> (I) Currently, dikes and non-used areas are frequently mowed. Biodiversity of these spaces is low due to the high mowing frequency. Transformation into flowering meadows is currently obstructed by legislation, effort, unclear responsibility and/or higher costs.

Opportunities arise from pilot collaboration projects with agriculture and forestry, e.g. in the context of sponge city and resilient landscape-water-balance (in the F&E projects KliMaWerk and KlimaBeHagen) as well as in the development of a new association for organic products (i.e. “Genossenschaft Emscher-Natur”). An **opportunity** for upscaling is the extension and continuation of these and other pilot projects.

Perceived **threats** result from climate change and needs for climate adaptation with arising conflicts for budget and resources. Despite adaptation measures, negative impact cannot fully be avoided in the future (e.g. streams will fall dry during extreme drought). The realization of planned measures is currently questioned by the energy and financial crisis.

Based on these SWOT characteristics **the way forward** for “multiple goal achievement” is to continuously use and update the recently developed long-term agenda and vision for EG's tasks (i.e. “strategic plan of EGLV”) to help prioritize, flexibly adapt and plan budget and personnel. Long-term agendas and visions are also needed by the municipalities to prioritize the various ambitions (e.g. “Bochum Strategie 2050”). Here, importantly, the societal benefits of the measures must be demonstrated (e.g. via ecosystem services). It would be helpful to develop more formats for collaborations with other sectors, e.g. agriculture and forestry, to create a more inclusive restoration process.

(I) Future optimisation potential includes to modify the maintenance of dikes and non-used areas for enhancing biodiversity. If these areas would be mowed less frequently, the mowed grass would need to be removed and used. Options include the use as sustainable feed for cattle or sheep (cooperation has already been established or initiated) or as renewable energy (e.g. as biomass material for co-fermentation with sewage sludge in WWTP). To put this into practice, large-scale concepts are required, to harmonize the alternative maintenance schemes with other requirements that address dikes and non-used areas (e.g. photovoltaics systems on flowering meadows). Such synergies will be evaluated together with EGLV's operating and planning departments.

To develop a holistic plan for climate adaptation, the existing flood and drought adaptation plans need to be regularly updated and possibly extended. Aspects of climate adaptation beyond flood and drought prevention, such as water quality and more heat-tolerant vegetation (i.e. trees and seeds for flowering meadows), will need to be considered soon.

2. Societal optimisation

Strengths: The Emschergenossenschaft (EG) has many years of experience with stakeholder engagement in restoration processes, e.g. working groups with agencies, municipalities, and dialogue with residents. Municipalities as key stakeholders are also members of the EG and therefore involved by the official biannual EGLV members meeting, where plans, costs and risks are communicated and, for example, land access questions are clarified. Using various dialogue channels, several human well-being aspects are communicated to the society (i.e. ecosystem services).

The main **weakness** is that participation is mostly informative, and no stakeholder analysis was conducted. Not the full range of possible ecosystem services has been considered. However, most measures are developed in a larger landscape context; various alternative scenarios are developed and compared to the main development goals.

Opportunities arise from the initiation of joint urban development projects with municipalities and climate adaptation projects like the sponge city concept. Also, a pilot programme "Mach mit am Fluss" to enhance participation with citizens in the Emscher region has already started.

Perceived **threats** result from missing acceptance of some measures and the risk of petitions and citizens' initiatives that may block the implementation of some measures. Restored floodplains and retention areas can lead to mosquito nuisance problems and related disease transmission. We are not aware of other disservices that arise from restoration measures, except for noise and dirt pollution during construction and a visually too "wild" landscape after restoration.

Way forward for "societal optimisation": EGLV's communication/outreach department will involve interested citizens already in early phases of planning to enhance understanding for and ownership of the measures. The range of formats to communicate relevant topics (e.g. biodiversity, invasive species, climate impact, ...) will be increased, including dialogue **opportunities** for residents, "open days" for citizens at construction sites, showing how life is returning to the streams.

(I) Citizen science is one way to involve people actively in the monitoring of streams and – at the same time – communicate important environmental topics to them.

To avoid nuisance of residents by mosquitos, restoration measures need to be designed in a way that allows for biological competition.

It is generally important to involve agencies at an early stage, and to discuss proposed plans before finalization. Also, agriculture and forestry need to be involved more directly at the local level to avoid conflicts and to agree on ecological land/forest maintenance and sustainable water use.
Furthermore, the already achieved multiple benefits of the Emscher restoration need to be communicated, because the underground sewage system is not visible, but its function is the precondition for a successful hydromorphological restoration of the Emscher streams.

3. Technical optimisation

Strengths: The Emscher restoration increases biodiversity. During the 30-year restoration project, first pilot streams were restored, and subsequent measures conceptualized based on these experiences. After restoration, biodiversity development was monitored. Furthermore, EG developed a "Traffic light system" for the construction of water management infrastructure and for ecological restoration projects. In addition, the "BSC system" (balanced score card) sets goals for multiple aspects in an integrated approach and annually checks achievement of intermediate goals.

Weaknesses: Water courses in the Emscher basin are strongly modified. The Emscher discharge consists to 80-90% of treated wastewater. Options for hydromorphological restoration outside of ecological focus areas are limited due to space restrictions and dikes. Furthermore, numerous combined sewer overflow facilities cause contaminant inflow into the streams during rain events, which compromises chemical and ecological development. Therefore, water quality in the Emscher basin – especially in the main stem – does not yet reach good ecological/chemical status and requires multiple technical measures for improvement. This comprises the

4th treatment level and oxygen enrichment at WWTPs and additional treatment at combined sewer overflow facilities, such as technical optimisation and constructed wetlands. Costs and available space restrict the use of the latter. To reduce diffuse pollution, the development of "secondary floodplains" are an option.
Several potential benefits of restoration measures are not yet monitored in a standardized way (e.g. cooling effect, provision of habitats, human well-being).

An **opportunity** arises from the project "Digital river twin", which is currently set up to merge datasets allowing for an integrated evaluation – possibly also of NbS effects.

Perceived **threats** result from climate change leading to strong flood events and extended periods of drought and desiccation. With climate change, invasive species will expectedly colonize the restored streams more quickly than native species and could compromise reaching good ecological status. Multiple stressors and migration barriers limit the recolonization of streams with native species. Intentional reintroduction of native species is not planned, as pilot projects showed limited success of reintroduction.

The way forward for "technical optimisation" includes a continuous monitoring of the NbS effects to further optimise their design and function and to prioritize NbS over conventional/technical measures. Near natural hydromorphology enhances stream resilience and reduces the risk desiccation. Retention polders might be designed to allow intentional "ecological inundations".
A continuous monitoring of biodiversity and ecosystem status and functions to further improve habitat and water quality would be helpful. EG will collaborate with agencies to find solutions and take joint decisions, e.g. concerning invasive species.

4. Economic optimisation

EG's "Genossenschaft" as a cooperative model is a main **strength**, because cooperate members finance 80% of the Emscher restoration on a long-term basis. Additional funding is acquired from national and EU funds as well as from linking restoration and regional development to leverage funds. EG is non-profit and has independent responsibilities. The distribution of costs is transparent, and the benefits are highlighted.

Weaknesses: Usually, no concrete cost-benefit-analysis is conducted, and the effectiveness of measures/costs is not tracked. No private funding is yet used for restoration measures.

Future private funding is an **opportunity** that could facilitate further restoration measures, e.g. insurance sector funding flood protection measures, which at the same time serve as local recreation sites (e.g. Lake Phoenix).

> (I) A new association ("Emscher Natur") is about to be founded, which will allow EGLV to market natural products, such as honey, wine and apple juice. This will support the transformation of land into organically maintained orchards or vineyards. Furthermore, "Emscher Natur" can also potentially cover the maintenance of flowering meadows. Sheep grazing might be a way to reduce costs. Urban gardening and other environmentally friendly ways of land-use in the Emscher region should be encouraged. This is also a way to involve many stakeholders in the region.

Sheep and cattle grazing can also be used to counteract succession in restored floodplains and retention basins (e.g. in the ecological core area "Holtener Bruch"). This will reduce maintenance effort and at the same time be a benefit for biodiversity and attractive for visitors.
Enhanced maintenance effort also emerges from constructed wetlands, which will be built in the near future. Mowed grass will need to be removed. Similarly, the mowing or management of aquatic vegetation might be required in the future, as mass production of water plants due to eutrophication is already observed. This can become a threat but also might open new ways of marketing biomass, as already successfully implemented by some Dutch regional water boards. Besides mowing, instream dredging of sediment might become necessary. The gained material could be re-used. The challenge is to transfer a cost into a benefit.

Perceived **threats** result from higher costs due to climate change impacts and adaptation needs, from new regulations (e.g. 4th WWTP level, P recovery, ...) or from enhanced energy prices.

The way forward for "economic optimisation" is to prepare for unforeseen risks. EGLV's risk analysis is regularly updated but might need to be extended. This could help to adapt the time schedule when prices are rising or search for alternative funding sources, e.g. private funding.

5. Policy/regulation optimisation:

Strengths: With the "Emscher master plan", a long-term agenda and vision has been developed, including restoration projects and links to urban development and climate adaptation.
To facilitate permit procedures, early involvement with agencies at different levels (federal, regional, municipal) are sought for by EG. Working groups with agencies have been established to regularly exchange and make joint decisions on the most pressing topics of the restoration programme. Beyond this, EG is voluntarily active in working groups of associations for water management and aquatic ecology (e.g. the national associations DWA and DGL). These associations act as policy consultants by providing expertise judgment, amongst others for policy adaptation.

Weaknesses: Currently, discussions are ongoing whether trees are allowed inside the diked area to provide shading for the Emscher. Solutions must be found to solve conflicts with flood protection requirements. The

entry of invasive species into the Emscher system is unavoidable. If they fulfil necessary functions in the ecosystem, they might even be of benefit. Biological quality targets would need to be redefined, as currently they are considered solely negatively in the standard assessment schemes. Mass reproduction should be avoided, however.

(I) Protected native species can be a challenge for planning. Especially birds and amphibians may colonize areas purchased by EG for potential later demand, e.g. for use as retention or constructed wetland area or for the exchange of land properties. The settlement of protected species may limit later use. A policy that allows to classify this type of land as “areas for temporary nature” would solve this problem.

Opportunities: EG works proactively on innovative and future-proof topics via research projects and pilot measures and seeks for solutions to pressing water management topics, which can then be adopted also by other water boards.

Threats: Trying to change policies is a lengthy process and success is unpredictable.

(I) **The way forward**: The interpretation of nature and species conservancy laws (i.e. BNatSchG) needs to be adapted, to facilitate synergies between river restoration and nature protection rather than obstructing restoration if single protected species occur. Agreement with agencies will be addressed to classify areas reserved for later use as “areas for temporary nature”. Currently, the risk of delay or stop of river restoration programmes forces operators to scare off protected animals before settling down. The project “Beleidslijn Tijdelijke Natuur” from the Netherlands shows that the concept of temporary nature is compatible with EU law (https://www.tijdelijkenatuur.nl/; staatscourant-29016-vertaling-beleidslijn-tijdelijke-natuur-en.23b6e5.pdf). Solutions applied in pilot projects, local agreements with municipal agencies as well as discussions with higher level agencies are planned to modify the static idea of nature protection from a legal point. Therefore, legal professionals are involved as well.

Furthermore, legislation on dike stability should be applied more flexible with regard to ecological dike maintenance, i.e. allowing for trees and shrubs to shade the streams and for extensive flowering meadows instead of regularly mown grass surface. Consultants should learn how to assess stability of ecologically maintained dikes.

In summary the most important conclusion/ major opportunity:

- New scheme for maintaining grassland on dikes and unused areas
- Strategy to use harvested biomass
- New scheme for public involvement, particularly through Citizen Science projects
- Regulation for "areas for temporary nature"

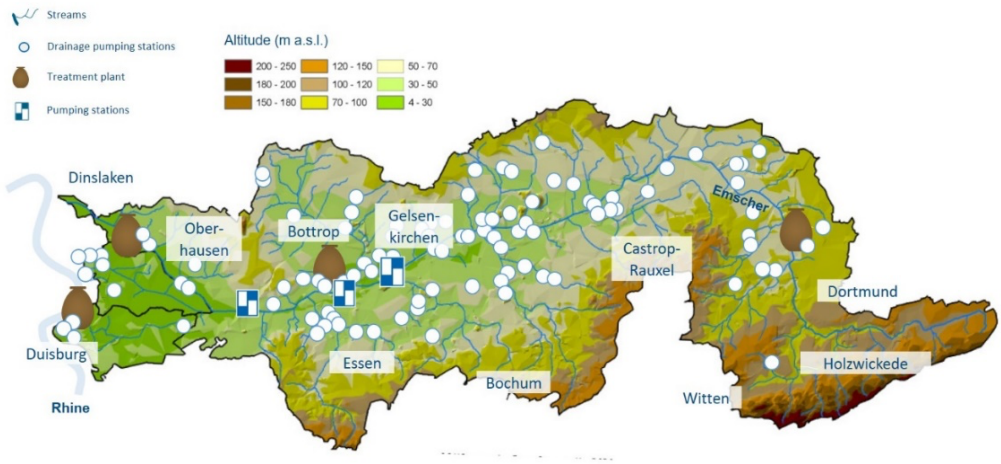

Figure 19 Emscher river basin

Table 4 Emscher river basin: optimisation aspects linked to the Green Deal goals

	Optimisation aspect				
EU Green Deal Goal	**Multiple goals**	**Societal**	**Technical**	**Economic**	**Policy regulation**
Biodiversity net gain	X		X	X	X
Climate regulation	X		X		
Flood resilience	X		X		X
Drought resilience	X		X		
Health and wellbeing		X			
Zero pollution goals			X		
Sustainable food systems (F2F)	X			X	
Sustainable energy	X			X	
Sustainable transport	X				
Inclusivity	X	X			X
Circular economy				X	
Financing the transition				X	
Green growth				X	X

3.2.3 Case study 13 Sorraia (Portugal)

Authors: Henrique Dias (DGADR); Luís Sá (DGADR), Teresa Ferreira (ISA-ULisboa), Claudia Brandao (DGADR)
DGADR: Direcao-Geral De Agricultura E Desenvolvimento Rural (Directorate-General for Agriculture and Rural Development)
ISA-ULisboa: Instituto Superior De Agronomia Universidade de Lisboa (School of Agronomy – University of Lisbon)

Note of the editors: this contribution is slightly different structured than the other case studies. The SWOT analysis is shorter and not presented separately for the five aspects (multiple goal, societal, technical, economic and policy/regulation) while the way forward has been detailed for each aspect individually.

The Sorraia River (southern Portugal) is the tributary of the Tagus River with the largest basin area, with ~7730 km2 and with a longitudinal length of ~155 km (*Figure*). The climate in the region is dry sub-humid, with dry and hot summers, and mild and wet winters. Two major reservoirs, Montargil and Maranhão, were built upstream in the watershed during the second half of the twentieth century as a part of the Sorraia Valley Irrigation Implementation Plan. Currently, the Sorraia Valley is one of the largest irrigation areas in Portugal, totalizing 16,000 ha, in which corn (Zea mays L.), rice (Oryza sativa L.) and tomato (Solanum lycopersicum L.) predominate. The land use in the remaining area of the watershed is characterized by holm oak forest, rainfed cereals and pasture. In terms of human population, the Sorraia watershed has a total of 153,000 inhabitants, with a density of 20 inhabitants km2. The population is mainly concentrated in three core cities: Ponte de Sôr (16,700 inhabitants), Samora Correia (17,123), and Coruche (19,950).

STRENGTHS – OPPORTUNITIES – WEAKNESSES - THREATS

The main **strengths** are proximity of partners to the territory; the knowledge of its territory including know how in wetlands and its issues and finally the dissemination knowledge. The most important **strength** of local authorities in managing wetlands is the proximity to the territory, which allows first-hand knowledge of the issues affecting these ecosystems - interactions between wetland ecosystems, communities, man-made infrastructures, and the economy in the area. This knowledge should be shared with decision makers. Water and wetlands provide a wide range of values and benefits to society; however, disseminating knowledge of these benefits to local communities is essential because these are often either not recognized, or only one is appreciated.

Opportunities arise from the need of an effective and efficient regulation of activities that impact water and wetlands. Local authorities can improve regulation and land use planning because they hold the competencies for zoning regulations in municipalities. Special Plans are local planning tools that regulate uses and activities. However, these plans present several disadvantages (e.g., limited scope, diversity of purposes and need to be approved by the regional authorities). In addition, Special Plans are limited to local scale, thus, they do not solve problems affecting the wetlands because these ecosystems are under a wider influence from all the catchment.

The main identified **weaknesses** here are common to other fluvial wetlands, although some are particularly relevant in the study area. There is the notion that private land ownership thwarts management of protected areas and this idea limits the scope of action of the various administrations. Local authorities usually need to mediate when conflicting interests among different users arise. Conflicting demands for water and land are continuous and inevitable, and usually conflict with wetland conservation (e.g., infrastructure pressure and developable land demand). Recognizing and strengthening the link of local communities to wetlands is critical in transforming the management approach. In addition, depending on the political orientation of the administration, these conflicts can be solved with different purposes and usually governments take decisions having into account the political repercussions at the polls. Corruption can be a major impediment to maintain the integrity of these ecosystems. The poor definition of prohibited, permitted and conditional uses and activities creates insecurity among users, through ignorance of the applicable regulations and fear of sanctions. In this context, farmers have abandoned some practices, which sometimes play an important role in wetland conservation. In fact, the role of traditional practices has not only been recognized, but also has been recommended to consider them in wetland management. To avoid this undesired situation in **the way forward**, environmental regulation should focus on three approaches: regulation of water uses (discharges, management practices, limits of abstraction, etc.), regulation of products (product use and production standards), and spatial planning (which regulates land uses).

The main **threats** to this project are related with the management by local authorities. One example is the division of administrative competences in fluvial wetlands of Portugal. Environment responsibilities were shifted to the Regional Hydrographic Administrations, but some competences are still responsibility of National authorities, especially in navigable sections of streams. To this must be added the multiplicity of existing environmental figures. Despite the different types of protection, abstractions continue, being the fertilizers and pesticides runoff a good example and cumulative industrial discharges upstream another one. Another large issue is the invasion of water hyacinth (*Eichhornia crassipes*) in Sorraia, and other invasive species. Most of the problems associated with water hyacinth are due to its rapid growth rate, its ability to successfully compete with other aquatic plants, and its ease of propagation. These characteristics give rise to enormous amounts of biomass that cover the water surface of a great variety of habitats often interfering with the use and management of water resources. Some of the principal problems are its interference with boating, water flow, and the recreational use of aquatic systems, as well as the risk it poses of mechanical damage to hydroelectric

systems. It is also responsible for drastic changes in the plant and animal communities of freshwater environments and acts as an agent for the spread of serious diseases in tropical countries.

This analysis enables the determination of specific goals for decision-makers, which are convenient. The research indicated that three objectives must be accomplished:

Objective 1. To manage wetlands as integrated parts of natural resource management both local and regional

Objective 2. To support the care, rehabilitation, restoration or creation of wetlands by the private and public sectors.

Objective 3. To raise community appreciation of wetlands as natural assets and generate support for their gaining attention in integrated natural resource management

The way forward is presented hereafter around 5 main aspects (multiple goal, societal, technical, economic and policy/regulation optimisation):

1. Multiple goal optimisation

- To fulfil the ecological functions of the wetland
- To secure the characteristics of the wetland
- Promotes ecological protection and environmental education
- To establish a monitoring system to secure the growth of ecological environment
- To include stakeholders in management decisions
- To determine whether to reduce human-made facilities

The improvement of general connectivity and the implementation of a riparian cover allow crop and land protection, especially during Autumn/Winter by sheltering crop fields and creating microclimates. Re-building natural lateral storage areas and small ponds temporarily connected to the main channel allow water conservation and waterlogging for longer periods, playing an important role in Spring/Summer and contributing to preserve aquatic life cycles too. The rewetting cycles can serve the farmers by improving groundwater availability and also promote biodiversity. Beyond that, and restricting pollution by farming, sustainable foods from good environmental practices become more and more attractive to public.

A better planning framework is also a goal being a practical tool for planning and management of the riverine and wetland system at supra-municipal level. This tool should establish wetland zoning taking into account bio-physical, socio-economic, and institutional characteristics, land uses and planning classification, and general and specific regulations for each zone, including the definition of prohibited, permitted and conditional uses and activities. Permitted uses must be plainly specified to avoid regulatory gaps that may cause undesirable conflicts. This tool should also define which institutions will be responsible for approval of conditional uses and establish its concession procedures with the final goal of improving water quality in Sorraia river. Here, the underlying assumption is that the natural form and functions of restored wetlands will retain sediments, and nutrients, and improve water purification. Despite the range of ecosystem services provided by wetlands and ongoing restoration efforts, wetland areas are still heavily farmed and altered, as water is scarce in Mediterranean areas as in Portugal. It is increasingly important to manage and restore wetlands for supporting biodiversity and human benefits, including water quality issues.

2. Societal optimisation

- Establish facilities for promoting ecological education and related resources
- To encourage agricultural activities that have less impact on the ecosystem
- Involve stakeholders in management plans and eventual planning restrictions
- To rearrange recreational facilities in activity zones

Maximize biodiversity gains and related-ecosystem services provided by the biological communities under analysis without detrimental effects to agricultural economic incomes (biological control enhancement for crop pests, and pollination), is the main purpose. Under this context, Wetland Zoning seems a major step in a societal framework, and the environmental planning of the area in general. As we see, in the scope area there are different interests: owners, farmers, irrigators, hunters, fishermen, residents, conservationists, and companies. A good wetland zoning requires involvement of all the stakeholders, otherwise the implementation and results become difficult. The making of a proposal/presentation/discussion of a wetland zoning plan with all the stakeholders is a fine tool to enhance communication between different actors. In fact, stakeholders should be integrated in the active management of these areas and the division of competences among different level authorities should be harmonized. Before implementing the measures, meetings and dialogues will take place with all the stakeholders. Plans will be communicated to the Sorraia Farmers Association. All land rights, including access to water, must be clarified and safeguards must be stablished. The Farmers Association has the register of the landowners' area and should be deeply involved in such actions.

3. Technical optimisation

- To establish a monitoring mechanism for water quality and quantity
- To promote the ecological management and conservation of habitats
- To maintain biodiversity
- To reduce agricultural areas and expand ecological habitats

Re-building water channels and improving lateral connectivity, will allow to slow down and minimize floods, also improving the crop fields by retention of transported nutrients; vegetation cleaning and riparian clearing and reshaping, will also contribute for land protection. There are also a set of measures to promote the habitat restoration (pollination, birds and insect shelters, temporary ponds for amphibia), building different adequate ecological infrastructures. In another part of the river (Zone 2) a connection of an oxbow and lateral branch to the main channel is foreseen promoting connectivity and creating a permanent wetland habitat (Figure 21). Mapping of existing vegetation enables to calculate carbon sequestration in the area, if relevant. At last, in some specific river points there are bottlenecks in connectivity, in small temporary weirs and in river crossings for crop products transportation. River crossings should use NbS solutions such as half-submerged structures or natural rock pavements, instead of the existing culverts, enabling that fish and other aquatic fauna move up and down the river.

An approach to the eutrophication problem should also be addressed. This is a problem in Sorraia, resulting in local water quality problems. The presence of Eichhornia crassipes weed (water hyacinth) at some places indicates eutrophication. Excess nitrogen and phosphorus from the fertilizers used in the agricultural fields, which reach water bodies, have promoted the extensive growth of water hyacinth. Addressing the causes includes a better efficacy in nutrient supply and more biological agricultural practices. Addressing the effect includes yearly vegetation cleaning, also affecting the aquatic communities. In the river, with the help of farmers a systematic and regular monitoring network of established points should be established allowing the extent of the invaded area to be reliably identified at all times for the removal of all detected plants or fragments. This monitoring should begin before winter, with teams of volunteers and the collaboration of fishermen or other river users. It is important that the different actors are motivated, informed and committed to eliminating all water hyacinth plants while promoting native ones. The elimination of harvested water hyacinth is also a problem as about 90% of biomass is water and transportation is costly. Given land availability for drying beds, however, such a biomass can be reused as soil cover.

4. Economic optimisation

- Establish a Buy-Out Programme with proper funding
- Create the notion of non-farming status
- To create a financial compensating mechanism for not farming

Currently, the main financial resources in the area are EU subsidies and some fees supported by Sorraia Farmers Association. Funding for river restoration from the Water Administration, and from landowners in a less scale, must be envisaged. Also, new forms of financial resources must be discussed in the framework of valuating ecosystem services. These can play an important role in guiding decision-making concerning the restoration of natural ecosystems which is particularly important in wetlands due to their widespread deterioration. In this framework, it is important to analyse if the local stakeholders attribute a good value to a riparian cover conservation, or to an improvement on water quality. In fact, in similar scenarios, stakeholders (Farmers Association, Municipalities) willingness to pay for modest and moderate wetland improvement may outweigh the potential cost of the restoration projects, especially for modest restoration objectives, and even under conservative assumptions regarding the benefits and costs of restoration.

Efforts must be done together with national government programmes to raise awareness and sensitivity about those issues.

5. Policy/Regulation Optimisation

- Create a Permit and Land use Regulation
- Apply a coordinated regional policy for wetland management in Sorraia
- For synergy, establish regional cooperation platform for Sorraia
- To create ecosystem management plans
- Create a local water council with the stakeholder's involvement
- To designate protected and buffer zones
- To implement effective control plans for the protected zones
- Local Schools Educational Programmes to include Wetlands themes
- Create a Management Body for the Wetland, with stakeholder's participation

NbS design and implementation streamlined by the Ministry of Agriculture, especially on the projects under his hand, involving funding, especially if there is some compensation mechanism that can be created, and regulation to stimulate it. Nevertheless, it would be better to see EU CAP policies linked into restoration

schemes, for examples via agroschemes. Defining a set of restoration measures in the projects/schemes as a condition for financing, could be the answer.

An interesting approach would be to analyse how the US Clean Water Act Section 404 Regulatory Programme to Agriculture could be adapted to European reality. This legal tool establishes how agriculture and wetland conservation can coexist in wetland areas like the Sorraia case. For example, if a farmer has been ploughing, planting and harvesting in wetlands, can he continue to do so without the need for a permit? Should some practices, be forcefully implemented such as no-tillage, and how can we do it in a free market setting? What farming activities are considered harmful for Wetland conservation, and how can we inform farmers of such effect, more precisely, can we counteract the economic issues driving profit?

Climate change will deeply influence the Sorraia area: there will be less water available for crops and the ecoflows, in a short time span. This will drive changes in land use, including the decrease in water supply by increasing efficiency, changes in crops, crop cultivars and farm practices. Although there will be less water used per area, the stress caused by the water supply decline will affect the aquatic systems, especially concerning floods and flooding, that will decrease in number and magnitude of events.

Conclusion

Summing up the issues presented in the document, continuous improving of the processes is a very important action that should be a part of each enterprise functioning including wetlands as cultural and natural resources. The used tool SWOT analysis identified possible strategies to be achieved. By having many important strong points, it can take advantage of a lot of identified **opportunities a**nd better overall performance of the strategies related.

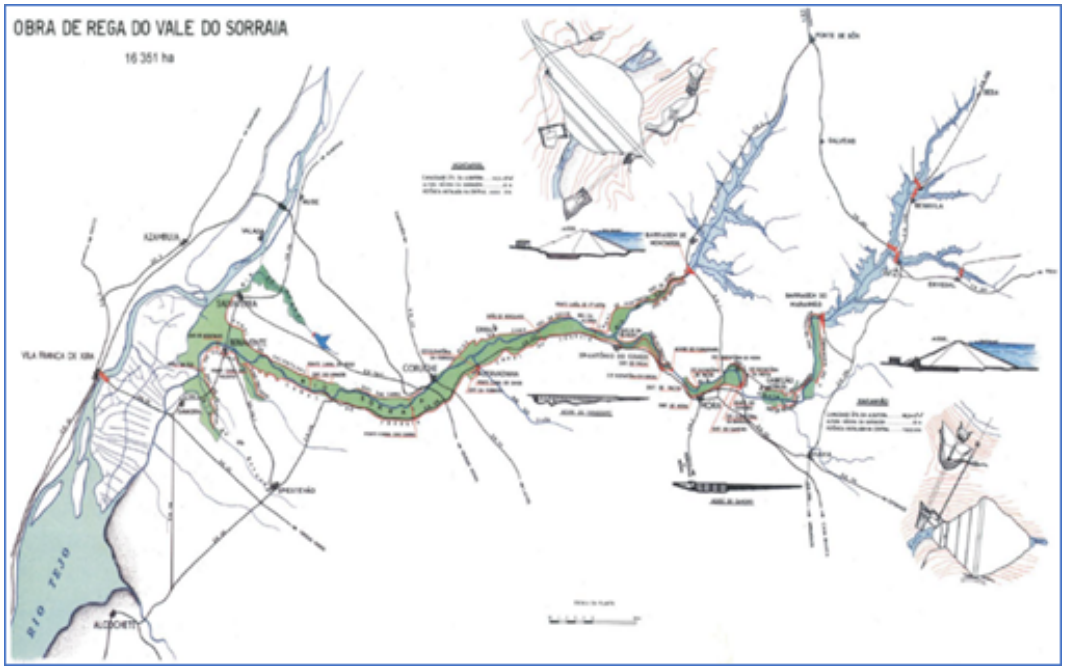

Figure 20 Sorraia basin with the upstream reservoirs

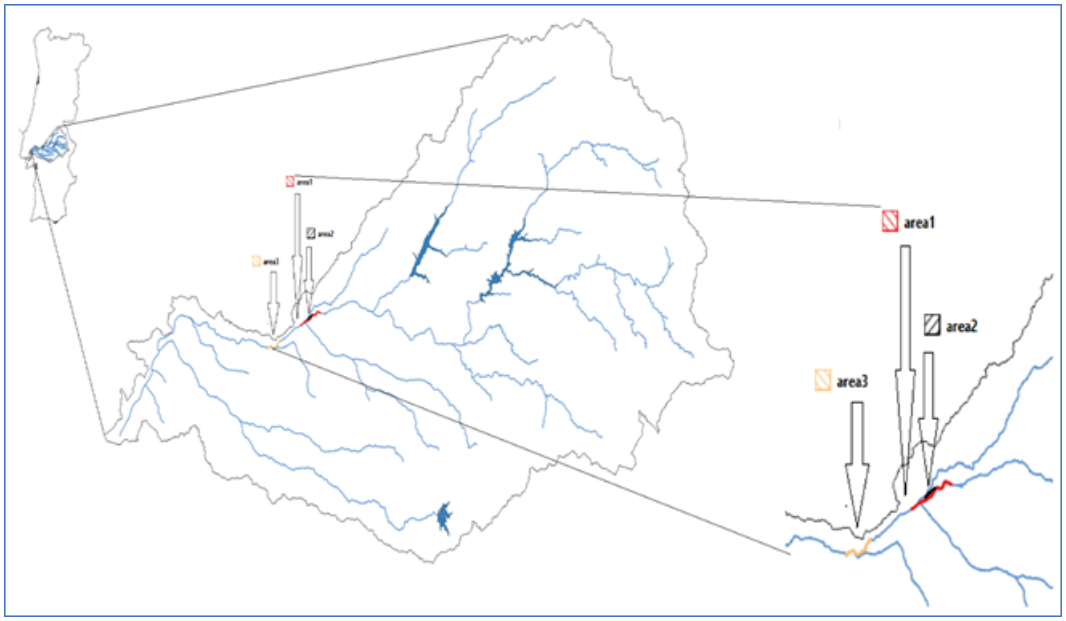

Figure 21 The restoration locations within the Sorraia Basin

3.2.4 Case study 15 Tzipori (Israel)

Authors: Yaron Hershkovitz and Avital Katz (TAU), Tal Ratner (KRDA) and Michal Grossman (AVIV-AMCG)
AVIV-AMCG: Private consultancy firm
KRDA: Kishon Drainage and River Authority
TAU: Tel Aviv University

1. Multiple goals optimisation

By creating newly flooded areas and restoring connectivity the project is aimed for achieving multiple goals and maximizing benefits that will: (1) reduce flood damages to agriculture and infrastructure, (2) restore biodiversity of unique habitats (alluvium soils), (3) create opportunities for recreation for local communities, (4) provide opportunity for an educational hub, (5) regain connectivity of water, matter, and organisms along the stream.

The implementation plan is part of a larger watershed restoration project that focus on transforming agricultural land into natural floodplains (Figure 22 and Figure 23).

https://rrcompetition.agma.org.il/wp-content/uploads/2020/10/Zippori-Board10-1_compressed-1.pdf

The main **strengths** are: The project is part of a large-scale watershed management project, led by the river authority and with a holistic approach and a strong commitment for involving local communities as partners in the process. It aims to create a better environment and functioning ecosystem, in a highly degraded landscape.

The main **weaknesses** are: not all landowners are in full agreement with the aims of the project. Some are concerned from loss of water use privileges, while others are threatened by overcrowding of visitors and vandalism to crops and plantations. We do not yet have a good quantification in place. Especially for floods/water quantity/water quality and biodiversity data this is needed.

Opportunities arise from: flooding that leads to damages is a real issue in this area. We offer a NbS that would be beneficial to all parties, including framers and other nature-loving inhabitants.

Perceived **threats** result from: The water masterplan that is the basis for this project, is expensive and time consuming, and thus will not come into effect before 2024.

The way forward is: to present the benefits that this project could provide to all parts of society, farmers and urban inhabitants as one. Making one-sided decisions is undesired and should be considered only as a last solution when all other idea have been exhausted.

In the current situation heavy rain events may lead to flooding of agricultural lands, causing substantial economic losses. As part of the negotiation process, we suggested to use uncultivated lands for recreating floodplains, which can reduce flood risk and economic losses. This newly created floodplain could support the establishment of flora and fauna typical to heavy soils marshlands.

The establishment of target organisms will be monitored and evaluated continuously. If needed, we will consider reintroducing missing fauna and flora species to speed up goal achievement.

As part of the restoration plan, invasive plants are mapped and will be eradicated. For the floodplain restoration we will use pioneering plants to prevent the establishment of unwanted invasive plants.

2. Societal optimisation

The Tzipori is a unique region where inhabitant from multi-cultural backgrounds share the same landscape. In addition, land ownership (private vs. state-owned), type of crops (vineyards, orchards, vegetables, or livestock) or land use (urban, sub-urban and cultivated) often leads to a conflict of interest concerning for water rights, pollution, and access. The project will try to ensure that all existing rights are kept, although trade-offs must be considered. For example, allowing free passage along the stream, while limiting access to private property is a substantial demand which is being considered in the planning process. Another example is the giving up use of uncultivated lands for floodplain functioning, which can reduce flood risk and economic losses.

The main **strengths** are: The KRDA has an ongoing programme of involving stakeholders and local communities in its activities, including educational programmes, and empowering of small communities. This infrastructure forms the basis for further discussions between the authorities and the communities.

The main **weaknesses** are: Some farmers are reluctant to the process where they are required to give up land for the greater good. This is particularly true for the Arabic communities which may feel ignored by the government.

Opportunities arise from: by involving all parts of society in the process and decision making, it might be possible to “break the wall of suspicious” and allow open discussion among all parties.

Perceived **threats** result from: Nevertheless, not all stakeholders are happy with the proposed changes, and may feel threatened by the process and its outcomes.

The way forward is a constant dialogue between stakeholders, planners, ecologists, and local communities to discuss issues of concern and suggest adequate solutions (though we can’t please all…).

- By discussing openly with farmers, we can generate better understanding of their needs and enable "win-win" solutions. For example, the KRDA can improve service roads for the farmers in exchange for larger riparian buffer strips.

- There is some social tension between local communities. We work to connect communities through joint meetings and mutual activities around the stream.

3. Technical optimisation

As some climate models predicts, the east Mediterranean region is expected to experience stronger floods and longer drought periods due to climate change. This project will serve as an example for NbS that could be applied in other projects too, as “soft measure” instead of current engineering solutions (channelization and damming). By using the “principle of “have the water and drink it too”: floodwater will be diverted into a floodplain, thus creating a “sponge” to collect storm water and reduce risk of floods. This water will gradually infiltrate and enrich groundwater and create a wetland ecosystem which is very rare in the coastal plain of Israel. For the loss of water to irrigation, baseflow will be collected further downstream and will be supplied to agricultural use from reservoirs. There will be no unauthorized pumping from the stream channel itself. This will ensure a steady supply of high-quality water for irrigation and at the same time will allow the stream to flow freely for several kilometres until being diverted. This process will involve removal of a large concrete dam which interrupts natural flow and sediment transport.

The main **strengths** are: The water plan has been approved, agreements with the main stakeholders have been reached and detailed planning has already begun.

The main **weaknesses** are: The implementation of the water plan will only be completed in a couple of years, Currently, since farmers have no alternative water source, they will continue to withdraw water straight from the stream.

Opportunities arise from: Restoring floodplains and creating of newly flooded areas, will have several benefits: 1) reduction of flood risks, 2) groundwater recharge, 3) biodiversity gain (plants, birds, invertebrates, mammals), 4) outdoor activities (e.g. biking), 5) educational activities. Hydrological models have not yet been performed. A monitoring scheme is under development.

Perceived **threats** result from: Using privately owned land for deliberate flooding requires long negotiations to reach an agreement on proper compensations. A principle “memorandum of understanding” exists, but no official agreement has been signed yet. Cattle grazing also affects water quality and riparian state.

The way forward is: Including landowners and stakeholders in the process of planning is a prerequisite for achieving restoration targets. It is needed in order to demonstrate how NbS can be more sustainable and beneficial than technical ones. For example, by using terraces we plan to reduce runoff from tributaries into the main channel. Water that accumulates on these terraces won’t be lost at sea and will recharge groundwater. In addition, the vegetation that will developed on these terraces could be used as alternative food source for cattle, away from the restored stream. Such actions are part of a larger spatial plan, that involves several stakeholders in the catchment.

4. Economic optimisation

The Tzipori restoration project is unique by the fact that it was initiated and supported by a private fund. The use of private capital for the benefit of the greater good is not a new idea in Israel, but is the first time in which this investment is done for stream restoration.

The main **strengths** are: The investment money gave a substantial push to set up the process and to ensure that the goals are met. Additional funding is secured by a commitment of the river authority and governmental support.

The main **weaknesses** are: Although needed, there is currently no economic plan to support a sustainable functioning plan for the region.

Opportunities arise from: With private funding at hand, the opportunity to advance a full watershed management has been easier than before. It also creates opportunity for investments by local municipalities and stakeholders to further capitalize from the process.

Perceived **threats** result from: Privat funds are secured for a 4-year period, including matching from other resources. Although this allows a fast progress in the first years, it is still not clear how the project will continue after this period ends.

The way forward is to develop an economic plan that will secure funding for restoration and maintenance, and long-term adaptive monitoring of the restoration actions. One goal is to ensure governmental support of the project and to include local municipalities in the process. As the water issue is critical for restoration, the national water authority is also involved in the project. Water is not free, and an agreement on fees will be made.

5. Policy/regulation optimisation:

The Israeli policies on river restoration is not as advanced as the European one. For example, the EU WFD that set clear restoration targets (i.e., good ecological state) does not apply here. Therefore, all regulations are currently stemming from the Israeli laws for water and drainage, which are insufficient for advancing an ecologically viable restoration plan. New policies should become available to address specific restoration needs.

The main **strengths** are: The Israeli water law is robust. All water is considered state property, and no one is allowed to use, pollute, or change the natural properties of water without an official permit from the water authority. In principle, this gives the water authority the right to control and restrict water use that does not fit restoration goals.

The main **weaknesses** are: Acting under different laws (the water law and the drainage law, respectively), the water authority usually does not take part in restoration plans, and rarely intervenes in the activities of the river authorities. However, in Tzipori case, the water authority and the KRDA have agreed upon a mutual plan to remove pollutants, and supply farmers with irrigation water. This limits the role of the river authorities to maintain stream flow and prevent pollution.

Opportunities arise from: A government decision to restore selected streams across the country, has secured some funding for the project. This enabled the river authority to advance an overall water plan that is vital to the success of the restoration plan. This includes water allocation to farmers, removal of all point source pollutants, and the upgrading of wastewater treatment facilities. A governmental decision or increased use of desalinated sea water reduces our dependency on rainwater and allow more options in water use across the country. With nearly 87% of wastewater treated, we are also able to irrigate crops without fear of droughts. This leaves more water for nature that can be included in restoration plans.

Perceived **threats** result from: multiple non-point pollution sources that are still difficult to address by standard engineering approaches.

The way forward is to reduce agro-pollutants for which NbS and other “soft measures” should be become more available as standard practices. In addition, we plan to initiate a programme to introduce farmers to more sustainable practices. The drainage law authorizes the river and drainage authority to use strict regulations in order to prevent flooding. However, the KRDA strives to create a lasting agreement between landowners and the authorities, in a way that serves all sides.

Figure 22 Location of the Tzipori catchment in Israel

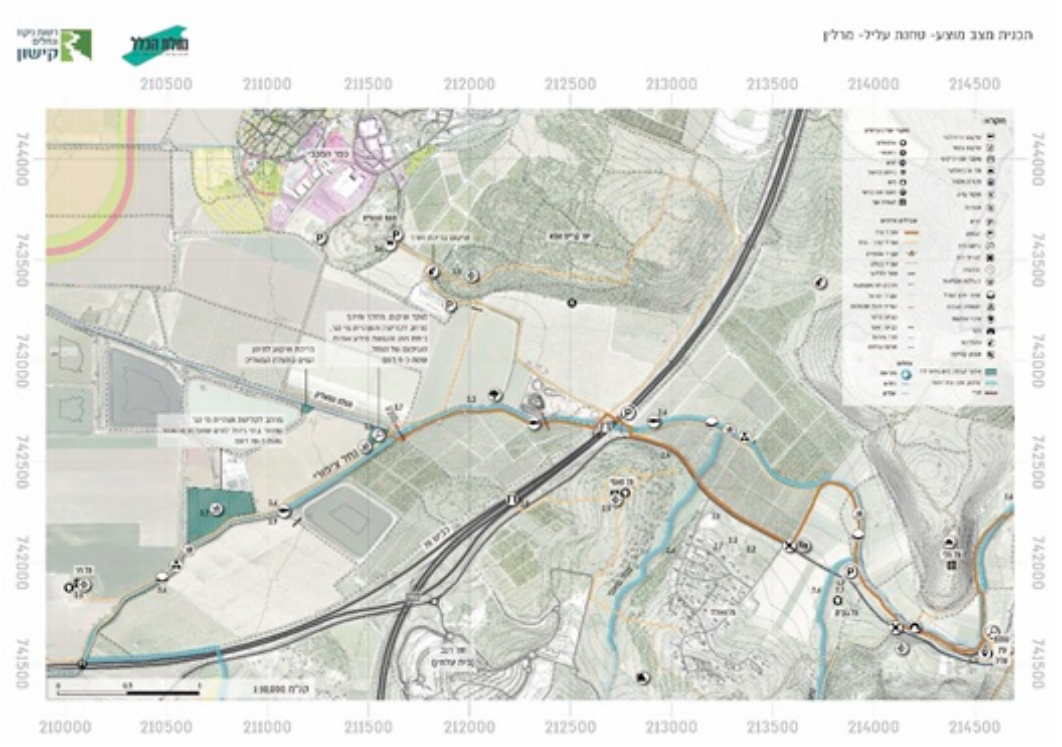

Figure 23 The implementation site showing the section to be restored. This is an extended plan that includes also connection to upper and lower sections pf the stream (Source: New Commons landscape planning office)

3.2.5 Case study 16 Scheldt (Belgium)

Authors: Marie Anne Forio (UGent), Pieter Boets (POV), Peter Goethals (UGent)
POV: Provincie Oost-Vlaanderen (Province of East Flanders)
UGent: Universiteit Gent (Ghent University)

1. Multiple goals optimisation

The different goals relevant in the upper Scheldt regions are the reduction of soil erosion and pollutants such as organic waste and agricultural runoff (nutrients and phytochemicals). Furthermore, enhancing biodiversity is important, i.e. macroinvertebrates, fish, water plants, and pollinator species. Aside from these aspects, flood and drought resilience are increasingly becoming important in these regions. Furthermore, agricultural production is also important as well as the reduction of greenhouse gas (GHG) emissions in the context of the EU Green deal.

The Nature-based Solutions in the framework of the MERLIN project are the implementation of grass-flower buffer strips and the restoration of a small stream through re-meandering, the removal of fish migration barriers, the installation of a buffer pond/erosion pond and the implementation of spawning beds for the reproduction of fish. However, within the region, other nature-based solutions are foreseen to be implemented in the future such as the implementation of trees and shrub buffer strips. This is however more challenging as farmers are less willing to implement these. Wooden dams near roads and houses are also constructed to mitigate erosion/run-off from agricultural fields.

The main **strengths** can be grouped into three aspects: (1) availability of various environmental data and numerous scientific studies in the past, (2) existing initiatives to improve the water quality in the region and (3) availability of varying funding schemes for the implementation of NbS. Firstly, within the case study region, there is an availability of long-term biodiversity data, data on climate and hydrology and various studies, which resulted in numerous scientific publications. There are also monitoring and assessments performed in terms of biodiversity and water quality in the region by The Flemish Environment Agency. Another advantage of the case study region is the existing experience with regard to multi-objective optimisation such as those in the PhD thesis of Dr. Sacha Gobeyn and Dr. Elina Bennetsen as well as the previous study for the optimisation of the locations of forest riparian buffer strips (*cf.* Witing et al. (2022)). Secondly, due to the WFD and other EU directives, there is a need to improve water quality; thus, wastewater treatment plants and sewer systems are being implemented. Thirdly, there is the presence of various available funding schemes from different government organisations. Examples of these are local initiatives such as the "boer aan boord" project, which provides compensation for the construction and management of grass (flower) strips along erosion-sensitive agricultural plots.

The main **weaknesses** of the case study region are that majority of the land is an agricultural area which challenges net biodiversity gains as well as the presence of many diverse stressors (e.g. invasive species, discharge of untreated domestic wastewater). Particularly, houses are scattered throughout the region which makes it challenging to connect them to the sewer system and wastewater treatment plants. Therefore, decentralized sewer treatment systems are needed. The combination of these factors challenges the added value of one single restoration measure. The currently implemented NbS measures may also be of a too small scale to significantly affect global climate regulation. Furthermore, drought and its effect are not yet regularly assessed and monitored in the region. On top of that, it is not easy to change the minds of farmers regarding their practices and it can be challenging to convince them to implement an NbS measure such as grass-flower buffer strips.

Opportunities arise from increasing awareness among stakeholders related to nature and biodiversity, but especially related to water availability. Furthermore, the case study site is a touristic region and thus the region has a high potential for implementing NbS to further increase touristic activities. The case study site is also dominantly an agricultural area, therefore more and more attention is paid to drought resilience as water is needed for crop production. With climate change, floods and drought events are increasing in frequency and intensity. This situation warrants the adoption of NbS measures to mitigate the impacts of these events. Lastly, due to the growing population, sustainable food systems are increasingly needed.

Perceived **threats** resulting from the adoption of NbS by users may be limited and may be dependent on the subsidies and/or compensation they receive, which limits the effect of NbS on biodiversity net gain. Moreover, planting trees on agricultural land is generally not a preferred measure taken by farmers and the high value of land may inhibit the implementation of NbS, for instance in flood-risk areas, as they prefer to keep or use the land for economic gains such as agricultural production. Another perceived **threat** by the farmers/local actors of not being motivated to implement the NbS measures is the uncertainty in costs related to the establishment and maintenance, which may also require additional labour during maintenance. On the contrary, the implementation of some NbS may potentially reduce the area for planting crops thereby reducing crop production.

In terms of data collection, it is costly and often challenging to collect multi-disciplinary data along with the related lack of expertise. Other perceived **threats** are the presence and problems with invasive species (e.g. Himalayan Balsem, Chinese mitten crabs, some invasive fishes, birds and macroinvertebrates) in the case study region which challenge the effectiveness of NbS measures in terms of biodiversity.

Based on these SWOT characteristics, **the way forward** for multiple goal optimisations can be achieved by combining five aspects (1) use of available data to gain insights into the effectiveness of the NbS measures in achieving varying goals, (2) develop and/or analyse the data using varying modelling techniques to optimise the locations and combinations of these NbS measures (3) conduct and involve multidisciplinary studies and expertise, respectively, (4) upscaling of the NbS measure (i.e. for grass-flower buffer strips and probably also stream restoration through meandering), (5) encouraging users (e.g. farmers, water managers) to implement measures at locations where they are effective in achieving multiple goals.

Firstly, based on available data (e.g. varying layers of GIS data and other environmental data), a researcher can analyse and determine whether these NbS are effective in achieving multiple goals and where these NbS measures are most effective. Furthermore, various modelling techniques can be explored and used to analyse the data to obtain multiple goals of NbS measures.
Secondly, a scientific study can be conducted to optimise the measures' design, spatial locations and allocations of these measures so multiple goals can be achieved, which can be further built upon from previous research studies.
Thirdly, another way to achieve this optimisation strategy is to involve multidisciplinary studies and experts. The involvement of knowledgeable stakeholders from varying sectors may help by designing the NbS measure in such a way that multiple goals are achieved. Increasing the scale of the NbS measure can be also a way forward so that noticeable benefits of the multiple goals can be observed.
Fourthly, the effectiveness of the measure for the different goals might be limited by the scale of the area it is implemented. The measures might need to be upscaled by implementing more of these measures in the case study region and also in the neighbouring region to have clear and large-scale effects.
Lastly, as the implementation of the measures largely depends on the agreement of the land users/owners, increasing awareness and providing the needed information on the effectiveness and benefits of these measures might convince the land users/owners to implement these NbS.

2. Societal optimisation

The main **strength** of the region is, firstly, the presence of a large network of relevant actors and their broad knowledge regarding the challenges and issues of the case study site. Furthermore, the presence of stakeholder platform(s) for the prioritized societal challenges in Flanders allows the sharing of NbS designs, implementation strategies and lessons learnt thereby triggering transformative change aspects. For instance, the restoration project (i.e. stream restoration) was presented to the GTO (Gebieds Thematisch Overleg), in which different stakeholders were present. The inclusion of different levels of stakeholders also provides a platform for policy regulation frameworks and provides **opportunities** to enhance ecosystem integrity and connectivity, incorporating them into the NbS strategy. Secondly, the NbS measure, i.e. grass-flower buffer strips, is built further upon local initiatives such as "boer aan boord", which is a project that compensates the implementation and management of grass-flower buffer strips along erosion-sensitive agricultural plots through the provincial climate fund. Thirdly, as the implementation of NbS (i.e. grass-flower strips) is based voluntarily participation, the stakeholders directly affected by the NbS implementation have been identified and consulted, and the rights and interests of all participating and affected stakeholders are strongly considered, acknowledged, and respected. This process is due to the existence of legislation. Lastly, there is a strong campaign for the public on re-using resources such as re-using buffer strips cuttings for compost production or possible biogas production.

The main **weaknesses** are the limited involvement of the industry and insurance sectors. Furthermore, local actors (e.g. farmers, and land users) only participate in the project if there is compensation/subsidies. Farmers also don't usually join in stakeholder platform(s), i.e., only their representatives are attending, and there is a need for a one-on-one talk with them to encourage/convince them to implement the NbS. It is also not easy to change the minds of local actors regarding their practices due to the potential losses of land, the lesser amount of manure that can be spread on their land and the fear that they might lose their land to biodiversity and nature. In general, those indirectly affected by the NbS are limitedly identified and consulted. It is challenging to bring all stakeholders together at the table for joint decision-making. Furthermore, the awareness and information of NbS provided to the public may be insufficient. Lastly, there are limited investigations and hard data (financial numbers) on relations between human well-being and healthy ecosystems/nature (e.g. forest, aquatic systems) as well the lack of related experts.

Firstly, **opportunities** arise from the fact that the area is of high priority for obtaining a good ecological status by 2027. Secondly, the case study site is a touristic area, which promotes the implementation of more NbS measures. The implementation of more NbS measures in the region will potentially have a positive effect on the human health and well-being of the locals and tourists. Thirdly, there is an increasing awareness and change of mind among stakeholders (in a good direction) as well as increasing awareness of the effect of nature on health, which is evidenced by the availability of public advisory reports. Fourthly, external factors such as the inevitable impacts of climate change and the increasing energy and water prices. Citizens and local actors will potentially be encouraged and motivated to use NbS to mitigate the impacts of climate change. Energy is becoming increasingly expensive thus there is a need to recuperate energy from different sources including biogas which can be potentially harvested from the cuttings of grass-flower buffer strips. On top of that, there is a general strong campaign to reuse resources and ongoing studies for the potential use of biomass (from plant cuttings) as energy. Aside from energy, water is also becoming more expensive and

scarcer, which necessitates the reusing/recycling of resources. Lastly, there is a strong participation of stakeholders and the increasing existence of multidisciplinary/multisectoral stakeholder platforms, which also provide **opportunities** for the stakeholders to be involved in all processes as well as to be informed or indicate their perspectives on certain policies and regulations. Furthermore, the presence of farmers' organizations provides a platform for providing feedback and grievance resolution related to the NbS planning and implementation. The availability of subsidies and compensation for implementing the NbS measures potentially encourages local actors to implement the NbS and possibly, the positive effect of the NbS will encourage these actors in applying NbS on their lands.

Perceived **threats** result from firstly, whether the community accepts and implements the solutions to the societal challenges and local actors may not be enthusiastic to adopt NbS. Some specific stakeholders (e.g. politicians) are also hard to involve and engage. Secondly, the diverse stakeholders have different priorities and diverse points of view, different opinions, and perspectives. Another **threat** is stakeholder exhaustion due to the increasing number of projects for coordination and implementation and stakeholders do not join the meetings or workshops due to their lack of time. Thirdly, with regards to the local users/actors, various factors may play a role in their scepticism of implementing the NbS. These include the high land value, as well as the economic loss as a result of implementing the NbS, changing of regulations and policies or short-term policies, and other related laws that they are required to comply to. These requirements also results in economic losses or more work which creates additional uncertainty in the future and whether NbS measures are sufficient to comply with the new regulations, distrust on authorities, and the fear of slowly converting their lands into nature. Furthermore, the need for sufficient subsidies and particularly long-term policies and programmes to convince farmers to implement the measures. For example, if there are no subsidies, farmers may stop implementing the measures. The disinterest of some local actors as well as their lack of time might lead to non-participation in dialogues and consultations. Fourthly, with regards to resource reuse/recycling, the amount of biomass that might be potentially harvested from the NbS (i.e. cuttings from grass-flower strips) might be too small in quantity for energy recovery and/or too dispersed in the region that collecting them might be even more costly. Lastly, as monitoring and assessment of the effect of NbS on human health and well-being are needed, this is threatened by the need for an approval of the ethical committee to perform social surveys or related studies, which usually takes time.

Based on these SWOT characteristics **the way forward** for societal optimisation is raising awareness of the benefits of these NbS measures and particularly on its benefits in mitigating climate change to the general public and more specifically to the implementors. Furthermore, talking to the land users/owners in their preferred “language” might be needed to convince them to implement, which is the economic costs and benefits of the measures. To minimize stakeholders' exhaustion from attending numerous meetings and workshops, it is best to organize an efficient and combined meeting with similar projects. It might be also interesting that projects with similar goals connect to be able to learn from each other. To recover as much biomass as possible from the cuttings of some NbS (e.g. grass-flower strips), it is best to organize knowledge-exchange events on how to collect the biomass in the most efficient and less costly manner. Furthermore, it is suggested to optimise NbS measures in publicly owned lands and possibly swapping of lands, i.e. between less productive/high-erosion risk/frequently flooded agricultural land for NbS development and state-owned productive land which will be converted into agricultural land, although this can be challenged by the limited availability of lands in Flanders.

3. Technical optimisation

The main **strengths** are the availability of long-term biodiversity data and the fact that the project site is prioritized for biodiversity gains. Furthermore, there is an adequate monitoring and assessment programme as well as long-standing expertise in data collection at the case study catchment. Thus, the lessons learnt from the monitoring and evaluation are generally included in the adaptive management of the basin. On top of that, the presence of EU legislation obliges the identification and assessment of measurable biodiversity conservation outcomes. The involvement of various stakeholders provides **opportunities** to enhance ecosystem integrity and connectivity, incorporating them into the NbS strategy. Lastly, various NbS measures are already implemented in the past, such as grass buffer strips, afforestation (small patches of forest), installation of fish spawning beds, restoration of aquatic habitats, maintenance and construction of small ponds, planting of shrubs along watercourses, removal of artificial materials to fixate banks, and recently, working with stones and wood and no artificial liners in which some are successful and continued.

The main **weaknesses** are the numerous and various stressors that enter the case study region as a result of the dense population and intensive agricultural production, which affect biodiversity net gain. The numerous and diverse anthropogenic impacts make it difficult to determine the net positive biodiversity gain and the added value of one single type of restoration measure. Furthermore, it is not always possible to disentangle the different impacts and their effects. Though extensive data are available, they are collected using diverse approaches and standards, which challenges the integration and compilation of these data. Furthermore, the data is missing many non-biological/environmental data, impeding a holistic evaluation of NbS of their effectiveness. The number of fixed monitoring points and frequency of monitoring have also decreased over the last years because monitoring and assessment are expensive. Importantly, most previous monitoring and assessment programmes are not always dedicated to the effects of NbS *per se*. Lastly, often, engineers managing the case study region prefer technical solutions for controlling floods as it is more controllable, and results are more predictable.

Opportunities arise from increasing awareness among local users (e.g. farmers) of the impacts of climate change such as drought and floods which encourages them to use NbS measures to mitigate the impacts of climate change such as planting trees to make the drought and heat more bearable for the cattle. Furthermore, the increasing occurrence of floods might encourage residents, and local landowners to change their minds and designate high-flood risk areas for nature development. NbS are also generally cheaper than technical solutions.

Lessons can be learnt from several restoration projects that have been installed or are already finished, and the experience from earlier restoration programmes can be used. Furthermore, the presence of a multidisciplinary platform can aid in the identification and incorporation of various NbS measures to enhance ecosystem integrity and connectivity. With regards to monitoring and assessment, this can be done via master students or/and PhDs thesis to reduce the costs and to be able to conduct studies of which NbS are effective for the region. Although technical solutions are preferred by some case study site environmental managers, these solutions are not always optimal for every issue. For instance, it is hard to think of a technical solution to mitigate the impacts of diffuse nutrient runoff from agricultural fields. Moreover, flood control buffer basins are increasingly considered and/or implemented to mitigate the impacts of flooding.

Perceived **threats** result from local users/local stakeholders who may not be enthusiastic to adopt NbS such as the grass-flower buffer strips, and riparian forest buffers. With respect to monitoring and assessment, they are expensive and some variables to be monitored (e.g. fish, social surveys) may need licencing and permits or approval from the ethical committee, which may delay the monitoring programme. Moreover, the NbS implementor has time constraints to do the monitoring and a potential lack of expertise in monitoring some elements. Due to the previously mentioned issues adaptive management and use of varying NbS as well as the adoption of NbS rather than technical solutions might be delayed or challenged.

Based on these SWOT characteristics, **the way forward** for technical optimisation is by integrating agriculture and nature as well as urban and nature as in the current spatial planning, locations assigned to nature, urban and agriculture are separated. The current climatic situation such as increasing drought or floods encourages the integration of nature and agriculture as farmers are becoming more and more interested in integrating nature into their lands to mitigate the impacts of climate on their livestock as well as crops. Other NbS such as forest buffer strips can be implemented in NGO-owned or state-owned lands. With regard to optimising the use of varying NbS, it is important to know their benefits from a broader perspective. The benefits of NbS can be determined if there are standardized and integrated multidisciplinary data (e.g. environmental, human well-being, economics) and collaboration with experts from different fields such as economics and social scientists, which is a way forward to the assessment and adaptive management of the NbS measures important. Furthermore, to reduce the costs of monitoring and assessment, students/interns are provided with topics including assessment of NbS.

4. Economic optimisation

The main **strengths** are the availability of funds for NbS implementation from the government and the EU. Trade-offs between different goals (e.g. increasing biodiversity and agricultural production) are acknowledged and taken into account. To limit these trade-offs, only those areas that need the NbS (buffer strips) are prioritized such as agricultural fields of high-erosion risk. Due to legislation, the rights, usage and access to the land of stakeholders are acknowledged and respected.

The main **weaknesses** are industry sectors/insurance companies which are limitedly involved and limited funding from the industry sector for the implementation of these measures is available. Probably the industry sector doesn't see an economic benefit from these measures (yet). Furthermore, there are no concrete cost-benefit analyses conducted, no insurance for the NbS and no long-term funding is in place, i.e., there is no structural funding provided and it goes from project to project, normally on a 2-3 yrs. basis with annual renewal of contracts.

Opportunities arise from the funding of NbS measures via future projects (research/government/EU) such as the Blue deal programme. Furthermore, researchers from the economic sectors might be interested to study the cost-benefit and economic feasibility of NbS as the information on the economic costs and benefits of implementing NbS may encourage the industry and agricultural sectors. Furthermore, a potential increase in tourist activities will increase economic activity in the region and the potential increase in pollination services may enhance agricultural productivity increasing income, although it is difficult to quantify the effect of pollination and agricultural productivity.

Perceived **threats** result from the low interest of private sectors in implementing the NbS measures. The high land value, as well as the economic loss, will discourage farmers to implement particularly the buffer strips. Additional costs for the land users (i.e. farmers) for the maintenance of an NbS (grass-flower strips) is the need for labour costs. NbS might be too small in terms of scale and might have limited effect on tourist activities, economic returns and enhancing agricultural production.

With respect to the situation in the case study area, the economic/funding aspects have the lowest importance as being the bottleneck for the implementation of NbS measures. Other factors are far more important such as

the willingness of the farmers to implement the NbS measure (e.g. grass-flower strips, forest buffers). So far, funding is available but for these measures to be implemented, landowners/users must first be convinced to implement them as most of the land in Flanders (Belgium) is privately owned. Farmers can either give up their land by selling it to the state or they participate in implementing the NbS. However, selling the land to the state is seldom done in Flanders as farmers generally need the land to spread manure on; otherwise, the farmers will have to reduce their livestock with less land available. In Flanders, every inch of land is already used. Although land swapping (with the Flemish land Agency) is being done, it is difficult, due to the high usage of land and the case study area doesn't have so many **opportunities** for land swapping, which is one of the big challenges as there is the dense network of roads/urbanization of the area.

However, based on the SWOT characteristics indicated above, **the way forward** for economic optimisation is perhaps by enlarging the area where the NbS (grass-flower buffer strips) is implemented making it larger stretches for facilitating biomass harvesting and fertilizing lands with the harvested material. It is also important to conduct a cost-benefit and economic feasibility study of NbS measures to be implemented in the area. For example, there is a need to look better into the (economic) benefits, and a need to get the numbers for this. These numbers might be difficult to obtain (also from literature) as there are a lot of aspects that need to be quantified to show the economic benefits of an NbS, but this is possibly doable.

5. Policy/regulation optimisation:

The main **strengths** are the presence of EU legislation which is translated by the Flemish region such as the Nitrates Directive, Water Framework Directive, Floods Directive, Habitats Directive and 2nd pillar of EU Common Agricultural Policy. These laws facilitate the implementation of NbS measures through the river basin management plan and rural development programme in Flanders. NbS measures were indicated in the 2nd river basin management plan such as creating new water retention capacity by using floodplain, elimination of fish migration barriers, structure restoration of riverbeds and measures from the Sigma plan which are the creation of wetlands, de-poldering certain areas. The 3rd rural development programme of Flanders indicates site development of Natura2000 areas and afforestation, which provides compensation, support, and subsidies.

Farmers with high-erosion-risk agricultural lands are obliged to adopt measures (e.g. NbS) to combat erosion. There is the existence of a programme (i.e. the Blue Deal programme) that supports the NbS measures for drought and water scarcity by restoration of areas that naturally retain water: peatlands, wetland forests, valley and swamp areas and moist grassland as well as the development of green-blue infrastructures with ponds, wadis, buffer basins, watercourses, banks as blue elements and hedges, trees, natural grasslands, parks, gardens, green roofs, green facades as green elements (*c.f.* link). These measures make the area work like a sponge again. There is a regulation that grants an allowance for the construction and management of grass (flower) strips along erosion-sensitive agricultural parcels in the province of East Flanders through the climate fund which can be executed on May 2021 to March 2025. This regulation facilitates the implementation of grass-flower buffer strips in the case study region. On top of that, the Flemish government is providing subsidies for small-scale erosion control works such as for dams from plant materials, earth dams with erosion pools, buffer basins, wood edges, recovery of slopes (*c.f.* link), grass corridors and grass buffer strips. Furthermore, the inclusion of different levels of stakeholders provides a platform for policy regulation frameworks.

Among the main **weaknesses** are the plans of using technical measures as indicated in the River Basin Management Plan which is creating new water retention capacity by using dikes and water level management, broadening certain water bodies, pumping stations and infrastructural works. Policies or regulations are generally on a short-term basis such as the regulation on granting an allowance for the construction and management of grass (flower) strips which is about 4 years.

The **opportunities** arise from the presence of multi-stakeholder platforms to inform or indicate their opinion/perspectives on certain policies and regulations. The new EU Green Deal and upcoming EU Restoration law will facilitate the development of laws prioritizing NbS measures. There is a regulation that farmers cannot plough, use pesticides, and grow crops at least 1 m from the watercourse. This provides an **opportunity** for allocating this area for buffer strips.

The perceived **threats** result from the policies that keep on changing and/or short-term policies. Furthermore, there is a need for sufficient subsidies to convince farmers to implement the measures and must be incorporated in the development/adaptation of the law as with the absence of subsidies/compensation, farmers most likely stop implementing the measures. Despite the existence of regulations and related subsidies and compensation, if the land is privately owned, the implementation of most NbS restoration measures will depend on the willingness of the land users/owners or if they are willing to give up their land. They will only be able to decide based on concrete and clear information on what will be done to the land afterwards and how much compensation they get. Lastly, another perceived **threat** is the new regulation "Common Agricultural Policy" which will come into place starting on 1 January 2023. This poses a **threat** now because the specific details are unknown and thus farmers are waiting to see if buffer strips are an accepted measure or whether other options are available with this new regulation. This leads to hardly any agreements being made at this point.

Most of the described SWOT analyses were based in the Zwalm River basin (Figure 24).
Based on these SWOT characteristics **the way forward** for policy/regulation optimisation is to develop or adapt a clear, good and decent legal framework that provides stability to the farmers and sustainable adoption of the NbS measures which has a long-term view and not on a short-term basis (i.e. 2 years, 3 years). It is important to consider and contemplate the incompatibilities between legislations as well as the trade-off between varying goals. Furthermore, another strategy for optimisation is to perform research-based analyses of existing policies and recommendations to improve these policies so that more local users/actors will be encouraged to implement NbS measures. Raising awareness of the existing policies to the potential implementors of the measures is to be ensured.

Figure 24 The Zwalm River basin. Most of the SWOT analyses were based on this basin. Photo obtained from Goethals, P., & De Pauw, N. (2001). N.B. Some elements in the SWOT refer to the whole Scheldt basin. Some of the SWOT analyses were also based on the Flanders region of Belgium.

3.2.6 Case study 17 Forth (UK Scotland)

Authors: Iain Sime (NatSc), Huw Streater (Forth River Trust), Amy Pickard (UKCEH), Peter Hunter (USTIR)
NatSc: Scottish Natural Heritage
UKCEH: UK Centre For Ecology & Hydrology
USTIR: University of Stirling

Forth catchment

The Firth of Forth catchment is an iconic place for Scotland and it has driven industry over the centuries. The Forth catchment spans a wide area covering over 3000km² and is home to roughly 25% of Scotland's population together with a wide range of wildlife (Figure 25). Within the Forth catchment are rivers and wetlands of international importance including the River Forth and its tributaries which support significant Atlantic salmon populations and Flanders Moss – the eastern part is the largest raised bog to remain in predominantly natural state in Europe. Within this case study, the implementation of NbS is focusing on river restoration in the Allan Water, a major tributary of the Forth, and various peatlands including a site to the south of Edinburgh (Figure 26). It therefore contributes to both the MERLIN cluster 'peatland and wetlands' and the MERLIN cluster small streams and basins.

1. Multiple goals optimisation

This case study is unique in MERLIN, in spanning two cluster groups – peatland and river restoration. However, the main goal of the case study is, via the restoration of peatland and river habitat, to improve biodiversity and climate change adaptation. This is the focus for the project where the funding and the implementation is managed by the combination of NatureScot (national public body) and the Forth Rivers Trust (local on-the-ground catchment management organization). Climate change effects are being addressed by; seeking to increase sequestration of CO2 in functional peatland habitat, using the NbS to help with flood management, and of increasing relevance and priority in Scotland, using NbS to sustain flow regimes during drought periods.

The main **strengths** are: the case study spans both peatland and river restoration, offering a unique opportunity to maximise multiple benefits (e.g. water quality and water flow) in a catchment continuum. This has the potential to maximize complimentary benefits, and impact, at scale. Within the Forth catchment there are already stakeholder groups, which the MERLIN case study is building upon, to achieve a good measure of inclusive governance.

The main **weaknesses** are: the case study working group is less familiar with the quantification and measurement of societal related goals and is conscious that the focus thus far has been on environmental measurements. Some of our restoration sites are in an unusually managed location, where the local landowner is pursuing less agricultural activity. This lessens the extent to which multiple benefits for sustainable food systems can be explored on particular parts of the Forth catchment where MERLIN is operating.

Opportunities arise from: to date, the focus of the case study has been on the flooding and carbon sequestration aspects of climate change. However, the restoration measures to improve flood management provide potential to sustain flows during droughts. A recently published review on that topic, for peatlands, provides the opportunity to help the case study realise that multiple benefit for climate change (Hare et al., 2022).

Also, as delivery is completed at one site it will lead on to potential future projects through demonstrating the multiple benefits arising at the original site to other landowners, and the availability of other funding streams, thereby enabling upscaling.

Perceived **threats** result from: Climate change effects (like the drought we experienced in 2022) meaning that benefits are not realised and measurable over the time frame of the project. Perhaps climate change means that NbS measurement periods need to be reviewed in a high-level way.

The way forward is: Co-location of restoration sites within the same subcatchment if possible, to maximize optimisation/synergistic opportunities.

Collation of comprehensive evidence on multiple benefits may be used to demonstrate importance of rigorous monitoring. Unlike MERLIN, most national funding schemes don't support monitoring costs (or if they do they are small) so these data could help to change the funding landscape accordingly and maximize the impact from the case study. This is of real importance given the emergence of e.g. carbon credits, nutrient trading where quantitative data is needed to back investment.

2. Societal optimisation

Parts of the Forth catchment where MERLIN is active (the River Allan subcatchment) has an established history of exploring the use of NbS to try and help manage flooding. MERLIN is building upon this strong basis, to extend the NbS and upscale the use of NbS for flood management. However, there is an increasing awareness that the same restoration techniques that can help society adapt to increased flood risk can also help sustain

flows during periods of drought – bringing multiple societal benefits such as sustained water supply, reducing potential effects on fisheries, sustaining important biodiversity.

The main **strengths** are: flooding has already been identified as a major societal issue in the area through public consultations and was the genesis of the stakeholder group working on river restoration – this can be extended to include peatland restoration and potential benefits of keeping more water on, and in, the peatlands to ameliorate flood peaks.

The planned works are within the context of prioritization by the Local Authority for affected flooded areas.

There are already local stakeholder groups such as the Allan Water Steering Group (who help coordinate and facilitate action and include decision making/regulatory bodies) who are active in contributing to the discussion of projects taking place in the area. Staff involved with the MERLIN project on the Allan Water already have good existing relationships with several individual local landowners, including a large estate that owns much of the land that the Allan Water passes through where restoration works have already taken place. This landowner has indicated interest in continuing to support restoration works in certain areas.

The main **weaknesses** are: There is currently a lack of close links to all affected parties, in particular the local communities downstream of the NbS works. This is simply a result of the fact that projects that have already taken place in the area have not had the resources to engage with local communities at large. Creating public awareness of projects and works taking place beyond simply through online communication tools is something that the previous projects' funding and time allocation has not allowed for. The works in the area have not been in areas frequently or commonly accessed by the public, which has meant that general public engagement with the project has not been of high priority.

The stakeholder groups do not currently include individual landowners and yet the project relies on the wills of landowners, which differ and affects the degree to which all stakeholder inputs can be considered.

Opportunities arise from: making greater connections to local communities as an affected party, through public engagement in MERLIN workshops and throughout the period of the restoration works, with the opportunity for them to have a direct input on the project. This will be key to scaling up restoration efforts across the catchment.

There may be **opportunities** to promote the restoration works – such as site visits, volunteering opportunities with other organisations, and the potential for citizen science programmes such as monitoring of wading birds on newly created wetlands. Thereby they contribute to human health and wellbeing by encouraging physical activity and experience of local wildlife and natural areas. While the local community upstream of the proposed initial river restoration works may be able to be engaged with the works, that community suffers from its own flooding issues and therefore there is the opportunity during the upscaling of works in the catchment to engage with them on a later phase when looking at their flooding issues from a different set of streams.

There are also opportunities to build upon experiences elsewhere in Scotland (e.g. Aberdeenshire and soon to be established 'Investment Ready Nature Scotland' project, and in other EU projects (e.g. NAIAD)), to explore with the insurance industry, the potential for payments from downstream beneficiaries (those at risk of flooding) to facilitate upstream NbS that helps reduce flood risk.

Perceived **threats** result from: Some local stakeholders can struggle to consider or accept Nature Based Solutions as an important or viable component of flood management due to both the perception that NbS are not as tangible as other engineered solutions such as flood embankments, and the lack of empirical evidence to demonstrate the NbS contribution to flood management.

If we fail to build and expand upon current relationships with stakeholders, then the important relationship with local communities will remain underdeveloped which could compromise optimisation of health and wellbeing and inclusivity.

The way forward is: To continue to foster the current relationships with stakeholders in the project area; to create and develop new relationships with more landowners to aid with future upscaling of works in the area; to create stronger links with the local communities (particularly downstream) of works, and try to allow the opportunity for direct involvement, e.g. through volunteering activities and citizen science projects as well as effective interpretation material. This would allow for strong feedback and communication throughout the project with affected communities, as well as contributing to their health and wellbeing in a more direct way on an individual level than solely through reducing flood risk in the community.

3. Technical optimisation

Action to restore and conserve peatlands is taking place across Scotland. The approach mirrors the restoration techniques that will be employed by MERLIN, building on the results and methods developed elsewhere. In the Forth the **strength** is the **opportunity** to integrate the MERLIN restoration of rivers and peatlands with the much wider establishment of sensor networks within the Forth Environmental Resilience Array and therefore better understand the multiple benefits of restoration.

The main **strengths** are: In establishing links between MERLIN implementation and monitoring of NbS, with wider monitoring arrays across the catchment there will be better understanding of benefits to key Green Deal indicators including biodiversity, climate regulation, flood resilience, and drought resilience. This provides the

opportunity, particularly the extra resources that can be used, that is envisaged to allow the case study to explore a tiered approach to monitoring benefits across the catchment. For example, with flux towers at some key peatland restoration sites and less intensive techniques at more restoration sites.

The main **weaknesses** are: There is a risk that monitoring to date of NbS, particularly prior to restoration, means there is a lack of comprehensive data to evaluate the effectiveness of NbS on some indicators. This is being addressed by using paired monitoring with control sites and seeking to utilize the **strength** of the wider sensor network being established across the Forth catchment.

Opportunities arise from trialling the use of different sets of NbS e.g. leaky dams (which are used to retain water in channels and disperse the water onto the floodplain), plastic piling (to block drainage ditches on peatlands and raise the groundwater level) and monitoring their (combined – synergistic and additive) effectiveness. This **opportunity** arises for river restoration in relation to both the existing work that has been done on the Allan Water, and the potential to upscale the work to more areas of the catchment. A PhD student from Heriot Watt University is starting later this year and working with the Forth Rivers Trust will be looking at the effect of how Natural Flood Management interventions combine together and propagate through the river system.

Perceived **threats** result from: A number of potential peatland restoration sites include proposed forest to bog restoration. This is a common situation in Scotland/UK, but less typical across Europe. Therefore, any lessons and results from this case study, while being applicable to elsewhere in the UK, may not have such an impact across Europe. More specifically with forest to bog, an identified **threat** is that after restoration has taken place, there is long term need for maintenance to remove reseeding conifers that could **threat**en the long-term restoration of peatland habitat.

The way forward is: The Forth-ERA programme is establishing a digital twin of the Firth of Forth catchment by combined data streams from networks of sensors, satellite observations, and models. The Forth-ERA platform will support new and innovative approaches to environmental monitoring, management and regulation supporting use-cases across a variety of thematic areas. The Forth-ERA use-cases currently include work on monitoring peatland restoration projects and floods and droughts. The peatland restoration use-case is developing new approaches to measuring the success of projects in terms of the net environmental benefit, not only in terms of carbon capture, but potentially also flooding and biodiversity. The floods and droughts use-case is developing an extended monitoring network to capture change in water storage and flow across the catchment and to provide the data needed to support immediate-term flood risk alerting and long-term flood scenario model.

Forth-ERA will therefore provide a blueprint for how digital twins can be used to support nature restoration goals whether by supporting the evaluation of existing management interventions including nature-based solutions or by facilitating **opportunity** mapping for new restoration programmes. In this manner, initiatives like Forth-ERA can help optimise investments in nature-based solutions will also demonstrating the return on investment of such investments.

4. Economic optimisation

The main **strengths** are: There are funding streams available for river restoration work and separate funding options for peatland, both through NatureScot and the Scottish Government; NatureScot's new Investment Ready Nature Scotland project will encourage applications from projects that need funding to develop them to a stage where they have the potential to secure private/green finance. This is due to start in 2022, with the aim of improving access to green finance within the timescale of the MERLIN project.

In particular river restoration examples there is also the potential to contribute to the circular economy indicator by using felled trees and other natural products to block ditches on peatlands, and/or to promote remeandering and river restoration on the Allan Water.

The main **weaknesses** are: There is less funding available for river restoration than for peatland restoration under current funding mechanisms. Currently funding for river restoration measures has to be applied for through multiple schemes and applications.

One **weakness** at present is also that the main landowner along the Allan Water is atypical, as agricultural activity has largely stopped in the area where restoration is due to take place. This makes applying lessons to elsewhere and exploring the potential for optimisation with agriculture more limited at that location.

A constraint to upscaling at present is that the processes for applying for funding through these schemes is different for each, with different amounts of time and information required for each type of application. An example of the current system is that in the last two years FRT has been involved with six different river restoration works, and they were funded through five separate schemes. This increases the time and resources required for application for further restoration works funding.

Opportunities arise from: Within the Forth catchment there is the potential for more integration with emerging green finance development; the MERLIN resources offer the **opportunity** to explore working with key landowners and encourage them to adopt the NbS being implemented by MERLIN using other funding sources – particularly carbon credits for peatland restoration. Landowners are very interested in gaining accreditation for carbon credits associated with restoration, and therefore gaining long term financial returns, well beyond initial capital investment. There is potential for a more streamlined funding pot for landscape scale land

management, which could make the process of sourcing and securing funding much faster and easier and allow for more efficient use of staff time for the actual delivery of more work on the ground. Also, many funding sources require match funding and being able to utilize MERLIN capital funding as a match funding resource for other schemes would increase the amount of funding available to be applied for overall, with the end result of allowing more restoration work to be done on the ground throughout the course of the project.

Perceived **threats** result from: There is a lack of engagement of some landowners with the Scottish Government's Agri-Environment Climate Scheme (AECS). Often this is due to the process for applying being long and over-complicated, and the rules and limitations often putting off landowners from engaging with it.

The way forward is: to re-examine the potential for green finance as a funding stream, particularly by improving linkages with WP3 and WP4 of MERLIN, and during the Investment Ready Nature Scotland project, which is due to complete in 2023.

To examine the potential means by which MERLIN resources can be used to support landowners to more rapidly gain accreditation for carbon credits for NbS of peatland restoration, using green finance and thereby sustain and upscale restoration. This will provide a long-term economic income for landowners, in contrast to current situation where they often only receive capital funding for the actual implementation of NbS.

This will provide a means for the case study to contribute to Green Deal indicators on financing the transition and green growth.

5. Policy/regulation optimisation:

The main **strengths** are: The rich funding landscape available for peatland restoration at the Scotland scale should enable upscaling simply due to the restoration targets that are in place nationally. A new Scottish Biodiversity Strategy, and associated funding is also expected to benefit the potential to upscale river restoration. There are opportunity maps for the Forth catchment to help identify and promote wetland and peatland restoration.

The main **weaknesses** are: We're already struggling to identify peatland restoration sites (ironically due to Peatland action funding everything or owner reluctance). This is delaying the implementation of peatland restoration action by MERLIN in the case study beyond year 1. We are exploring why this ironic situation has developed and trying to learn from it.

Within Scotland generally, and within the Forth catchment sometimes landowners have tenants that work and manage the land, which makes discussions more difficult – there is a wide arrangement of tenure settings. This can create differences in 'who does the work' vs 'who benefits' and 'who manages' associated with the distinction between owner/tenure - this can create a hindrance in taking forward **opportunities** for restoration.

While there are **opportunity** maps that help generate partnerships for restoration (e.g. based on topography and land use), land ownership is an important aspect and can confound the potential for restoration. Overcoming reluctance to undertake NbS or improve any poor relations between tenants and landowners takes time and is challenging – hindering rapid upscaling.

Opportunities arise from: Looking into understanding the need for complementary funding to support and maintain restoration, rather than limiting funding to direct restoration works. An example could be a payment scheme for farmers who are removing livestock from land during restoration works, or a long-term restoration maintenance scheme fund to ensure that the restoration successes continue to be realized.

While there is an established carbon credit scheme in place to support the restoration of peatlands, there is no such scheme for other freshwater restoration such as rivers or lochs. Work is underway to develop a metric in Scotland to support freshwater green finance credits. There may be an **opportunity** for the case study to explore applying that scheme during MERLIN.

Perceived **threats** result from: At present, public funding for river and peatland restoration must be applied for through multiple schemes and applications. A policy action to take a more streamlined approach for landscape scale land management could make the processes much easier and allow for more efficient and incentivized use of time for project delivery.

The way forward is: Bringing together relevant partners to understand how Scottish (and EU) policies on Biodiversity and climate change can be best adapted to aid local implementation?

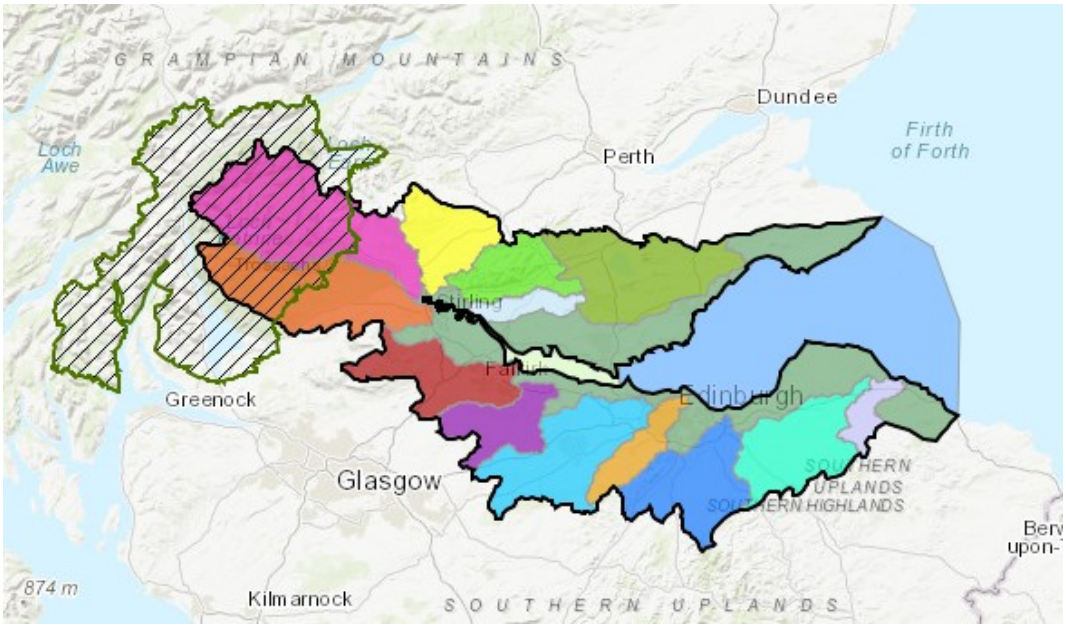

Figure 25 Forth catchment (with subcatchments in separate colours and Loch Lomond & Trossachs National Park in hatching). The SWOT was based on a whole catchment assessment. From Forth Rivers Trust

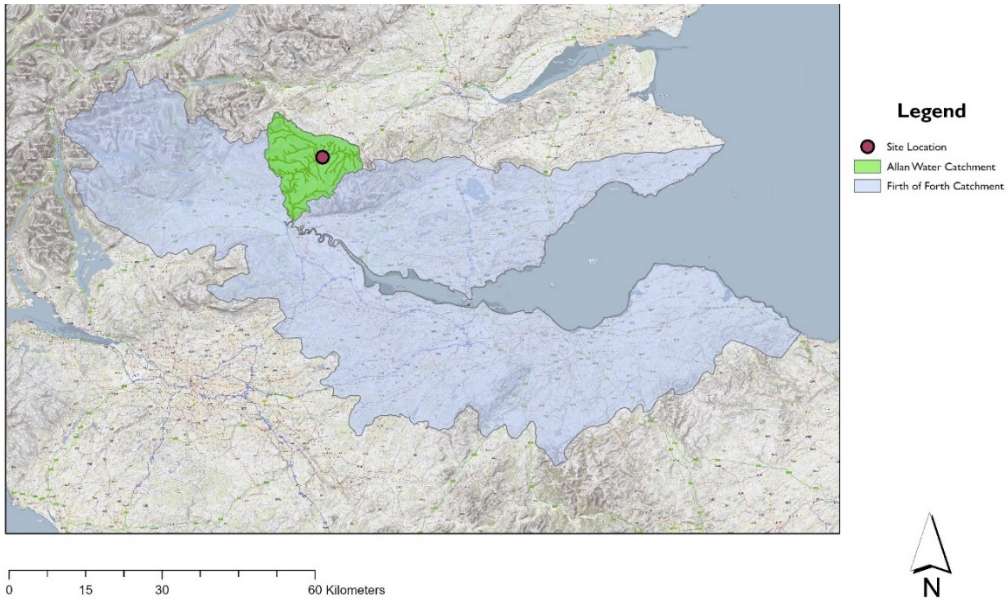

Figure 26. Catchment map of Allan Water works with the implementation site.

3.3 Cases per cluster large rivers

3.3.1 Case study 4 Room for the Rhine branches (Netherlands)

Authors: Marieke de Lange (RWS), Gertjan Geerling (Deltares) & Eline Wijnen (RWS)
RWS: Ministerie van Infrastructuur en Waterstaat (Ministry of Infrastructure and Water Management)

1. Multiple goals optimisation

The main **strengths** are that the Room for the Rhine branches (RfRB) programme had two goals, that were equal in importance: flood risk reduction and spatial quality/restoring nature in floodplains. RfRB programme was specifically intended to combine multiple projects into a single strategy for the overall Rhine branches in the Netherlands and recognized the role of stakeholders up- and downstream of individual measures (Figure 27). The effectiveness of individual measures was assessed within the larger framework of the full programme of complementary measures along the Rhine branches. A thorough process with external stakeholders (inhabitants, farmers and terrain management organizations) in the area was conducted to show the impact of individual measures locally to build understanding and discuss potential concerns.

In the current context the main **weaknesses** are that the focus of the RfRB programme has been limited to flood resilience, spatial quality and nature development, while drought resilience, freshwater supply and navigation were not considered. Further, the impact on health and well-being was not a big issue, nor was zero pollution goals or sustainable energy production. The RfRB programme was set up after extremely high-water levels in Dutch rivers in the 1990s, while todays challenges involve a wider range of problems that were not yet fully recognised when the RfRB programme was developed. During the stakeholder consultation, not all experts of various backgrounds were consulted in the various phases of the implementation of this long-term process (e.g. on potential impact of morphological change on navigational sector) and not all stakeholders were equally important (e.g. agriculture received more attention than residents). Possible relocation of local inhabitants is furthermore quite expensive.

New **Opportunities** arise from the new Dutch Integrated River Management programme (IRM) and the Delta programme that both embrace a wider scope than RfRB. Furthermore, the European Green Deal provides new challenges in reaching multiple goals within a given area. The concept of Smart Rivers proposes a new method called 'quality relay' (‘kwaliteitsestafette’), in which inclusion of experts of all disciplines is ensured during all phases of a project. Furthermore, wellbeing by recreation in floodplains and associated lower burden on health budgets is a new driver for nature development.

Perceived **threats** result from increased impact of climate change, that may increase flood and drought risk to a level beyond what was designed for in the original plans and can lead to partially unknown changes in discharge patterns due to more extreme weather. There is a potential conflict with the GD goal on sustainable transport (increase in inland navigation and navigability during low discharges might request weirs) and the GD goal on biodiversity (construction of weirs is in contrast with the GD goal on free-flowing rivers). Further, the GD goal on health and well-being might increase the recreation pressure on biodiversity. The GD goal sustainable food systems (farm to fork) may also conflict with nature goals, mainly because space is still limited in our river systems (i.e. space used for agriculture, even nature-inclusive agriculture, cannot be used for nature).

Based on these SWOT characteristics, **the way forward** for multiple goal optimisation is to include drought risks in the climate scenarios, and to broaden the scope and include goals on biodiversity net gain, sustainable transport, health & well-being and sustainable food systems. The concepts of the RfRB are now implemented in the new IRM programme (Integral River Management). Within IRM, regional governments and central government work together, based on a single shared vision, on a safe, navigable, vital and attractive Meuse and Rhine area. In this programme the rivers are considered as one system, where they consider more interests such as flood protection, river nature, navigability, freshwater availability and recreation, making the whole river system robust for the future. Furthermore, to have all functions cared for, we need to have all representatives on board from the start of the planning phase of each project and keep them involved during the whole timeline of the project. This can only be achieved when roles and functions of each organization is clear, and expectations of stakeholders are managed in a transparent way.

2. Societal optimisation

The main **strengths** are that the needs of local inhabitants, such as the need for new housing (relocation/new houses) when measures are implemented was openly discussed with all relevant stakeholders. This was provided a thorough process with external stakeholders (inhabitants and terrain management organizations) in the area, to show the local impact of individual measures, build understanding and discuss potential concerns. This resulted in a large appreciation for improving the spatial quality in the floodplains through to the RfRB programme. Combining goals of flood risk management, attractive landscapes and nature restoration has helped make the programme successful.

The main **weaknesses** are that health and well-being were not a clear goal of the RfRB programme, and therefore they have not been monitored in a structured way. For health, for example, the role of re-wetting

might contribute to an increased burden of mosquitoes, but this has not been assessed. The increase in nature value and positive effect on recreation was also not monitored in a structured way.

Opportunities arise from the experiences in COVID-19 crisis, which showed the increased need and appreciation of people to recreate in their near areas. The RfRB projects can cater for more recreational activities if managed well. The wellbeing by recreation in floodplains and associated lower burden on health budgets and can be seen as a new driver for nature development. This is not yet fully incorporated in IRM and can be regarded as an **opportunity**. Another **opportunity** lies in the more integrated approach of IRM, in which a systemic approach of different landscape layers is followed, e.g. the geophysical base layer, the network layer, and the occupation layer (van Schaick & Klaasen 2011). When this approach is followed, it will ensure that the different layers are better connected, which will enhance societal optimisation.

Perceived **threats** result from the excessive recreation pressure which can have negative effects on biodiversity. Another **threat** is that when several goals and functions are combined, that the functions that have no own funding might have a lower priority.

Based on these SWOT characteristics, **the way forward** for societal optimisation is to take goals for health and well-being into account, involve stakeholders from the start and ensure that a monitoring plan for such goals is in place from the start onwards. IRM has ambitions for better stakeholder involvement, guided under the upcoming new Environmental law. The integration of NbS as standard way of working in IRM would also be beneficiary.

3. Technical optimisation

The main **strengths** are the available strong scientific, quantified backing of the flood risk challenges and measures. The RfRB programme was specifically intended to combine multiple projects into a single strategy for the entire Rhine branches in the Netherlands and recognized the role of stakeholders up- and downstream of individual measures. Each project can consist of multiple individual measures (Figure 28, Figure 29). There is a knowledge base on ecosystem status (WFD, N2000) and pressures of degradation available. Moreover, monitoring is done for the hard technical goals (flood safety and navigation).

The main **weaknesses** are that there were no key performance indicators (KPIs) on biodiversity goals defined at the start of the programme, nor tailored on biodiversity gain. Monitoring was not part of the programme, though individual projects were monitored for biodiversity haphazardly. Nature-based solutions were not the 'default' option in the programme. When chosen, that was based on lower maintenance costs, not biodiversity gain. Still, maintenance costs were not a regular part in the comparison of the project alternatives.

Opportunities arise from the new Dutch Programmatic Approach Large Waters (PAGW) programme (https://www.pagw.nl/ in Dutch only) that can help support enhanced ecosystem integrity and which is based on a NbS strategy. KPIs for 'biodiversity' are developed as part of the PAGW and are adopted in projects with WFD synergy (based on WFD assessment system). The PAGW focusses on improving the ecological water quality and strengthening the nature of the large inland, estuarine and coastal waters in the whole country. These large waters are shown in *Figure* , where MERLIN overlaps with the Large Rivers cluster. The projects that are developed in the large rivers are part of the IRM programme. Rijkswaterstaat , Staatsbosbeheer and the Netherlands Enterprise Agency (RVO) are working together on the PAGW commissioned by the Ministry of Infrastructure and Water Management (IenW) and the Ministry of Agriculture, Nature and Food Quality (LNV)[1]. The PAGW, as part of IRM, is developing a new set of technical measures, as an improved 'toolkit'. This includes reversing riverbed erosion, improved interaction between river water levels and floodplain groundwater levels, improved management of floodplain inundation patterns, such as rewetting floodplains.

Perceived **threats** result from the scale of the current monitoring: the scale of the WFD monitoring for ecological status does not pick up changes in the status of individual projects. Although the positive resonance of the PAGW programme, funding is still an issue, and collaboration may be hampered.

Based on these SWOT characteristics, **the way forward** for technical optimisation is to ensure that professionals from different fields collaborate from the start onwards. It is important to carry out monitoring in similar fashion as before the project was implemented. The current impact of the climate crisis combined with biodiversity crisis encourages the development of nature-based solutions.

4. Economic optimisation

The main **strengths** are that Cost Benefit Analysis was carried out in individual projects. The combination of goals of flood risk management and spatial/environmental quality has helped making the project successful.

The main **weaknesses** are that on programme level, only costs were evaluated, not the benefits. The focus on cost effectiveness only leads to a narrowed scope and did not reflect the multi-functionality of nature-based solutions. Natural restoration was not the core of the project and presumably resulted in less optimal choices for river floodplain restoration.

[1] https://www.pagw.nl/over-het-programmema (accessed: 31-10-2022)

Opportunities arise from external parties (such as the partnership of six organizations in Living Rivers; https://www.levenderivieren.nl/) who performed CBAs for their alternative design scenarios (on programme level). The recent strategy 'Panorama Gelderse Rivieren' of the province of Gelderland for spatial development, combining economic development with increased nature values, is also an **opportunity**.

Perceived **threats** result from the low interest of private sectors in co-financing NbS measures when public funds may not be enough. The economic costs of NbS might outweigh the economic benefits, thus, private sectors won't be attracted to invest.

Based on these SWOT characteristics, **the way forward** for economic optimisation is to make improvements on the available methods and approaches in performing CBAs in which the benefit of nature is better incorporated.

5. Policy/regulation optimisation

The main **strengths** are the experiences with the RfRB programme and available knowledge on governance of long and complicated projects and stakeholder involvement and management.

The main **weaknesses** are that individuals may not feel represented by their representatives in management boards and stakeholder boards.

Opportunities arise from the potential positive effect of the NbS that will encourage local stakeholders to implement the NbS. The presence of multi-stakeholder platforms to inform or indicate their opinion/perspectives on certain policies and regulations. Further, the inevitable impacts of climate change will potentially encourage citizens/actors to use NbS to mitigate to these impacts. The IRM programme can be regarded as an **opportunity**, because it has a long-term aim for healthy river systems in a changing climate.

Perceived **threats** result from when solutions are sought to cater for too many functions, resulting in a solution that does not fit any function. Another **threat** is that EU policies or guidelines (i.e. Green Deal goals on biodiversity and free flowing rivers) are not (yet) implemented in Dutch policies and regulation. The IRM programme, under the upcoming new Environment law, can also be a **threat**, because the focus of IRM is on riverbed erosion and flood safety and not nature, whereas the outside world considers it an integral programme including nature.

Based on these SWOT characteristics, **the way forward** for policy/regulation optimisation is to develop a clear legal framework that provides stability to the stakeholders and has a long-term view and clear, undisputable goals for nature. Furthermore, another strategy for optimisation is to raise awareness of the existing policies to the potential implementers of the measures.

Figure 27 Map with all Room for the Rhine projects, on which the SWOT analysis was performed. Ruimte voor de Rivier (2015, August 25). Dutch Water Programme Room for the river. Issuu. Retrieved October 31, 2022, from https://issuu.com/ruimtevoorderivier/docs/projectenkaart_engels

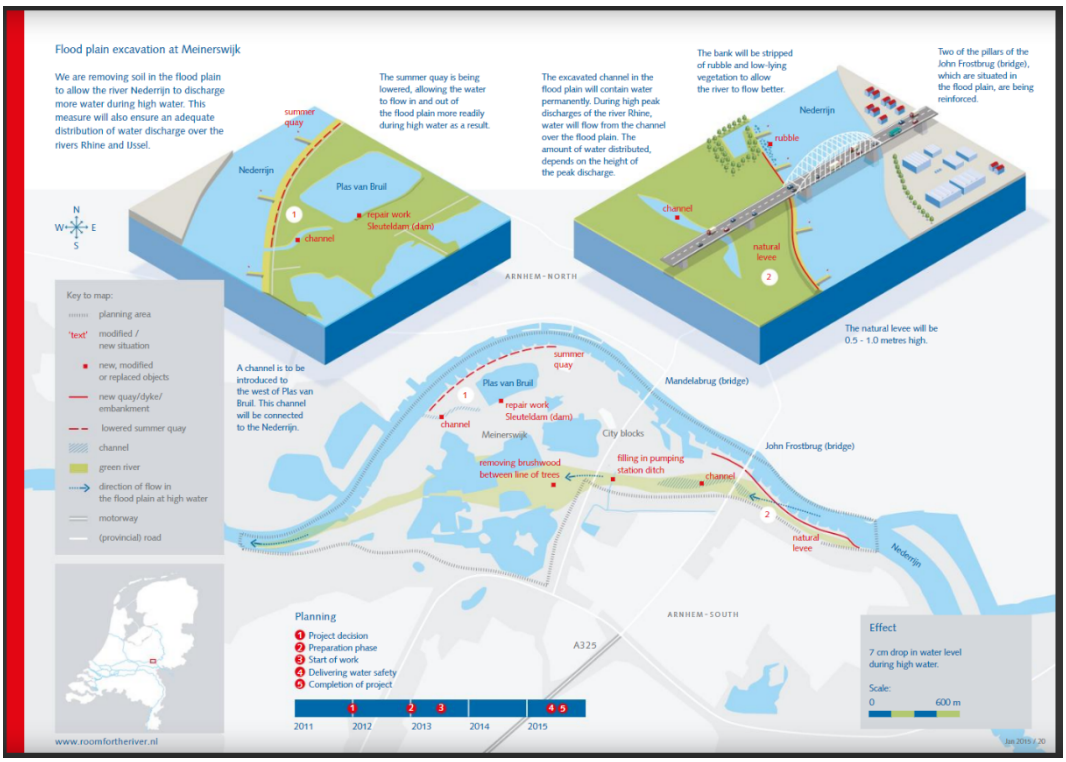

Figure 28 Room for the River project. Example Meinerswijk

A menu of measures

Lowering floodplains
Lowering/excavating part of the floodplain increases room for the river in high water situations.

Lowering groynes
Groynes stabilise the location of the river and ensure its correct depth. However, in a high water situation, groynes may obstruct the flow to the river. Lowering groynes speeds up the rate of flow.

Dyke relocation
Relocating a dyke inland widens the floodplain and increases room for the river.

Removing obstacles
If feasible, removing or modifying obstacles in the riverbed will increase the rate of flow.

Depoldering
The dyke on the riverside of a polder is lowered and relocated inland. This creates space for excess flows in extreme high water situations.

Water storage
The Volkerak-Zoommeer provides temporary water storage in extreme situations where the storm surge barrier is closed and there are high river discharges to the sea.

Deepening summer bed
Excavating/deepening the surface of the riverbed creates more room for the river.

High water channel
A high water channel is a dyke area branching off from the main river to discharge some of the water via a separate route.

Dyke reinforcement
Dykes are reinforced at given locations where river widening is not feasible.

Figure 29 Room for the River measures

Figure 30 The four inland, estuarine and coastal areas in the Programmatic Approach Large Waters.

3.3.2 Case study 7a Danube (Austria)

Authors: Silke-Silvia Drexler (BOKU), Andrea Funk (BOKU), Thomas Hein (BOKU), Iris Kempter (VIAD), Robert Tögel (VIAD)
BOKU: Universitaet fuer Bodenkultur Wien (University of Natural Resources and Life Sciences, Vienna)
VIAD: Via Donau Osterreichische Wasserstrassen Gesellschaft MBH (Viadonau)

1. Multiple goals optimisation

One of the main **strengths** of the Austrian Danube section east of Vienna is the duration of the overall-restoration project (Figure 31; Figure 32). With the establishment of the National Park in 1996 the impacts of the upstream impoundments on the natural sediment transport should be balanced. The start of this large-scale restoration project 25 years ago had two main goals: to maintain the waterway as a sustainable option of transport and at the same time to safeguard the ecosystem of one of the last free-flowing stretches of the Danube in Austria. The implemented action strategy for the whole Austrian Danube (from border to border) combines the topics of ecology and navigation (with a new update for the period to 2030); the current version also focusses on floods and droughts.

With the implementation of the "Catalogue of measures for the Danube east of Vienna" stabilizing water levels, preservation or improvement of the Danube floodplain habitat and improvement of the waterway infrastructure are identified as priorities for the Danube section. A large integrated planned overall concept was established where additionally a modelling approach was applied. Prior to the implementation of the measures including NbS a detailed analysis of scenarios was conducted for the trade-offs and synergies between economy (cost for restoration and management for navigation), society (cultural ecosystem services especially nature experience and recreation) and ecosystems (especially habitat for protected species). A lot of synergies and only few localized trade-offs were identified clearly supporting the NbS.

Reconnection of sidearms in the demonstration site has positive impacts on several Green Deal Goals. The restoration activities improve biodiversity (habitat availability, connectivity for aquatic organisms), climate regulation, also flood and drought resilience (increasing groundwater levels and stabilization), zero pollution (improved nutrient retention), sustainable transport (measures are implemented to stabilize the fairway depth and to reduce shallow areas in the river bed), inclusivity (an established stakeholder board exists since 2012 and after registration everyone interested can join it), circular economy (removed armour stones will be sold or reused in other projects).

The main **weaknesses** are that within the established stakeholder forum for the demonstration site stakeholders for eco-tourism and recreation are not yet involved, which are important topics related to the national park. It is also possible that new indirectly affected stakeholders will appear in the future and therefore maybe will not be involved at an early enough stage of new restoration projects.

When regarding societal challenges not all can be addressed with the same priority in the demonstration site. Integrating all the challenges in the stakeholder board meetings will be time-consuming and discussions might delay the implementation of measures. Additionally, integrating all the societal challenges is also a question of budget. For instance, evaluation of health and wellbeing is not yet done regularly and will thus need additional resources to assess it.

Beside the "good ecological status" for all waters which has to be achieved according to the EU-Water Framework Directive, viadonau is also responsible for a "good navigation status" for the Austrian Danube. Hence the minimum requirement to all projects/actions is that they do not impair neither the current ecological status nor the current navigation status. Thus, it is possible that projects or actions contribute to an improvement of the navigation status but have no positive effects for the ecological status.

Plans for ecology and navigation (updated version for the period to 2030) exist for the demonstration site, but no similar document exists yet for flood protection. There is an investment plan (including a financing plan) where missing spots in the flood protection are highlighted and how they can be solved. But the strategy is not yet clear as well as the extent of integration of river engineering knowhow.

Opportunities arise from the fact that the demonstration site is embedded in a national park. Therefore, a high protection status of the implemented restoration measures is given as the NATURA 2000 Habitats and Birds Directives are applied and legally binding. The whole Danube section also profits from the already established stakeholder board. The restoration design of the Danube section east of Vienna can be transferred to other waterways that have been heavily modified in the past.

Perceived **threats** result from increasing costs for construction work due to the actual energy and Ukraine crisis. Another point is the prioritization of applied laws and restrictions. Flood protection, for example, has always priority above other regulations, e.g. conservational laws and thus might have a negative impact on

biodiversity. New stakeholders in the stakeholder board might also evoke possible trade-offs and problems to be solved in future due to their different/new perspectives.

Based on these SWOT characteristics **the way forward** for "multiple goal achievement" is to check the stakeholder involvement/engagement regularly. Possibly new fields are touched. For example, when the areas outside the dams are affected due to opening of dikes, agriculture will become a more relevant topic in the area. Respective stakeholders should be actively contacted to be involved in the board to cover all interests and to avoid any conflicts. The same applies for societal challenges which can be addressed due to restoration measures. A regular check in the planning process of implementation will help to analyse which societal challenges need to be addressed to meet the best results.

Another aim is to integrate the Green Deal Goals in the planning process and to screen for additional important topics (like drought resilience also seen in relation to climate change) to widen the view besides only focusing on biodiversity and navigation. One example is health & well-being where already good progress was achieved: e.g. the loss of hiking trails by the implementation of a restauration project was compensated by a newly formed bathing place in the river.

2. Societal optimisation

The main **strengths** are that the implementation of the Catalogue of Measures for the Danube east of Vienna is accompanied and supported by a stakeholder forum. A guidance document for river engineering management on the Danube east of Vienna was agreed by affected stakeholders including representatives from the economy (e.g. the Austrian Federal Economic Chamber or Pro Danube Austria, an organization representing the navigation sector) and from the environmental sector (e.g. the Donau-Auen National Park, ICPDR, WWF, BirdLife Austria, Fishing Association). The agriculture sector is not represented in the stakeholder forum as the respective stretch of the Danube is lying mainly in nature protection areas with no agriculture. The stakeholder forum outlines the objectives as well as the management principles and working methods required to achieve the objectives. All involved stakeholders are interested and willing to cooperate.

The main **weaknesses** are that in the stakeholder forum the environment sector is well represented, just as the navigation sector and authorities but representatives from other sectors are yet missing, e.g. from the tourism sector. Another "**weakness**" is also that the meetings of the stakeholder forum (at least two per year) are not that well-attended anymore as in the beginning of the forum. This, on the other hand, can also be seen as a success of the stakeholder forum as the points for discussion are not that severe anymore and as a proof for confidence in implementing the measures by viadonau.

The **opportunities** are that there are many lessons learnt within the last 25 years of the implementation of the "Flussbauliches Gesamtkonzept". So far, the stakeholder board manages to reach restoration goals with discussions. The level of what is possible is not stable over time, but the more projects that have been realized by viadonau, the more experience is gained and the easier it becomes to implement newly proposed restoration initiatives. The same applies for the authorities. They have gained more confidence and expertise in restoration over the years and it became easier to receive the needed permissions from their side. This "joint learning process" is supported through viadonau, the stakeholder forum and is also accompanied by organized field trips for experts from the authorities. This is a key activity to keep the implementation going on at a large scale.

Another "lesson learnt" is that the scope of the "integrative river engineering project" was in the very beginning too large to successfully implement the restoration measures. For the long-term vision of the overall project to become reality a step-by-step-approach was needed. Therefore, the huge project was scaled down to several smaller projects and measure by measure was implemented. To prioritize the measures the stakeholder board (especially representatives of navigation and ecology) is involved as well as a screening of critical spots for navigation is done.

The main **threats** are constraints imposed by existing infrastructure which has to be considered as a precondition. The Danube river used to be a braided river system with many dynamic side-arms, which cannot be restored in their original configuration. Flood protection and navigation require that some of the engineering constructions remain in place, as restoration measures alone would not solve the flood risks.

There are sometimes also conflicts of interests. For viadonau, for example, side-arm reconnections should always be as deep as possible to ensure flow and sediment dynamics. For the Donau-Auen National Park, on the other hand, construction works always poses a major **threat** in terms of disturbing sensitive species that are already present in the area concerned. This always leads to discussions between these two parties about the depth of reconnected side-arms between these two parties.

Based on these SWOT characteristics **the way forward** for "societal optimisation" is a regular stakeholder mapping to include the relevant ones at an early stage of the project development and implementation. To clearly communicate the contents of the respective projects and to give room and time to discuss important topics, where stakeholders might have different opinions for a joint result at the end.

3. Technical optimisation

The main **strengths** are that the assessment of restoration measures includes the current status of the ecosystem based on a data driven modelling approach. Most of the restoration measures are intensely monitored and assessed, which is also linked to an adaptive learning process for over the past 25 years. The direction and magnitude of the desired change as well as potential future development are assessed. This also includes possible adverse impacts on biota or ecosystem services. The main target of the restoration measures is to recover the ecosystem integrity and connectivity of the system. First management measures were already implemented more than 20 years ago and implementation of NbS is continuously optimised since then.

The identified **weaknesses** are the missing connection between the active floodplains and the hinterland caused by a flood protection dam and obstructions of restoration measures by infrastructure, e.g. electricity cables or masts, subsurface pipes or similar, which cannot be removed or relocated easily. Expanding villages and infrastructure related to this urbanization must be respected as well. Various interests and requirements of different stakeholders in the area are an issue as well. For example, groundwater quality is important as in some areas of the floodplains water wells deliver drinking water for the city of Vienna. There are therefore concerns about larger connections to the floodplain because of the potential negative impact on groundwater quality.

Opportunities for the restoration measures arise in terms of protection. For the Danube east of Vienna, a high protection status exists as the majority of the area is located in a national park where Natura 2000, Habitats and Birds Directives have to be applied and are legally binding.

Another **opportunity** could be a new project in Lower Austria where a side arm reconnection will be extended into an area of an existing drinking water well in agreement with the well owner. The goal is an increased water supply by the well through a better groundwater connection to the main river. If the results show that there is no negative impact on water quality (which is expected) it could be a positive example for further reconnections of side-arms in areas where groundwater is a source for drinking water (s. above "**weaknesses**").

Threats are that long-term effects of the restoration measures may be impacted by climate change (lower discharge) and overall negative trends in biodiversity (invasive species).

Based on these SWOT characteristics **the way forward** for "technical optimisation" is to focus more on NbS in the implementation but also on awareness raising. Clearly communicate the positive effects of NbS among authorities but also to the public and to highlight the benefits of restoration measures.

Thinking also out of the box and not only improving the waterway and biodiversity but also including the Green Deal goals especially in terms of climate change for example.

4. Economic optimisation

The main **strengths** are the cost-benefit analyses (CBA) for the catalogue of measures for the Danube east of Vienna. By including non-financial elements "winners and losers" can be identified. Regarding ecosystem services, winners of restoration measures are clearly the regulating services in terms of nutrient retention, provisioning services in terms of provision of habitats, losers are to some extent cultural services as hiking trails will be reduced due to restoration measures. The CBA also shows that the navigation sector is a winner of implementing the catalogue of measures as it contributes to better fairway depths. Financial costs are to some extent included in the CBA.

The **weaknesses** are that large river engineering is expensive. Cost-benefit-ratio is probably less favourable compared to smaller rivers. Monetizing the results of restoration is not always feasible.

Circular economy is identified as an **opportunity**. Currently, removed groynes, riprap etc. are treated as waste but new possibilities to recycle the removed material in other river engineering projects are identified. Additionally, negotiations with companies interested in the material are in progress. The income of sold stones can be used as additional funds for restoration.

The above-mentioned project with the extension of the side-arm reconnection into the area of a drinking water well could also act as pilot project as the well owner contributes financially to the measure because they will profit from more water delivered by their well.

The major **threats** are that private funding is not a substantial source for the Danube floodplain restoration. Restoration measures along the Danube are very expensive and therefore only public money can be invested.

Based on these SWOT characteristics **the way forward** for "economic optimisation" is to follow up on the circular economy process with selling removed stones. The aim is upscaling this process to increase the income from 10k EURO to 100k EURO of revenues.

Another way forward is still to follow the idea of private funding through depicting the advantages and benefits of implementing NbS to attract the private sector.

5. Policy/regulation optimisation:

The main **strengths** identified are the long-lasting experiences in working together with authorities in the field of restoration measures. An action plan was defined together with the respective ministries for the whole Austrian Danube which combines the overall topics navigation and ecology. The current version also includes floods and droughts.

The main **weaknesses** identified are that individuals may not feel represented by their representatives in management boards and stakeholder boards.

Opportunities emerge from the well and for a long-time established stakeholder forum which covers the majority of relevant stakeholders and is also open for every new organization or person wishing to join.

As **threats** political changes can be identified. Changes in ministries can lead to changes in responsibilities and further to changes in integration of different topics (e.g. navigation and ecology). When responsibilities in ministries are changing, interests can change as well. In Austria – for example – there is currently no real responsibility or interest for the topic of floods as the responsibility was shifted to another ministry where expertise for that subject needs to be built up. The topics of waterways, water bodies, floods and flood protection no longer fall under one ministry.

Based on these SWOT characteristics **the way forward** for "policy/regulation optimisation" is a new action plan for the Austrian Danube which provides stability and a long-term perspective. This is currently under progress.

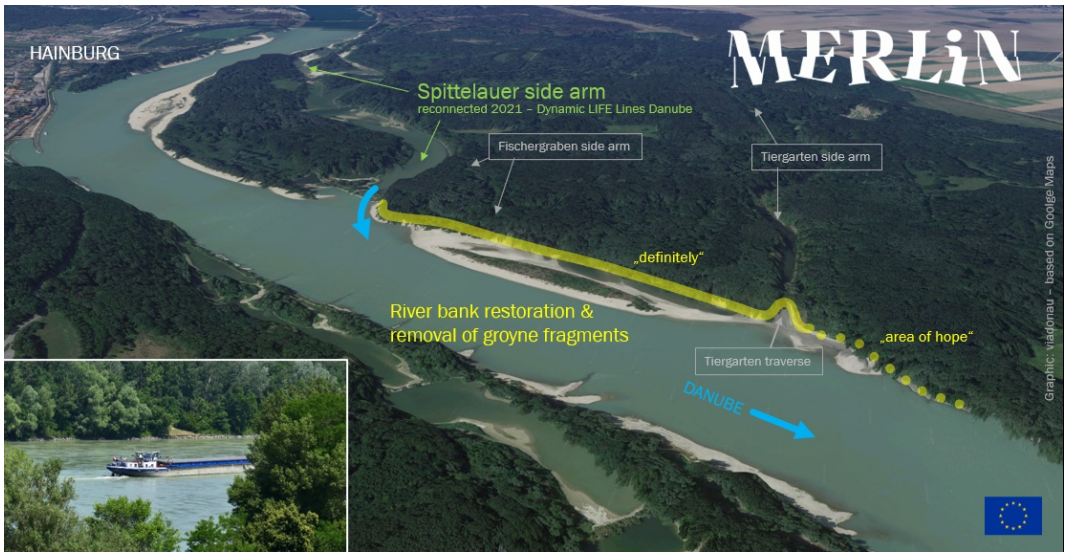

Figure 31 The MERLIN implementation site along the Danube east of Vienna.

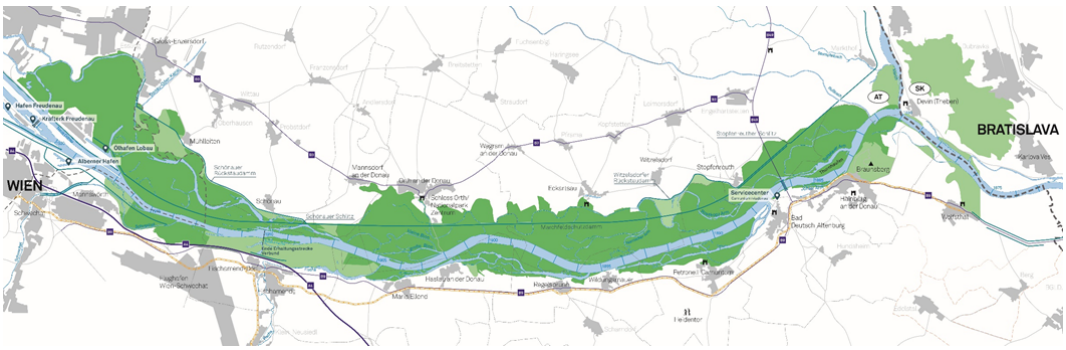

Figure 32 The MERLIN demonstration site in the large scale (dark green = Donau-Auen National Park; lighter green = floodplains outside of the national park; red circle = implementation site for the restoration measure within the MERLIN project). There are 2 main owners of the land: In Lower Austria it is the national forestry department and in the Viennese part it is the City of Vienna. Some minor areas exist with other owners, mainly villages.

3.3.3 Case study 7b Danube (Hungary)

Authors: Tamás Gruber (WWF HU), Andrea Samu (WWF HU)
WWF HU: WWF Vilag Termeszeti Alap Magyarorszag Alapitvany (WWF Hungary)

The case study 07b is about one pilot (Liberty Island and side-branch; Figure 33), where restoration activities have already been implemented and the ambition is to expand this to the Danube stretch from Budapest to the Croatian/Serbian border. The **strengths** and **weaknesses** (the SWOT) reflect on the Liberty Island projects' lessons learnt, while in **the way forward** it is indicated what should be done to make some progress on the Danube downstream Budapest until the border with Croatia and Serbia.

1. Multiple goals optimisation

Main **strengths** of the Liberty Island project are the realized improvement of the longitudinal connectivity which brought additional benefits for biodiversity and recreational use; the successful cooperation between the various sectors (as project partners: water directorate, waterworks, national park, local government) and stakeholders (forestry agencies, inhabitants of Mohács (closest city), angler (and other recreation) associations). This is considered to be a good example for future cooperation.

A good monitoring design was put in place that monitored the relevant biodiversity indicators. whereby the relevant biodiversity indicators were monitored during and after the life of the project. As a biodiversity-focused project it also yielded other benefits such as improving climate regulation, reducing local flood risk, mitigating drought and enabling better water filtration to improve water quality.

The restoration of Liberty Island and side-branch was one of the pilot sites in Hungary where the river restoration was done by using innovative approaches (aspects of the project development, financing, composition of partners) and measures (the implemented technical measures on the field).

A **weakness** of the project is the local scale and not the whole river system or at least a section, only partial results can be achieved because of the dynamic nature of the river system and that international regulations are not harmonized. Local scale also means that smaller number of people can benefit and enjoy the results of the restoration.

It would also be more beneficiary if land does not have to be purchased like in this project, but the owners or managers of the area could ensure the proper land use and restorations. This could help in maintenance of results in the long term and need to be optimised during upcoming restoration projects.

As a result of the groyne on the upper part of the side channel and due to low water periods sedimentation is quite significant and might close the connection for longer periods between the main channel and sidearm. Such outcomes could be overcome if navigation and restoration goals were harmonized.

A general **weakness** is that invasive species require constant management otherwise it is not only a constraint for biodiversity improvement but also for flood risk and other uses of the area. These are high risk from flood management aspects, because in the shrub zone the surface becomes covered with dense vegetation up to 4-5 m high. The invasive alien species might increase flood risk more than native willow forests.

while planning monitoring indicators of health & wellbeing were not included in the project.

We only have moderate knowledge on the impacts on e.g. the Green Deal goals. One reason of it is that these goals did not yet exist during the project life, which also makes it now difficult to assess the project's results for some parameters.

There is an **opportunity** that tourism or other local benefits can be still more improved with citizens recognizing the benefits for them.

The project and its results are a good example of cooperation between different sectors which could be used in wider scale cooperation and restoration works in the future. This could be supported by the identification and harmonization of policy goals and incentives.

Post ante feedbacks of stakeholders could be useful during upcoming projects. After finalizing a project more energy needs to be put to awareness raising, which may help increase ownership of local inhabitants.

Perceived **threats** result from increasing pressures such as maintenance of the river for navigation, port development or angling which can negatively influence the site.

Society is not aware enough of the services which a healthy ecosystem can provide so it can be easily put under risk. Stakeholders are not interested in many cases which is a result of ignorance of their expectations in decision making processes.

Although there is a big need for restoration of ecosystems, the number of integrated projects with concrete restoration actions on the field is still small and the implemented actions may not deliver the expected results (improved sediment balance, disappearing invasive species, relatively stable water levels).

For the biodiversity a constant **threat** is the spreading of invasive species, the presence of the groyne (altering structures for navigation or flood risk) and more frequent droughts with low water stands.

Based on these SWOT characteristics **the way forward** for multiple goals optimisation with the potential partners who are responsible for the management of the river and the floodplains (water management directorates, protected area management bodies) would be to have an integrated planning process for the whole Hungarian Danube section (harmonized with the upper section countries on management issues to be jointly managed, e.g. invasive species, sediment management) on restoration measures. This would bring multiple advantages (e.g. stable connection between the main channel and the side-branches, to be further specified later distinguishing between local, regional and even transboundary issues) for other sectors and citizens as well.

Interactions and cooperation of sectors would be necessary to implement restoration on a wider scale. Identification and harmonization of policy goals and incentives might support this approach.

Putting more emphasis on the connection among good ecological status of rivers and human health and wellbeing goals can help citizens to understand the restoration needs and have also synergetic effect in the realisation of project objectives.

2. Societal optimisation

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

Main **weakness** is that maintenance of the navigation route has impacts on the side-branch. The groynes cause sedimentation upstream of it, and this impact is still not mitigated and no safeguards on trade-offs were assessed during the project.

Opportunities are to use stakeholders input in upcoming further cooperation. The network of relations serves quite well and key stakeholders together can reach wider audience effectively.

Ideally the impact on stakeholders' well-being should be more measurable, and/or the stakeholder groups which are impacted by the restoration are regularly monitored.

Main **threat** is contradictory interest of stakeholders without the intention to overcome them. This is also true for influential ones, e.g. landowners, management bodies (water, forest, protected areas). Also, if decision making processes do not consider stakeholder expectations, they lose their interest to take part in such planning processes.

Restoration actions are usually not of interest for most of the stakeholders and as a consequence only the minority is aware that improvement of the ecological status provide services to the society.

Based on these SWOT characteristics **the way forward** for societal optimisation is an early and active participation of a wide range of stakeholder groups which is necessary for reaching results that are widely known and approved. Stakeholders need to have the **opportunity** to influence decision making and they need to be reached via the proper communication channels. This will be highlighted in more detail in the regional scalability plan.

3. Technical optimisation

Examples for typical measures which have been implemented on the Hungarian Danube are the reconnection of side-branches by removing silted sediment from them and opening it upstream or downstream. For water retention purposes sluices were built in oxbows in the active floodplain. To improve habitat conditions cutting of invasive alien species and introducing ancient plants have already been tested. Some of the measures also serve climate change mitigation, but dedicated measures for drought management might be conflicting with flood management.

Clear **strengths** of the project are not only improved biodiversity health indicators but that after restoration it was one of the first multi-taxa approaches for quantifying changes in taxa composition in Hungary. This biomonitoring was implemented during and after the restoration measures and no adverse consequences were identified. Improvement of recreational **opportunities** like rowing or angling is also characteristic. With change of invasive to native species carbon sequestration was increased and flood risk reduced. More details are reported in the Monitoring reports and updates.

One of the main **weaknesses** is that solely local scale restoration of a sidearm enhances historical natural diversity but is not enough for restoring the biodiversity and ecological integrity of the floodplain. Also, no before-after, or before-after-control design has been designed and applied for the project.

Adverse effects of some interventions can be evaluated only in the long term, see also the monitoring reports including Green Deal goals. The Liberty Island project improved the habitat and hydromorphological conditions, and indirectly improved the purification capacity and the bank filtering capacity for drinking water supply.

Another **weakness** was that the monitoring during and after the implementation did not include other elements than the biological ones.

An **opportunity** could be to develop a long-term monitoring programme on restored side-branches (not only Liberty-Island, but other side-arms on this river stretch) and make use of lessons learnt in upcoming restoration projects.

A more diverse set of restoration measures could be realized for the entire floodplain. The potential measures are listed in the river basin management plan's annexes and are also selected and tailored to water bodies of the Danube, which is a good starting point. Without mentioning details, the measures need to handle the main channel and the active floodplain as an integrated system.

As for technical improvement of the project there are still more **opportunities**: there is a groyne on the northern side of the sidearm which initiates an undesired sand bar formation. During lower water levels this hinders the water inflow to the sidearm. By breaking up at least the part of the groyne, which is next to the bank, flow system would be much more improved. This would be helpful to improve biodiversity, flood resilience and also climate regulation goals.

Perceived **threats** result from the lack of further funding if unfavourable changes arise in ecosystem integrity (e.g. with the forefront of invasive species) and there is no intention to develop NbS strategy.

A balanced climate regulation is threatened by deepening of the main river channel, groynes which enable an intensive sedimentation and expansion of the land on the cost of river channel. This process also threatens the flood and drought resilience of the area and hinders **opportunities** for health & wellbeing for especially local communities which usually visit the project site and its surrounding.

Based on these SWOT characteristics **the way forward** for technical optimisation would be the spatial extension of planning from local to watershed or at least section-length scale, to choose and design a proper monitoring programme, study and evaluate properly the appropriate NbS measures and evaluate which can bring most net asset values.

Monitoring should be continued to explore changes in both hydro-geomorphology and community structure. Monitoring is needed to demonstrate the restoration efficacy.

4. Economic optimisation

Many lessons were learnt in previously implemented projects along the Hungarian Danube and these experiences are both **strengths** and **weaknesses**. These are true in the demonstration project reported in MERLIN (Liberty Island and side-arm restoration), but also for other restoration projects on the Lower-Hungarian Danube stretch. A typical **strength** is that the side-branch and oxbow restoration and reconnection has a big potential on free-flowing rivers and have relatively quick and visible results. The targeted habitats and species are among the priority ones (Birds and Habitats Directives) and due to that the EU financial instruments, especially the LIFE programme provide available sources for restoration. Other funds can also be applied for e.g. operational programme from structural funds. Another available financial resource for the Lower-Hungarian-Danube is the World Bank, a pilot site of a World Bank funded project was on this river stretch. Summarizing the good restoration potential attracted financial sources and successful projects were implemented.

The **strengths** mentioned here are also reasons of some **weaknesses**. These funding sources did not require cost-benefit analysis, or other types of financial sustainability assessments in a detailed manner. The result of it is that once the public fund is available and the projects are donated and the own contribution is provided, then the lead partner and the project partners are not interested in exploring alternative funding **opportunities** or to establish a long term and strong financial viability of the maintenance and post-management of the project aims. Due to that the afterlife management of the projects' results from economic point of view do not satisfy some rationale and important aspects.

A relevant information is that the **strength** of the Liberty Island LIFE project was that private funding also supported the implementation. Due to the cooperation between Coca Cola and WWF, a significant part of the WWF Hungary's budget was provided. This company had a dedicated target to protect and restore water resources, especially the ones which provide drinking water. The Liberty Island restoration fitted to this Coca Cola target, and this was the reason for the financial support.

The **opportunity** arises from the experience that the well-functioning partnership is a kind of guarantee that upcoming project ideas can be realised. The monitoring results justifies the positive impacts of the restoration on the biotic and hydromorphological conditions, but there are also negative impacts which became known through monitoring. An **opportunity** is also that many restoration measures are already included in the existing plans or strategies (e.g. river basin management plan of Hungary, which includes potential measures in rivers and on the floodplains).

Perceived **threats** result from the condition that the related sectors' cooperation which deals with social and financial topics have been quite weak in the previous decades and does not seem to make any progress (nature conservation, water management, navigation). The counterproductive sectoral behaviour might be a bottleneck for the economic aspects of upcoming restoration and NbS projects. Another **threat** is that the river restoration

works are very costly, providing funds and own contribution requires stability from the lead and project partners as well as significant capacity. These are usually missing ingredients during the proposal development and the implementation.

Based on these SWOT characteristics **the way forward** for economic optimisation is to identify costs and benefits as accurate as possible. Scenarios of degradation or restoration of side-branches and all other riverine habitats should be accompanied by cost-benefit analyses. A pre-condition of CBAs is gathering the missing data and information, not only biological ones, but on the services which the restored river systems provide to the society. This is already a big task, since the status of rivers and adjacent habitats and the added value of restoration is difficult to be monetized. The soft indicators and the role of ecosystem services needs also to be considered in the CBAs. An open discussion among sectors (who do the restoration or have impact on rivers' status) is necessary on 'what do they expect from the rivers' with a proper knowledge on the economic background.

Another aspect of the economic optimisation is that the economic aspects need to be addressed in the proposal phase e.g. with a decision supporting tool. The economic assessment needs to be developed before any projects or programmes starts and not only follow and assess the results.

The economic optimisation requires developing integrated restoration and for NbS proposals to strongly consider the cost-benefit aspects to make them attractive to others than public funds. There are many aspects which belongs to healthy rivers and these aspects need to be important components in proposals to make them interesting for the private sector investments.

5. Policy/regulation optimisation:

The **strength** of the project was that the case study is an example which raised the attention of the wider group of local stakeholders and also the wider public to the added values of river and side-arm restoration.

The restoration works contributed to the water, river relevant EU directives' goals which also have relevance to the riverine habitats. A **strength** was that the support of the local mayor and the local community was strong since they already witnessed the degrading conditions of the project site.

The project **weakness** was that not all sectors' representatives which make use of the Danube were open-minded to jointly evaluate the project results. During the project, no policy-relevant recommendations were drafted and there was no discussion with project partners or stakeholders.

The **opportunity** arises from the fact that the implementation of EU directives is a joint responsibility of the responsible ministries and their background institutions. This requires cooperation at least on some fields and instead of sectoral approach the integrated planning is a solution. Another **opportunity** is that many experts have already seen good experiences and much knowledge was gathered among Hungarian experts. The time is here to start sharing knowledge and working together.

Perceived **threat** result from the condition that there are still many influential stakeholders who consider restoration of rivers and habitats serving only nature conservation interests and no other benefits. There are also some management authorities (mainly flood risk management) who consider maintenance and improving old floodplain forests a risk which decrease the conveyance capacity and increase the flood levels. Improving lateral connectivity of rivers is also opposed by some river users such as the navigation sector. The sectoral approach of management bodies (flood, agriculture, navigation, conservation) usually do not show any sign towards adopting NbS as an alternative, but prefer the simple solutions with limited cooperation.

Based on these SWOT characteristics **the way forward** for policy/regulation optimisation is to analyse the EU and national strategies, policies and actions in depth to explore how sustainability goals can be integrated into development of upcoming restoration project proposals. The policy framework does not seem necessary to be modified either on national or on EU level, but the harmonization of the implementation of activities to reach the policy targets is necessary and essential. This is a missing element which might also bring the sectors together which are impacted by the river restoration actions or which have significant impact on the river status. This harmonization process is a long learning process which requires openness from the sectors and incentives from policy and decision-making level.

The biomonitoring justified that the Liberty Island project had many positive results, and that the upscaling of side-branch restoration would contribute to serve many policy targets. NbS design, implementation and lessons learnt of our projects and previous experiences are to be shared with stakeholders from the related sectors, e.g. water management, navigation, drinking water supply, eco-tourism.

A more comprehensive set of measures on longer Danube stretches and on the entire floodplain could also be part of **the way forward** in the policy optimisation plan. A pre-condition of that is not only nature conservation sector including NGOs push the restoration needs, but there is another sector or some active municipalities or communities on board, which have political power and influence.

An essential part of **the way forward** is to learn lessons from the Middle-Danube Austria site downstream Vienna where the proposal planning and also the technical implementation is on the way with good experiences. These experiences are also about the involvement of relevant stakeholders and integrated

planning mechanism. Organising bilateral talks, field visits by inviting diverse key stakeholders is a way forward. The first steps will happen during the MERLIN project.

During the optimisation steps the ideal spatial dimension needs to be defined, which is considered to be the Danube between Budapest and the Croatian/Serbian border, since the whole Hungarian Danube stretch might be too long and diverse for developing one optimisation plan.

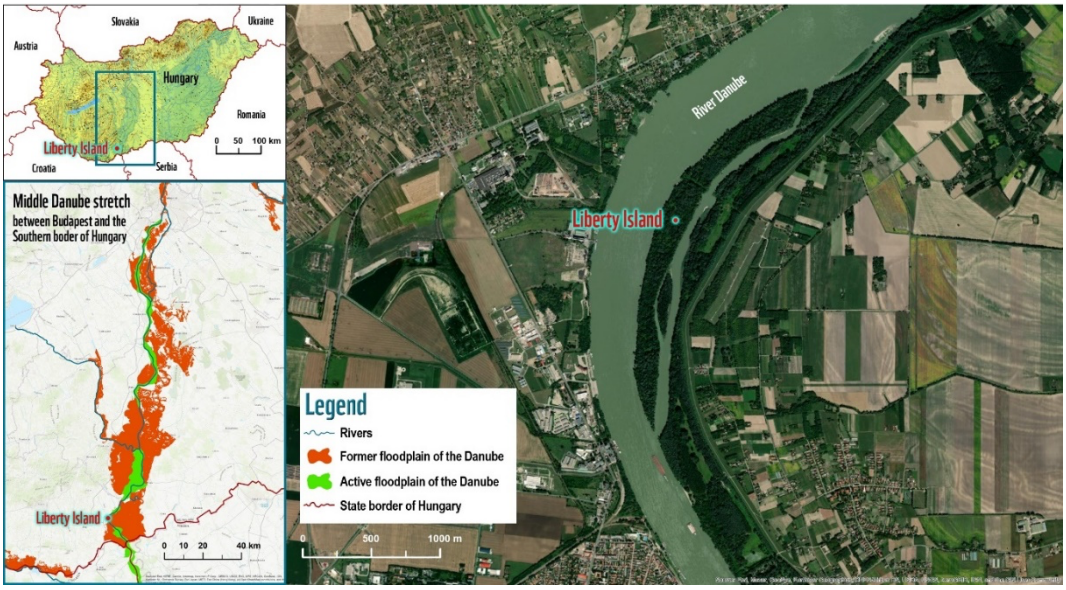

Figure 33 Liberty Island, the floodplain demonstration site in the Hungarian stretch of the middle Danube downstream Budapest.

3.3.4 Case study 8 Danube (Romania)

Authors: Iulia Puiu (WWF RO), Albert Scrieciu (GEOECOMAR), Cătălin Anton (WWF RO)
GEOECOMAR: Institutul National de Cercetare-Dezvoltare Pentru Geologie si Geoecologie Marina – GEOECOMAR (National Institute for Research and Development of Marine Geology and Geoecology)
WWF RO: Asociatia WWF Romania (WWF Romania)

1. Multiple goals optimisation

The main **strengths** are that flood risks are one of the well-recognized societal challenges in Romania, including in the Danube floodplain area. The restoration projects consider the multiple benefits, besides improving of conservation status of species and habitats, also the benefits of the local business (fish farming and other potential business), flood risk mitigation and the needs of the local communities to access natural resources (access to fishing). Also, the River Basin Management Plan is already considering the restoration projects as a measure that improves the water body status. Stakeholder engagement has been performed to build understanding and discuss potential concerns. WWF Romania developed a list of potential restoration sites. Similar NbS areas along Danube have been discussed with authorities and some of them are proposed to be implemented under the Recovery and Resilience Plan. The summer of 2022 brought the droughts into public attention and the need of water storage increased. The availably of water for agriculture is an issue. As the new Common Agricultural Policy (CAP) is scheduled to begin in 2023, all issues related to its applicability need to be resolved for it to be prepared to address climate change, biodiversity loss, and soil degradation as well as other increasing challenges.

The main **weaknesses** are that the entire range of challenges associate to water management (e.g. droughts effects) have not been fully addressed and documented until now. The human wellbeing outcomes are vaguely addressed by the restoration projects since only direct benefits to the locals considered (like access to local natural resources) without providing any evidence. At this stage, the level of integration and the synergies among sectors are not documented and assessed properly.

Opportunities arise from coordination with the development of Flood Risk Management Plan (FRMP) at basin level and national level to show cumulative effects in flood risk mitigation. The droughts plans at national level and climate change strategy and plans could be an **opportunity** to include the need to address and document floods and droughts in the project area using NbS. Under the partnership of WWF with the Coca Cola company (TCCC) for 2022, a socio-economic study will be developed to show, among others, the way the local community could sustainably develop. For the upscaling potential WWF conducted a process to identify new potential restoration sites along Danube floodplain.

Perceived **threats** from climate change may increase flood- and drought risk to a level beyond what was designed for in the original plans. Global food crisis could jeopardize the efforts in promoting the floodplain restoration favouring the expansion of the agriculture, including at the project site. Lack of openness from other sectors (fishery, forestry) and complementary interventions to cooperate in order to identify and analyse the synergies. The positions of the key stakeholders towards upscaling the restoration could change due to food and energy crises, diminishing the importance of nature restoration. The interest of the stakeholders could be very low in providing feedback during the process.

As a result of these SWOT characteristics, drought risks should be included in climate scenarios for multiple goal optimisation. During the planning phase of each project, all representatives must be on board to take care of all functions.

2. Societal optimisation

The main **strengths** are that the needs of inhabitants are openly discussed with all relevant stakeholders. The stakeholder engagement has been performed to build understanding and discuss potential concerns. WWF Romania developed a list of potential restoration sites. Similar NbS areas along Danube have been discussed with authorities and some of them are proposed to be implemented under Recovery and Resilience Plan. All the rights, usage of and access to land and resources and stakeholders' responsibilities are discussed and agreed at the first stage of the restoration. The biodiversity safeguards are clearly understood by the stakeholders and responsible authorities, together with other types of safeguards under the applicable laws.

The main **weaknesses** are that health and wellbeing were not a clear goal of the restoration projects, and these have not been monitored in a structured manner. For health, for example, the role of re-wetting in potentially contributing to larger burden of mosquitoes has not been assessed. The trade-off analysis has not been performed.

Opportunities arise from upscaling potential by reconnecting the Gârla Mare-Vrata wetland to the Danube River (Figure 34; Figure 35), it will enhance the area's biodiversity and contribute to flood and water management as well as climate resilience. Water retention will be increased, a more natural flow regime will be restored across the marsh, flooding impacts on local communities will be reduced as a result of the restoration, biodiversity will be restored and maintained, especially those habitats vital to spawning fish, and fishing **opportunities** will be provided.

WWF conducted a process to identify new potential restoration sites along Danube floodplain. The wellbeing by recreation in floodplains and associated lower burden on health budgets, can be seen as a new driver for nature development

Perceived **threats** result from the interest of the stakeholders could be very low in providing feedback during the process. Perceived **threats** result from the excessive recreation pressure that can have negative effects on biodiversity.

Recreational activities can cause perceived **threats** by exerting excessive pressure on biodiversity. In addition, it is possible that functions that do not receive their own funding may be given lower priority when multiple goals and functions are combined.

Based on these SWOT characteristics, **the way forward** for societal optimisation is raising awareness of the benefits of nature-based solutions, both to the general public and to the professionals in integrated river management.

3. Technical optimisation

The main **strengths** are the Danube floodplain is almost completely covered by Natura 2000 sites having management plans and adjacent studies and the Natura 2000 management plans include targets and general objectives on protecting, restoring and monitoring the biodiversity. There is knowledge on ecosystem status and pressures of degradation available. The societal challenges (flood and drought risk mitigation) are part of restoration objectives.

The main **weaknesses** are that the social and economic indicators have not been considered and some indicators could not be measured adequately (e.g. fish species) due to some missing data regarding the biodiversity status (species and habitats relevant for Natura 2000 management),

Opportunities arise from the new restoration law that should be implemented at the country level, could be an **opportunity** to be exploited to promote the results of the restoration to upscale the restoration potential.

Perceived **threats** result from the fact that the state authorities do not ensure recourses for a long-time monitoring.

For technical optimisation in accordance with the SWOT analysis, it is imperative to ensure continuous monitoring similar to that carried out before the implementation of the project in the initial phase. Additionally, it is essential to engage and collaborate with professionals from a variety of disciplines. As a result of the current climate crisis along with the current biodiversity crisis, nature-based solutions are in great demand.

4. Economic optimisation

The main **strengths** are the cost - benefit analysis has been performed under the feasibility study for the previous restoration project stage. A basic rate of return has been calculated and benefits identified. Alternative technical solutions have been considered. The biodiversity safeguards are clearly understood by the stakeholders and responsible authorities, together with other types of safeguards under the applicable laws. The combination of goals of flood risk management and nature restoration has helped making the project successful.

The main **weaknesses** are there is a risk of not covering the entire range of additional benefits (e.g. improving the water quality or other hidden benefits). A comprehensive analysis of the impact of regulations and subsidies have not been included into the feasibility study. The analyses have been done using the basic economic analysis, without performing a thorough analysis of externalities. However, a very specific analysis is not yet performed. The trade-off analysis has not been performed.

Opportunities arise from the performed CBAs for the alternative design scenarios (on programme level)

Perceived **threats** result from the availability of the costs are deficient threatening the achieving of a very precise cost-benefits analysis. The willingness to invest in the future stages of the restoration and to submit for grant type of funds, could be reduced at local level.

According to these SWOT characteristics, the most efficient approach to economic optimisation is to improve the current methods and approaches for performing CBA. The incorporation of the benefits of nature is improved.

Consequently, the proposed model can assist decision-makers in making appropriate evaluations of NbS solutions. Moreover, the projects generated by the proposed model are likely to significantly improve the economic feasibility of the entire system without compromising certain parties' financial stability.

5. Policy/regulation optimisation:

The main **strengths** are the experiences with the design and implementation of NbS (floodplain restoration). Based on the lessons learnt, the recommendations are communicated to the stakeholders. The policy, regulations and law analysis are part of the promoting, designing and implementing NbS. The proposals for improvement of the policies are addressed.

The main **weaknesses** are the presentation of the addressed challenges and solutions are not planned to be presented targeting the specific stakeholders / public. The project is focused mostly on the implementation and less on inform and enhance policy and regulation at higher level. The NbS targets have been partially identified and promoted.

Opportunities arise from the potential positive effect of the NbS that will encourage local stakeholders to implement the NbS. The presence of multi-stakeholder platforms to inform or indicate their opinion/perspectives on certain policies and regulations. Further, the inevitable impacts of climate change will potentially encourage citizens/actors to use NbS to mitigate to these impacts.

As a result of these SWOT characteristics, the most effective method for optimising policies and regulations is by developing a clear legal framework that provides stability for stakeholders and provides a long-term vision. Moreover, increasing awareness of existing policies among potential implementers is another optimisation strategy.

As a result of existing national and European regulations, decision-makers and key stakeholders are provided with a comprehensive standard for enhancing policy coherence, addressing integrated economic, social, and environmental goals, and accelerating progress toward the sustainable development objectives (SDGs) and the Green Deal targets. The interested parties will need a road map, based on these regulations, to implement the proposed measures in a proper manner.

Figure 34 Garla Mare floodplain area.

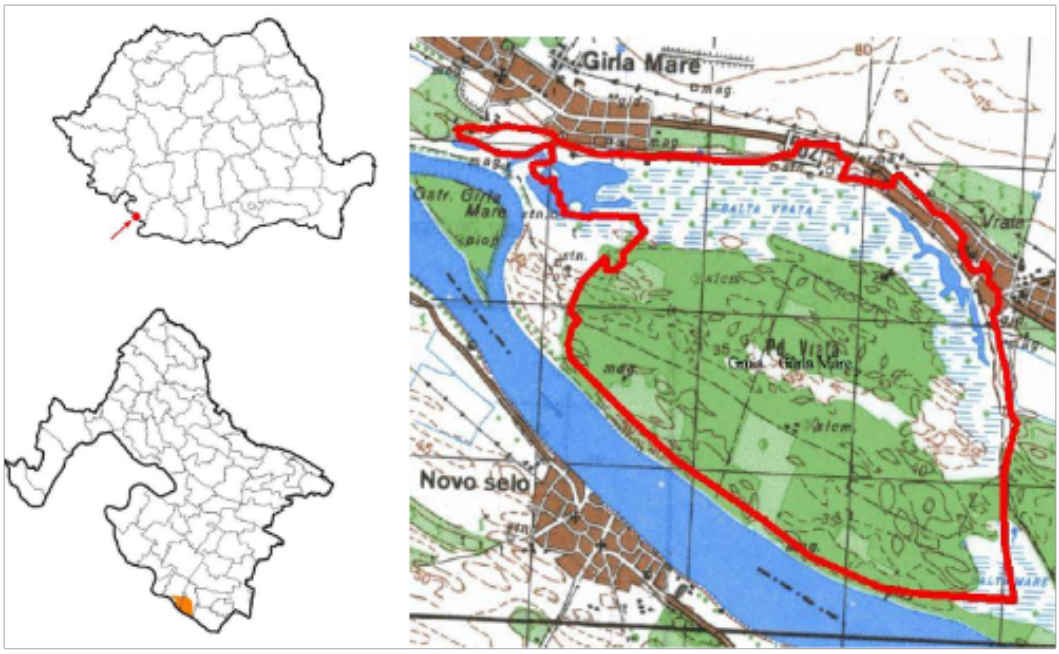

Figure 35 The SWOT analysis was performed on the Garla Mare floodplain area.

3.3.5 Case study 9 Tisza (Hungary)

Authors: Péter Kajner (WWF HU), Tamás Gruber (WWF HU)
WWF HU: WWF Vilag Termeszeti Alap Magyarorszag Alapitvany (WWF Hungary)

Demonstration site: Nagykörű

- Type of restoration: Planning and implementing a floodplain farming system in the floodway of river Tisza near Nagykörű village, based on water retention in former wetlands, and restoring habitats (Pilot Site A). Another potential pilot initiative is a local farmer irrigation community in the floodway fringe of the Tisza to create the infrastructure for providing water for farming and habitat restoration, reconnecting former floodplains to the river (Pilot Site B).
- Size: 1,800 ha (affected areas: Pilot Site A approx. 300 ha, Pilot Site B approx. 1,500 ha; directly restored areas will be ~70 ha).

Implementation site: Bereg

- Type of restoration: regular inundation within the Bereg Flood Risk Reduction Reservoir System, transition in land use, floodplain reconnection and rewetting, introduction of floodplain farming, biodiversity enhancement by the upper reach of river Tisza, in the Bereg landscape (Pilot Site C).
- Size: min. 200 ha to be restored. Affected area of the Hungarian part of the Bereg landscape is 38,000 ha (27 municipalities, mostly belonging to the Vásárosnamény district by the river Tisza).

Both the Demonstration and the Implementation sites are near the Tisza (Figure 36) coping with very similar problems (droughts, drying landscapes, loss of biodiversity, economic and social problems etc.) as detailed below. Formerly, there were projects implemented at both sites to establish Natural Water Retention Measures (NWRM) systems, but today none of them is used for water retention as previously planned.

The Demonstration and Implementation sites have different geographical and water management characteristics, but both need water replenishment. The MERLIN project experiences to gain in both areas will be useable in other areas along the Tisza and can be scaled up to help NbS-based land use change in 150,000 ha of the floodplains along the Hungarian part of the river Tisza.

In Nagykörű, a reboot of a previous project will be implemented, adapted to the current situation. The Bereg project aims to technically upgrade the existing, much larger water management system and the creation of social and economic conditions for water retention. The experiences gained by the Nagykörű project in 'small' will help to implement the Bereg project in 'big'.

The technical, economic and social conditions in the two areas are very similar, but there are also differences. Most of the statements below apply to both areas. Where statements apply only to one or other of the sample areas, this is indicated.

1. Multiple goals optimisation

Strengths. Case study projects focus on success in economic, social and ecological terms at the same time and sustainability. Restoring habitats is directly linked to more environmentally friendly land uses and farming and does not serve conservation purposes alone. Interactions between economy, society and ecosystems were revealed by former studies and the practice of stakeholders. Both in Nagykörű and in the Bereg there were former projects implemented for NWRM, and these areas are flagships of floodplain farming initiatives in Hungary.

Nagykörű. Between 2000–2005, WWF implemented a LIFE supported wetland restoration project here. A sluice was built, which enabled partial inundation of wetlands, enhancing biodiversity. The local community intends to plan and implement a next stage of the development. Based on water retention, biodiversity enrichment, they would like to start the development of local economy (animal husbandry, fishing, managing traditional orchards, eco-tourism etc.). Local experts have made a project concept for WWF HU on landscape rehabilitation and floodplain farming in the area.

Bereg. The area suffered a catastrophic flooding in 2001, when the dike of the Tisza breached. After that event, the government started a huge flood protection programme along the Tisza 'Further Development of Vásárhelyi's Plan', which included building flood emergency reservoirs in the former floodplains. One of the reservoirs in the Bereg was built by 2015, because local communities specifically asked water management leaders to build a reservoir there. By 2019, also on the initiative of local people, a supplementary water management system was implemented that would allow water replenishment from the Tisza and floodplain farming. After the huge state financed investments, relatively minor further developments are needed only to operate a natural water replenishment system that benefits natural habitats and farming.

Weaknesses. The farmers', land users' financial motivation for water retention and floodplain farming, instead of intensive land uses (e.g. cash crop production, intensive fruit plantations) was not created at either pilot sites. Therefore, the land use has not changed and water retention systems are not used as planned. Sectoral short-term interests counteract each other and the long-erm considerations many times (agriculture vs. nature

conservation, large farmers vs. small ones, irrigation vs. water retention, flood protection vs. water retention etc.). However, more farmers and other stakeholders should be interviewed to understand motivations in depth.

Nagykörű. After the restoration of wetlands, between 2005–2010, traditional fishing, grazing was started, but local conflicts arose concerning the operation of the sluice after 2010. Now the sluice is not in use, no water retention measures are in effect, as several landowners oppose the idea of water retention. Nevertheless, the river can flood a part of the area for a shorter period of the year. The municipality and local activists did not communicate well with stakeholders, and the initiative was not well managed by the municipality between 2010 and 2019.

Bereg. The government has not created the incentives in the agricultural support system for landscape management based on water retention, so land use has not changed here. Local developments were brought under governmental control and communities lost control over it. Many people are frustrated by this.

Opportunities. Climate change and drying of landscapes make more land users realise problems and understand the significance of water in landscapes. It is clear for many of the stakeholders that the lack of water, heat waves, droughts cause losses in local ecosystems and for farming. The new CAP period may offer new types of incentives. Several higher-level leaders (at water authorities, agricultural decision makers, county level leaders) seem to understand the connection between the condition of the landscape and human wellbeing. The projects to be implemented will enhance human-wellbeing by providing a more stable foundation for sustainable farming and local economies.

Nagykörű. The wetlands, habitats of the pilot area still can and should be restored and sustainable floodplain farming could be introduced here. A long-term cooperation between the local government, farmers, inhabitants of the village, water management authorities and other stakeholders was initiated for realizing this vision. From 2019, the new local government is committed to the rehabilitation of the pilot area and sustainable economic development. They negotiated with the National Land Center of Hungary to prepare the state's buyout of the lands of owners. Most of the pilot area will be managed by the state via a national park directorate. A smaller part will remain private property, but there the landowners agree with the necessity of water retention. Concerted operation of the water management system will make it possible, that the pilot area is inundated not for 3 but for 6 months and regular management (grazing, orchards management, fishing etc.) can start again.

Bereg. Local governments, the Upper Tisza Water Management Directorate, the national park, a mayor, state owned forestry, hunting associations and several other decisive stakeholders support the idea of water retention. Their support will be very important when lobbying for sources for additional investments. All of them understood that droughts and the lack of water cause catastrophic changes in the landscape and for farming, they are losing cultural and public goods as wetlands, oxbows dry out. Most of the local communities urge water replenishment.

Threats. The land use structure and rights are fragmented, and the lack of local community decision mechanisms in land use hinder water retention measures and setting priorities. The agricultural subsidy system gives distorted incentives for land users. The war in Ukraine, extreme drought and the rising food-security crisis make cash crop production more profitable and that may hinder land use change. Political decision makers push irrigation and dams on rivers, rather than Nature-based Water Retention Measures (NWRM). Due to climate change, water levels and quantities in the river Tisza decrease. Economic decline in Hungary may decrease national development sources needed for implementation. The climate change, biodiversity crisis, soil crisis, war in Ukraine, energy crisis, inflation, pandemic, a potential migration crisis and other factors tend to form a superstorm, which makes even the near future hardly predictable. Time is ticking and too slow answers to landscape degradation may accelerate losing population and potential workforce from case study areas. Sectors and sectoral players are used to compete each other. The present political structure is rather centralised and leaves little space for bottom-up initiatives in Hungary.

Based on these SWOT characteristics **the way forward** for multiple goal achievement is to create financial incentives for land use change, and run open and transparent planning and implementation processes for water replenishment both in Nagykörű and in the Bereg. A substantive collaboration of local stakeholders has to be developed and operated. All decisive sectoral players have to be involved in planning and implementation. Continuous risk assessment and proper management will help smooth planning and implementation. Present state of local ecological, economic and social systems will be recorded and changes tracked according to the Monitoring Plan.

2. Societal optimisation

Strengths. Meetings with key stakeholders so far revealed several basic conflicts and an initial conflict management system was begun to be drafted. The experience of similar, former projects helps planning the safeguards systems.

Nagykörű. The engines of the changes are the local government and a local NGO, the 'Foundation for Nagykörű'. These actors can involve practically all local stakeholders and help understanding potential conflicts. Floodplain farming initiatives have a history in the village since the beginning of the 2000s.

Bereg. The local leaders of processes are well known actors (a regional rural development association and a municipality). Workshops and negotiations were facilitated in an open and positive atmosphere, all stakeholders

had the **opportunity** to have their say. Key stakeholders (including county and regional level authorities) were identified and involved in planning. Workshops, negotiations were held to include opinions and ideas in planning.

Weaknesses. The feedback and grievance resolution mechanisms are not elaborated in detail and not all stakeholders are involved yet. The projects are in their early stages and appropriate methods need to be developed to balance the needs and influence of different weighted actors. The Case Study Board was not yet set up. Clear decision-making processes are to be developed and implemented. The most important disservice may be the consequence of the land use change necessary for NWRM: the options for intensive cash crop farming will narrow, so farming alternatives have to be established.

Opportunities. Running (and completed) EU-funded projects require(d) feedback and grievance mechanisms to be in place, so Hungarian governmental agencies and municipalities are somewhat familiar with these. NWRM needs cooperation in the landscape level between stakeholders, and that may form a new culture of respect and equality. The problems that brought the project to life (e.g. droughts, agricultural damages) are obvious to the majority of local stakeholders, what helps to engage them. The expected harms of inaction are much greater than the potential adverse side effects of interventions (e.g. habitat drying is much more damaging than the expected damage to some current habitats from flooding; agricultural yield increase is higher than the production in the area 'lost' due flooding etc.). Local stakeholders are mostly supportive.

Threats. The culture of genuine participation in public administration processes and project management in Hungary is rather weak. To reach success in tourism, a strong collaboration is necessary between local economic actors, but the culture of collaboration is weak. Stronger actors (e.g. large-scale farmers) may try to impose their will on the local community. In a complex project, there is always the danger that there will be a small but loud group of stakeholders, which could block the process. Private interests and the centralized governmental decision-making systems may be obstacles for joint decision making. Land use is very fragmented, and it is difficult to trace owners and land users.

Based on these SWOT characteristics **the way forward** for societal optimisation is to set up local communities' leadership mechanisms, the Case Study Board, feedback and grievance resolution mechanisms and fine tune step by step as new stakeholders are involved. Clear decision-making processes are to be developed and implemented. Further stakeholder involvement is needed. Costs-benefits of associated trade-offs of NbS intervention are to be revealed and acknowledged. Safeguards and corrective actions are to be listed and presented for stakeholders. Established safeguards are to be periodically reviewed. The wider the stakeholder involvement, the more aspects can be revealed, and the less trade-offs can possibly occur. Study tours will be organised to familiarise stakeholders with the benefits of water retention to showcase successful farms.

3. Technical optimisation

Strengths. The projects include developing complex, sustainable food production, processing and retail systems in pilot areas (Short Food Supply Chains). The projects are planned and implemented involving all relevant stakeholders. The methods, potential benefits and bottlenecks of floodplain farming were revealed by a vast number of studies in Hungary, so the general insight of these research results will be a solid foundation for technological optimisation at the pilot sites. Former ecosystem service assessments and several parallel project researches give us good arguments to convince decision-makers that green solutions can be more effective than grey ones. WWF has a small project in Nagykörű to measure and assess the GHG sink potential of grasslands and wetlands.

Weaknesses. There is little data on GHG mitigation potential of habitats other than forests. Our project areas are known, but not among the most popular tourism destinations yet. The local food supply is dominated by large retail chains, small-scale production has declined. There are hardly any examples of farming based on water retention to study in the regions. Complex financing mechanisms are very complicated and lengthy to set up.

Opportunities. Our project goals fit EU Biodiversity Strategy and national biodiversity goals too. Many local farmers have already understood the significance of water retention, vapour and microclimate in increasing yields, avoiding damages. A slow change started in the water management sector (e.g. building reservoirs, widening floodways), what may allow NbS to be included in flood risk management. Drought causes more losses on a national level than floods. It is becoming clear that irrigation is not a viable solution to mitigate droughts. People turned to domestic tourism during and after the COVID, healthy local food, remote rural areas are becoming more popular. Uncertainty in the world is driving more people to buy their food from reliable sources. Farmers may try to build more on NbS because of input supply difficulties. Some local actors may be driven towards alternative sources of finance because of the more difficult availability of subsidies or market sources. Green growth can partly be financed by EU subsidies. Rewetting landscapes and reconnecting floodplains will help stopping the degradation of landscapes. Land use change will create more habitats, increase biodiversity, enhance conservation status of protected sites. Rewetting landscapes are powerful tools of adaptation, mitigate climate extremes (droughts, heat waves, spring frosts). New habitats may sink more carbon. Reconnecting floodplains may help to reduce flood risk by storing more water. New habitats will be new places for recreation. A better microclimate will make communities more resilient to climate extremes. Complex ecological–economic–social developments will benefit local communities and reduce climate related risks, so not only public but private investors can be involved too. Restoration and sustainable economic

development will result in a more resilient agriculture and create jobs e.g. in eco-tourism, extensive animal husbandry, local product processing.

Threats. The interests of intensive farming (e.g. draining inland waters, irrigation, cash crop production), angling, tourism, settlement management and other local interests often contradict biodiversity enhancement goals. Rewetting landscapes must consider valuable habitats adapted to drier conditions. Climate change may speed up the decrease of precipitation and water quantities in the Tisza, it will bring longer and more extreme droughts, but may cause unexpectedly high, extreme floods even after a decade of dry years. The ruling dogma of flood protection is still to drain waters as quick as possible. Though, flood risk is high on the agenda of political decision makers, drought management by NbS has very low priority. Quick political fixes for short term problems may result in less green and more harmful economic actions (e.g. increasing agricultural production, firewood production, loosening regulations).

Based on these SWOT characteristics **the way forward** for technical optimisation is to design water retention systems with conservation values in mind. Methodologies and data collection need to be developed and improved to detect the GHG sinks of wetlands, grasslands and other habitats in order to be able to involve carbon sink financing. Due to decreasing water flows, solar-powered pumping will also be needed in the Bereg. The benefits of NbS in protection against droughts need to be explored more in depth. The water management operational arrangements serving the interests of water retention in landscapes and flood risk reduction at the same time must be elaborated at all pilot sites. Technologies to combat drought by water retention need to be developed and widely demonstrated. We will design and develop short supply chains, promote local products and showcase the regions through marketing to boost economic development. A system of open planning must be developed and kept operational. Monitoring activities based on our plan will provide feedback for fine tuning project implementation.

4. Economic optimisation

Strengths. There are cost-effectiveness analyses, models, methodologies available for other pilot projects along river Tisza very similar to our ones, which can be evaluated for their **strengths** and **weaknesses** and reflect what can be optimised. There are general analyses for our pilot sites from former research, which must be updated and specified. A complex local economic and social development plan can be based on landscape restoration. The global WWF network is very active in developing methods of Bankable Nature Solutions and are ready to help our initiative with consultation and in finding partners. The ‘Living Tisza’ trademark system of Nagykörű is relatively well known and has a good reputation in Hungary. The development of this and similar local trademark systems can greatly help the market access of floodplain farming products.

Weaknesses. Lacking exact project plans makes financial planning difficult in this stage of implementation. Lacking exact project plans, quantification and comparison of alternatives has not yet been possible. The benefits are to be mapped and a financing structure must be drafted (including bankable solutions) so that investors, state and EU sources can be involved.

Opportunities. There are well useable databases for the calculations. Cost-effectiveness studies are necessary for EU funded projects, so the methodology is rather known for decision makers. CBAs in other cases (e.g. in Middle-Tisza case study research) proved the effectiveness of NbS vs. grey measures. NWRM will provide benefits for the public and land users, so costs can be co-financed by farmers and the state / EU. Political decision makers and decisive economic actors can be involved in planning to maximize benefits. As NbS decreases losses and increases profits, farmers and insurance companies may be interested too. NbS and NWRM will provide economic benefits for farmers, ecological benefits, on which eco-tourism can be based, and that may help the processing of local products.

Threats. Several important ecological services cannot be well quantified. There may be farmers whose production is hampered by excess water and who may therefore be obstacles to the process. So, if the new CAP and related legislation do not provide sufficient incentives for NbS, it will be difficult to persuade farmers to change and other sources of finance will be harder to attract. There is a stronger lobby behind private profit interests than behind public benefits, so even the best cost-effectiveness study can be weak in debates. Cost-benefit analyses and the quantification on non-quantifiable elements (e.g. ecological services) contain a lot of uncertainties. Sometimes the methodology just leaves out factors for which there is not enough data for quantification, so the results of cost-benefit analyses should be treated with reservations, and they may be not too convincing for a lot of important stakeholders. It is not very common that private investors can be involved in large scale, complex nature conservation projects in Hungary.

Based on these SWOT characteristics **the way forward** for economic optimisation is to develop and implement complex local economic development plans based on the NbS, involving as many local stakeholders as possible. Costs and benefits (if possible, at landscape and farm level) have to be presented to farmers, decision makers responsible for public funding, banks, investors, insurance companies to channel resources into the projects. We will build on WWF’s Bankable Nature Solutions initiative and its knowledge base to find financial sources. Complex regional marketing will be initiated to promote local tourism.

5. Policy/regulation optimisation

Strengths. WWF is very active in policy and lobby work and our pilot projects are directly linked to those activities. A fundamental aim of local projects is to pioneer transformational changes. The pilots will serve as best practices for mainstreaming NbS into policies. The local, regional and county level decision makers of key sectors (agriculture, water management, nature conservation) are directly involved into the projects. Some national and global targets for human wellbeing, climate change and biodiversity have been identified as part of the NbS design for the pilots.

Weaknesses. Planning is in initial phase, sharing experiences will come later. Not all relevant goals are identified and included in our projects yet. Not all of the important national level decision makers have been contacted yet.

Opportunities. The well communicated success of pilots may be very impressive for stakeholders of similar landscapes and help lobbying. In case land users can get profit by NbS that will give a great impetus for lobby work. Supranational goals may be tools to force the support of national governments for NbS (as seen e.g. for RRF). The EU Green Deal, the EU Biodiversity Strategy, Farm to Fork Strategy, national WFD management plans, the new CAP represent somewhat integrated perspectives. The green architecture of the Hungarian CAP Strategic Plan includes several measures that could encourage farming based on water retention after 2023.

Threats. Short term interests, fighting economic and social crises may be obstacles for solutions sustainable in the long term. The war and the related energy, food crises, inflation have shrunk the EU's ambitions to reach sustainability goals. The centralized system of public administration in Hungary leaves little space for NGO interest representation, so we can proceed only by little steps forward. The Hungarian government often criticizes progressive, green EU initiatives like the Biodiversity Strategy, so many of the EU level **opportunities** cannot be used on a local level.

Based on these SWOT characteristics **the way forward** for policy/regulation optimisation is to analyse EU and national strategies, policies and actions in depth to explore how sustainability goals can be integrated into development and everyday action. NbS design, implementation and lessons learnt of our projects and previous experiences are to be shared with decision makers in agriculture, water management and other related policy fields from the early stage of planning. A targeted CAP subsidy system is necessary for NbS and NWRM to make these alternatives realistic for land users and incentivize land use change. In the Bereg, research of the project will help to understand farmers' motivations and based on that proposals will be elaborated for better targeted subsidies. We will lobby to ensure that these proposals are incorporated into the Hungarian CAP measures.

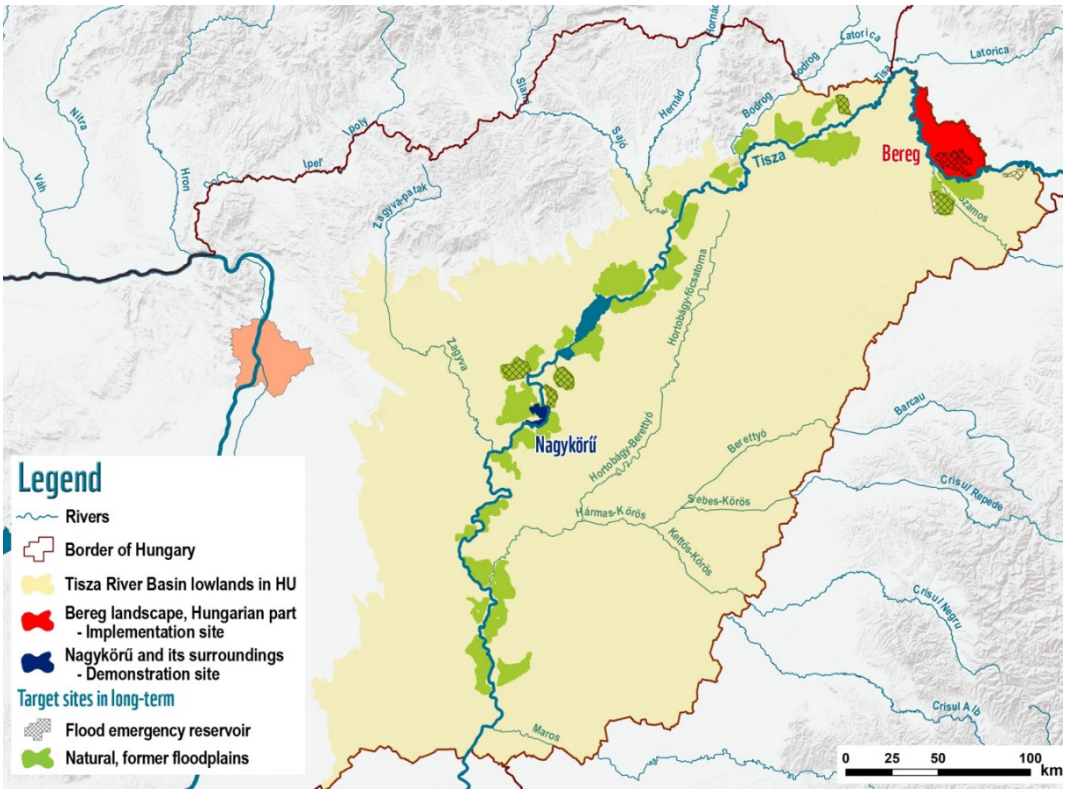

Figure 36 The Hungarian stretch of the Tisza River with the demonstration and implementation sites

3.3.6 Case study 10 Blue Belt (Germany)

Authors: Michael Gerisch (BfG), Elmar Fuchs (BfG), Andreas Anlauf (BfG)
Reviewed: Sebastian Birk (UDE), Daniel Hering (UDE)
BfG: Bundesanstalt fuer Gewaesserkunde (Federal Institute of Hydrology)
UDE: Universität Duisburg-Essen (University of Duisburg-Essen)

The MERLIN case study 10, "Germany's Blue Belt" (BBD) is a national restoration programme that sets the frame for implementing individual restoration projects within the network of Federal Waterways (Figure 37). The major aim of the BBD is to restore river and floodplain biodiversity and re-establish a functioning habitat network along the large rivers in Germany until 2050. There is no legal obligation to implement BBD-measures, which means the programme depends strongly on voluntary commitment. The BBD aims not in improving conditions for shipping and navigation; it has a clear restoration focus. Requirements for navigation and shipping are, however, the most important boundary conditions that needs to be considered (BBD restoration projects must not impede navigation!). The BBD consists of three major administrative bodies (for which recommendations are formulated in this document): BBD-steering group (SG, ministerial steering), the implementation partner (IP, those who are responsible for the single projects, generally an association or a Waterway Office) and the BBD expert group (EG, the technical and scientific support group).

The projects are (formally, not necessarily functionally) independent from each other. They might differ tremendously in the ecosystem covered, in the type of restoration measures applied, in their size or in the approval and stakeholder processes adapted. Hence, optimisation recommendations cannot be general and must be project specific. In the frame of MERLIN, such a project-specific evaluation is not possible for BBD. However, we identified **strengths**, **weaknesses**, **opportunities,** and **threats** on a higher, programme-related scale that may be considered general for the entire BBD. Our elaboration therefore is more on a strategic or conceptual level. For example, "[...] which additional GD goals are relevant to the restoration case" cannot be answered for our scale, but we tried to provide recommendations how to address this aspect (consideration of multifunctionality) when projects are to be designed or implemented.

1. Multiple goals optimisation

The main **strength** of the BBD is the tight connection between the "biodiversity-sector" and the navigation and shipping sector. With this, the two most important fields of conflict have joined together to restore waterways and at the same time enable shipping and navigation. This is a valuable foundation for fostering nature-based solutions and multiple goal achievement. Moreover, although being primarily a restoration programme with biodiversity protection/enhancement as top priority, the BBD is focusing also on sustainable transport, flood resilience, water quality, health and well-being, climate protection and regulation (although far less prioritized). The BBD strongly supports large-scale projects that include floodplain restoration and rewetting to increase Carbon and Nitrogen storage and to allow for recreation and also regional development. Hence, the implementation measures serve multiple "political" targets: primarily those resulting from EU Habitats and Water framework directives, but also on national strategies on water transport, water supply, human well-being, and also economic prosperity.

One of the **weak** spots of the BBD is the requirement to not impede navigability and shipping, which is the most important trade-off and big hurdle when it comes to restoring federal waterways. But although the BBD aims in resolving this field of conflict (e.g., by involving both the environmental and navigation sector in the BBD-steering group), restoration often falls short behind the major use of navigation and needs to be built around it rather than include navigation as part of the solution.

Another problem that may complicate linkages to other sectors and societal groups is the imbalance of the addressed GD-goals: restoration and biodiversity enhancement is a top priority for the BBD; the participation of the navigation sector is mandatory to maintain navigability of the river. Other challenges (like climate change) are considered important but are not anchored in the BBD programme and thus are not considered in the design of the measures. There is no formal way to prioritize other societal challenges. For example, although climate change increased tremendously in its importance during the last years, there are no suggestions/proposals which type of measures should be primarily implemented to mitigate or adapt to climate change and enhance biodiversity. This is maybe because for many GD-goals or societal challenges (such as well-being, green growth, partly climate regulation) the consortium does not have the necessary knowledge/competence how to assess and monitor the social importance, requirements and success of measures.

Opportunities for a stronger multifunctional perspective of the BBD arise from the public perception of global change and global crises (e. g. biodiversity crisis, droughts and extreme flood events, global political crises) and its consequences (increasing demand for biodiversity protection, agricultural and flood protection areas, areas for energy production and for economic prosperity, but at the same time tight public finances) and that effective actions are needed quickly. If communicated properly, this could increase acceptance for and relevance of river and floodplain restoration for the public. Another **opportunity** is certainly the EU restoration law and national activities to combat climate change using nature-based solutions. These strategies will provide important legislative and monetary frameworks for many sectors, e.g. for spatial planning. **Opportunities** emerge also from the increasing relevance of ecosystem services in cost-benefit-analyses: if multiple goals (and hence multiple ESS) are addressed by an implementation project there might be additional justifiers (other than purely monetarily costs) at hand.

Threats to the BBD may result when biodiversity protection falls further behind competing claims of other sectors, such as navigation, agriculture, flood protection or others that need area/space for their activities and when these issues are prioritised over nature. For example, socio-cultural or economical changes in a society (e.g., modal shifts, energy and agricultural demands) can change the balancing of requirements and actions towards "improving navigation and infrastructure, sacrificing nature". But a **threat** might also be the over-prioritization of restoration (and also for conservation) e.g. although increasing human well-being is a general aim of the programme, it is only rarely considered on the implementation scale of the BBD and often overweighed by biodiversity demands (that means, restored areas are predominantly designed for species and biodiversity and consequently, access for recreation and relaxation will be limited in these areas). This is threatening public acceptance and the relevance of the programme (although it might be more effective from a restoration/conservation side). The rather “in vogue” multi-functionality of measures might therefore become threatening for restoration, as it might be very inclusive for people but less effective for biodiversity, which may impede the overall goal achievement of the BBD.

Based on these SWOT characteristics **the way forward** for multiple goal achievement is to widen the biodiversity focus of the programme and to integrate river and floodplain restoration in a broader spatial context, like e.g. riverine landscapes, and in the system of societal goals that are urgently needed to address. By stronger linking the programme to climate change related action programmes or strategies regarding agricultural changes and to economic sectors, it may increase public/social relevance and step out of its “biodiversity-navigation bubble” (without, however, losing that focus) and put restoration on a broader basis. As the BBD is a “framework restoration programme” on a national level, it is not possible to elaborate the importance/relevance of single GD-goals. However, the following recommendations to “broaden the scope” of the BBD can be given. The recommendations are targeted both for the implementation partner (IP) and the BBD-expert group (EG):

1. Establishment of a structured analysis on which Green-Deal or societal goals are mostly relevant and beneficiary for the Blue Belt (and vice versa: for which goals the BBD can contribute most) (EG)
2. Developing a process of prioritisation that includes strategic (e.g., which societal challenges needs to be addressed in a given watershed/region and what kind of measures could be built around that) and also technical aspects (regarding the design of a nature-based solution; how NbS can maximize biodiversity benefits and simultaneously serve other goals) (EG)
3. Setting up a communication and participation strategy to highlight multi-benefits of restoration measures also for other sectors, not only biodiversity. (EG)
4. Including the formal requirement for each implementation project to outline the impact on other societal challenges/goals (with some being prioritized) and to establish procedures to stronger weigh these issues into the approval of the method (EG) (IP)
5. Increase awareness and knowledge within the project consortium on how to consider and how to measure other challenges than biodiversity (esp. social challenges, economic aspects) and how to evaluate the success of measures also for these challenges and goals. (EG)
6. Initiating proper stakeholder involvement processes before and after project implementation (see also next chapter). (IP)

2. Societal optimisation

The main **strength** of the BBD is that stakeholder participation has a prominent position in the planning and implementation process. Interactions between biodiversity, shipping & navigation, regional development and recreation are acknowledged and regularly assessed during the design of the implementation measures to

reduce conflicting goals. The Blue Belt is accompanied by a stakeholder advisory board, which comprises high-level representatives of major stakeholder groups on a national level. Hence, important strategic and fundamental issues are discussed and agreed upon at an accepted basis. Another **strength** of the BBD is that there is a lot of experience how to organize stakeholder participation, how to consider their objections and inputs and also how to harmonize conflicting goals and views into a coherent concept.

A **weakness** is that although stakeholders are involved at all levels (national, regional, implementation scale), the process itself is not always very transparent and supposedly only partly inclusive. Authorities are clearly the main type of stakeholders that are integrated. Involvement of public stakeholder (e.g., local residents, landowners, farmers, companies, tourist associations etc.) is often postponed to formal approval processes, unless it is absolutely critical to involve them earlier. Systematic stakeholder mappings are usually not conducted during planning of implementation measures. There is also often a certain self-understanding of the administration that implementing measures (and the measures itself, and also the reconciliation process) "belong" to the authorities and hence they decide who may participate. Therefore, decision making is not very transparent for third parties. Certain sectors, especially agriculture, are regularly affected by restoration projects (mainly because they claim the same areas) and considered important stakeholders. Nevertheless, they are rarely considered "real partners" but rather should subordinate (e.g., their farming practice etc.) to biodiversity-related goals, which impedes real cooperation and can foster mistrust among the partners.

The increasing public awareness of ecosystem services is an **opportunity** to highlight/communicate benefits of restoration for society (or more specific: the local communities) and therefore to increase acceptance of the implementation measures. It may be also an incentive for other sectors including the private sector to participate into restoration actions and provide financial or other support. As climate change and the biodiversity crisis are acknowledged to cause disservices to many sectors it probably makes it easier in the future to mobilize stakeholders to work together "with nature". Most promising in this regard is intensifying cooperation and discussion with both the agricultural and the economic sector, which will need to adapt to changing environmental and societal conditions. Moreover, legislation will change (CAP, restoration law etc.), so that a "more inclusive BBD" might be a nucleus to form alliances for freshwater restoration based in NbS.

A major **threat** is that the process of coordination, implementation and planning can take much longer (up to several years) if many stakeholders are involved. Also, stakeholder "demands" may modify the initial project idea in an unintentional way (i.e. with dis-benefits to biodiversity) and they could block the implementation if they don't feel that their input was considered. The whole process of "harmonizing" can paralyze the process if it is not professionally moderated and each partner insist on their objectives.

Based on these SWOT characteristics **the way forward** for societal optimisation is by being even more inclusive, communicative, transparent and on equal terms. Most importantly, early and equal participation of relevant stakeholders should be mandatory to develop balanced targets for a given region and identify/communicate/solve tasks and responsibilities in order to mitigate conflicting goals right from the start. Following optimisation potential can be seen. The recommendations are targeted for the BBD steering body (SG), implementation partner (IP) and the BBD-expert group (EG):

1. Systematic stakeholder mapping processes/procedures needs to be defined and established to integrate also interest groups that are usually postponed to formal authorization processes or otherwise overlooked. (EG)
2. Communicate available BBD showcases to the public to display the multiple benefits society can obtain from and to attract for more project applications. (SG)
3. As a prerequisite for funding, each project needs to go through an early stakeholder participation phase in which all relevant stakeholders were involved. (IP)
4. Establish informal meetings on a regular basis to continuously matching goals and address open issues or contrasting ideas and a basic understanding of everyone's needs and objectives. (IP)
5. Professional moderation/mediation of this reconciliation processes to accelerate planning speed and to "leave no one behind" by externals who "speak every language". (IP)
6. Providing documents accessible for everyone describing the goals of the project, the decision-making process, potential alternatives and also objections of the stakeholders. (IP)
7. Incorporate and develop procedures of pre-planning on a broader spatial (more strategic) scale, e.g. how/where is it possible to combine restoration with solving urgent other societal challenges and what needs to be done when potential areas or "problems" have been identified. (EG)

8. Especially for projects that extend beyond (not only legislative) boundaries their advisory boards must include (a) responsible bodies/persons from the governmental level, (b) from the level of the Federal States and (c) representatives of the most relevant stakeholders that cover these scales (link to stakeholder mapping). (IP)

3. Technical optimisation

The main **strength** of the BBD is that it builds upon a comprehensive scientific study (publicly available) on the **threats** and the status quo of riverine and floodplain habitats and species as well as on restoration needs and potentials. The "restoration objects" of the BBD are in large parts complementary target elements for both the WFD and the Habitats Directive. One the one hand, this leverages synergies with political aims of the EU and Germany. On the other hand, this complementarity sets a basic understanding for measure multifunctionality within the BBD. Although being primarily a restoration programme, a **strength** of the BBD is that is proposes a set of 39 types of measures (e.g., removing riverbank fixation, reconnecting floodplain oxbows, dyke relocations) that can in principle enhance biodiversity and simultaneously fulfil also navigational requirements. Moreover, many of them potentially serving also other GD-goals (such as flood and drought resilience, well-being). Especially measures to restore floodplains or riverbeds are stimulated by the BBD to enhance flood and drought resilience, climate regulation, zero pollution, human well-being, sustainable transport and food production.

There is consensus among the partners that monitoring and evaluation are important cornerstones of the BBD. Each implementation project is evaluated against the overall goal biodiversity net-gain and the success of the entire programme needs to be reported regularly against the federal government. Principles of monitoring schemes (including indicators, intervals, responsibilities, reporting, costs etc.) were developed (some of it still in progress) and monitoring programmes are already applied and have a long-term-character. Monitoring of implementation measures and progress of the entire programme will be coordinated by a scientific expert group.

A technical **weakness** of the BBD is the lack of a systematic restoration strategy. Planning and evaluation of single measures are mostly conducted isolated from other measures, a "network character" or a "chain of measures" this not yet visible in practice (maybe because the BBD is still in a rather early stage), but also not on a conceptual level. There is no strategic prioritisation (e.g., which areas are important hotspots for biodiversity, which ones are (just) corridors/stepping-stones, where to implement measures to maximize biodiversity efforts on larger scales, where are the largest potentials for NbS etc.). There is still strong dependency on the good-will of the local authorities to implement measures. Another **weakness** is that monitoring is mainly restricted to biodiversity effectiveness of restoration. Additional benefits (e.g. flood protection, drought resilience, climate change regulation, recreational options, sustainable food, green growth) or trade-offs are rarely evaluated, mainly because they are not in the focus of the measure, but also because indicators are often not identified and outside of the competence circle of the partners. A monitoring & evaluation handbook is still in progress, but it will address mainly ecological, morphological and chemical aspects. Most likely, it will not contain indicators to evaluate if other GD-goals are met, nor will it provide information on how these "classical" indicators can be used as proxy for other GD-goals. Monitoring should inform the partner about best-practice and provide knowledge to them. However, BBD-specific learning frameworks are only poorly established and there is no systematic process to share/upscale experiences from local projects. Another **weakness** is the non-existence of a common reporting or communication strategy of monitoring results. Experiences and knowledge mostly remain at the responsible implementation partner and are no subject for further analyses. There is also no risk management available.

Opportunities emerge mostly by the strong increase in staff responsible for restoration and ecological management of waterways in the WSV in the coming years. This will provide a boost in manpower and also in restoration knowledge. This will (a) shift implementation speed and (b) provide chances to strategically implement measures within the entire network of waterways. An **opportunity** is also the increasing interest of universities and research institutes to cooperate with the BBD. The monitoring data could be used to analyse and generalize findings and increasing scientific knowledge on upscaling restoration. In this context, measures following the NbS principle can be developed, realized, monitored, and evaluated. This then serves as basis to demonstrate the ecological effectiveness of NbS compared to conventional solutions. Communicating these efforts to the public and involved administrational bodies clearly can contribute to mainstream NbS in public acceptance, riverine engineering practice and respective legal frameworks.

Threats can emerge from the unwillingness of sectors (especially navigation, but also agriculture) to implement multifunctional measures (because it won't fit exactly their needs) and their unwillingness to accept or make compromises. This imposes the risk that measures are too strongly conceptualized around biodiversity and

therefore remain in a “biodiversity bubble”, which could a) impede/ slow down/ complicate implementation and b) cause a loss of acceptance in the region for further methods. There could also be danger that interests are unbalanced (e.g., strong lobby of navigation vs. weaker lobby of the biodiversity community) and multifunctionality is used to “greenwashing”, so that ecological impacts will be too marginal to be functionally effective. **Threats** may also arise from changing political, societal or environmental conditions (e.g. extreme floods and droughts, invasive species, intensity of farming, urban escape, austerity, shifts in political importance of certain activities etc.). This would have financial consequences (see Chapter “Economic optimisation”), but potentially also affects the size, arrangement, quality and connectivity of restoration sites and measures. As there is no specific “risk management” available for the BBD, there is a potential uncertainty how to manage unintentional restoration trajectories and a risk of low success.

Based on these SWOT characteristics **the way forward** for technical optimisation is to improve communication on the benefits of multifunctionality, improve monitoring workflows, **strength**en adaptive and risk management and establishing learning procedures. Following recommendations can be given. The recommendations are targeted for the BBD steering body (SG), implementation partner (IP) and the BBD-expert group (EG):

1. Set up a science-based, systematic restoration strategy to strategically conceptualize and implement restoration measures/ NbS. (EG)
2. Strengthening the role of monitoring and improve workflow between implementation partner, scientific partners and coordination by finishing and further developing the monitoring and evaluation handbook. (EG)
3. Compile best-practice experiences and develop strategies and methods to limit failure, increase technical (and financial) effectiveness of NbS. (EG)
4. Intensifying the identification of linkages between BBD and other programmes and initiatives (outside the restoration and navigation world) to stronger, jointly contribute to EU-green deal goals, to share resources and put the process on broader footings. (SG)
5. A stronger communication that monitoring is not a self-purpose and more than "data collection", with also economic, scientific, PR benefits. (EG) (SG)
6. Publish the results of monitoring on a regular basis and with a high public profile. (SG) (EG)
7. Implementation of a comprehensive and easy-to-understand reporting of monitoring results (in terms of lessons learned) to the public, relevant stakeholders and responsible governmental bodies. (EG)
8. Establish a procedure/forum to "learn and adapt" (e.g., regular inspections of projects, alignment of goals & expectations, identification of changes and suggestion of adaptation). (EG)
9. Include adaptive management costs in the overall investment costs of an individual project. (EG) (IP)
10. Stronger cooperation with universities to analyse data in a scientific way. (EG) (IP)
11. Increase the cooperation with other sectors (e.g. through proper stakeholder process and early integration) to elaborate synergies and potential measures and indicators. (SG) (IP)

4. Economic optimisation

The main **strength** of the BBD is that its endurance and hence also basic long-term-funding is secured by a cross-ministerial agreement, formal budgets and dedicated staff positions for the authorities. Additionally, **opportunities** for third-party funding exist (e.g., from associations, municipalities). A further **strength** is that stakeholders are included at all organizational (strategic, conceptual, implementation) and spatial scales (national, regional, local). During formal and informal meetings, they are enabled to contribute their objectives and to balancing trade-offs among the different parties involved. The BBD is jointly steered by two federal ministries and accompanied by an advisory board and by a scientific expert group, which review trade-offs regularly and make recommendations to dissolve them or which to prioritize.

A **weakness** of the BBD in this regard is that municipalities who wish to implement measures need to provide own resources to use Blue Belt-funding. Although these are only small percentages of the overall financial costs, this is a major stumbling stone for many cities, counties, and smaller associations. Another **weakness** is that cost-benefit-analyses are usually not conducted for the implementation projects. There is the need to provide budget documents for formal approval of the measures, but in these documents, the role of financial costs of the measures far outweighs the role of benefits for society even in monetary terms. Ecosystem services are usually not addressed or literally are only used as “justifiers” in such analyses. A potential **weakness** is also, that the door for private, innovative funding (crowdfunding, donations etc.) is not explicitly

opened and not considered an option for the BBD. Furthermore, the BBD does not specifically communicate the connections between biodiversity protection through restoration and economic growth (besides tourism and the vague term “regional development”), for instance to raise incentive for corporations to involve in restoration.

Opportunities: In general, there is some potential of sharing monetary costs of measures, especially if the multi-benefits of river and floodplain restoration are communicated and “sold” also to other sector groups and especially then, when they are involved in those projects. As climate change and biodiversity crisis are acknowledged problems in society it could make it probably easier to mobilize stakeholders and sectors to work together "with nature". The increased public awareness of the role of ecosystem services for society/communities may also contribute to this. This offers a big **opportunity** to include ecosystem services quantitatively and qualitatively in “conventional” economic cost-benefit-analyses, in the end displaying the value of currently non-regarded co-benefits, even in monetary terms. Another **opportunity**, especially in situations of decreasing finances, is to combine multiple goals which can potentially decrease costs (can be possibly shared), which will in turn “advertise” the collaboration between sectors in this regard. Moreover, a better use of universities can be helpful in keeping costs low.

Threats for the BBD emerge, on the one hand, through costs. Increasing costs and decreasing financial margin of the public sector may paralyze the implementation process. Moreover, changing legislative frameworks, as well as market-based or climate-change-induced conditions may boost the monetary costs of restoration and lower the economic efficacy of restoration. In this regard, it can be seen a **threat** if financial costs remain the most important “justifiers” and other aspects, such as ESS, are not included in CBA or budget documents. Another **threat** is: Monitoring costs money and there are general financial restrictions and limitations (10 year-funding after implementation of measures) for monitoring, whereas it is not sure if this is a sufficient time span to fully understand the dynamics of restoration.

Based on these SWOT characteristics **the way forward** for economic optimisation is to:

1. Boost active networking: To date, restoration projects are the “monopoly” of either authorities or large environmental associations or foundations. Smaller, individual or less “financial powerful” interest groups are usually not able to trigger restoration. The BBD could and should provide a forum also for these stakeholder groups, in order to form alliances, especially for counties, small associations, individual people, corporations etc. This could tremendously spread costs. (SG)
2. Establish proper cost-benefit-analyses into the BBD approval process. Scientifically (not just financially) sound CBA should be mandatory and a prerequisite for local projects. For this, a hands-on guidance how to incorporate that is to be developed. (EG) (IP)
3. Integrate ecosystem services into CBA in order to evaluate the impacts of a given/planned restoration project to a multitude of societal goals. Prepare a suited generic framework for realizing this recommendation. (EG)
4. Communicate results of such overall societal CBAs to relevant sectors, including the financial sector, to provide powerful arguments for preparing and realizing a transformative change in conventional regulations and behaviour. (EG) (SG)
5. Intensify collaboration with universities, e.g. dedicated science- programming to be in line with BBD objectives. (EG)

5. Policy/regulation optimisation:

The main **strength** is that the BBD is jointly steered by two ministries (environment, navigation) and their subordinate authorities. This allows for generating a basic understanding among the different partners and in that way a very powerful mainstreaming in administration and politics. A good example and important achievement in this regard is that the BBD has already provided strong impetus for modifying national laws & regulations (e.g., by (1) adopting of the new task of the German Waterways and Shipping Administration to actively restore rivers and floodplains, which was legally stipulated in the German waterway act and (2) of re-defining the official waterway network towards a stronger nature based classification) and therefore also changed budgetary frameworks and also areas of responsibilities for the administration. This shows the high degree of synergistic overlap of the BBD with the EU WFD and HD and the potential to mainstream ecological aspects in administrative tasks if there is strong commitment. Helpful is, that the steering group consists of high-level representatives with extensive responsibilities. Another **strength** is that, compared to other/pure restoration activities, the BBD intrinsically addresses also other societal challenges, not only the biodiversity crisis, but also fostering climate regulation, floods and drought resilience, human well-being, sustainable

transport and zero pollution. This further opens the gate to harmonize restoration activities with other sectors and mainstreaming the idea of restoring river and floodplain for the benefits of others.

This **strength** of the BBD is at the same time a **weakness**: it's administrative structures, processes and responsibilities are hierarchical and historically set for each partner individually. This may sometimes lead to lagged decisions, over-carefulness and in reluctance to think out of the boxes. Moreover, only two sectors are directly involved (environment, navigation), others only via advisory board or later during planning and implementation phase of the local projects. A mainstreaming-**weakness** is also that it is not communicated so far how NbS or restoration can benefit other aspects, which makes it probably hard for other sectors to "jump on the restoration train". A sound and effective communication is a general non-regarded issue, because until now there is no common communication strategy available: PR depends on the good will of the project management and implementation partner.

Opportunities emerge from the strong linkage of the BBD to the WFD and Habitats directive and the clear understanding (among the BBD-partners, but also among authorities and politics in general) that measures of the WFD serve, in principle, also nature conservation and vice versa. There is now at least a basic understanding between two different sectors (water-related conservation, water management), which can serve as a nucleus for promoting an even stronger multifunctional river and floodplain restoration. One example in this regard is the new legal "restoration task" of the Federal Waterway and Shipping Administration, which is laid down in the National Water-Management Act and which enables them to actively restore riverine and floodplain habitats, even if there is no relation to navigation and shipping. Another **opportunity** for mainstreaming is the upcoming EU restoration law, which is fostering active restoration outside of protected areas and which should impact different sectors and authorities. At the level of Germany, there will be an action plan for "nature-based climate protection", which can be considered an implementation tool for climate and biodiversity strategies of the EU. This will provide massive financial support and strives for a cross-sectoral and cross-administrational problem solving. These facts strongly support the mission-oriented innovation policy of the EU, which is set by the Green Deal targets. On a national level, we expect incentive for realizing a transformational change on the basis of the German Federal High Tech-Strategy 2025, in which the preservation of biodiversity as well as a good life without unemployment are stated as 2 of 12 missions.

Threats for the BBD can emerge if important partners omit their commitment and therefore also **threat**ing the base funding for the programme. Another **threat** (or rather a stumbling stone, because time will probably change that) is that the new "restoration task" still is not widely perceived and acknowledged within the waterway and shipping administration. Navigation/shipping is still the top priority task and decision makers still look rather on risks and financial costs of restoration, lack of tangible financial benefits and on compliance with formal procedures (which is good on one hand) than on possibilities, chances and creative solutions. This can paralyze and resign many stakeholders that want to "go green" together with the WSV. **Threats** for mainstreaming will generally emerge if important stakeholders are not integrated and if tensions and contradictory targets of authorities, implementation partners, societal groups are not well mediated or moderated.

Based on these SWOT characteristics several aspects of policy optimisation can be identified. The recommendations are targeted for the BBD steering body (SG), implementation partner (IP) and the BBD-expert group (EG):

1. Most importantly, restoration must be accepted as important future task by decision-makers and "staff level" of the Waterway and Shipping Administration *before* mainstreaming in other sectors will be successful. Therefore, BBD should increase the work on further extending the principle that river restoration is as equally important as the genuine task of maintaining navigation & shipping. This could be done by either training & education, regular field visits and exchange of ideas especially for decision-makers. An important option will be to formally change jurisdiction, e. g. by modifying existing laws and regulations in order to put these (often competing) tasks on similar levels of jurisdiction. (SG) (IP) (EG)
2. To make the BBD relevant for other policy sectors and also "fit for the future", it is recommended to develop arguments and narratives that clearly display the contribution of BBD to mission-oriented innovation policy in terms of the German Federal High Tech-Strategy 2025. (SG)
3. The data and results of scientific monitoring and evaluation need to be prepared and synthesized in an easy-to-understand way in order to show policy-/ decision makers the need for further action and also cooperation with other sectors. (EG) (SG)
4. A communication strategy/process as well as learning and sharing procedures to exchange ideas and experiences on success and failures of multifunctionality and NbS could improve the mainstreaming progress. (SG)

5. Establish ecosystem services as important evaluation criterion for important infrastructure projects (e.g., at the scale of strategic environmental planning), but also implement such strategies in planning processes for other ministries (e.g. Ministry of Transport, Ministry of Environment, Ministry of Economics and Climate Protection, Ministry of Food and Agriculture, Ministry of Health, etc.). (SG)
6. Further improve informal grievance mechanisms to harmonize contrary goals in order to achieve win-win situations and multifunctionality as a sign of “good governance” and a basis for mainstreaming restoration. (IP)
7. Improve/formalize a proper stakeholder mapping process for the regional and local scale to include all relevant sectors with “mainstreaming potential”. (IP) (EG)

Figure 37 Spatial setting of the case study “Germany’s Blue Belt”. Bold blue lines represent Federal Waterways that are subject to application for BBD restoration projects within the BBD program

4 Summary findings per cluster

This chapter gives the summary findings per cluster for each of the five aspects that are reported in the individual case study optimization plans.

4.1 Peatlands & wetlands

4.1.1 Multiple goal optimisation

Table 5 Relevant Green Deal indicators for the case studies on peatlands and wetlands. Please note that the scoring may differ between case studies whether the indicator already has been or will be used, and whether the indicator is an explicit main goal or implicit side goal. Note that the Forth optimization is reported under the small streams and basins section, but the peatland restoration part is also included here in the peatlands & wetlands cluster.

Case study	1	3	5	6	12	14	17
Green Deal indicators	Kvorning (DK)	Beaver (SE)	Kampinos (PL)	Hutovo Blato (BiH)	Lima (PT)	Oulujoki (FI)	Forth peatlands (UK)
Biodiversity net gain	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Climate regulation	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Flood resilience	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Drought resilience	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Health & well-being	Yes	Yes	Maybe	Yes	Yes	Yes	Yes
Zero pollution goals	Yes	Maybe	Yes	Maybe	Yes	Yes	Yes
Sustainable food systems (F2F)	Yes	No	No	No	Maybe	Yes	No
Sustainable energy	Yes	No	No	Yes	No	No	No
Sustainable transport	No	No	No	No	No	No	No
Inclusivity	Yes	No	Yes	Maybe	Yes	Yes	Yes
Circular economy	No	No	No	No	Maybe	No	Yes
Financing the transition	Yes	No	Yes	Maybe	Yes	Yes	Yes
Green growth	Yes	No	Yes	Maybe	Yes	Yes	Yes

Climate regulation through carbon sequestration is an important goal in the peatland wetland-cluster next to biodiversity net-gain (Table 5). Installing monitoring systems for GHG emissions is seen as a way forward to improve the knowledge and understanding towards reaching this goal. Exchange of knowledge on this topic within the MERLIN project is also mentioned as potential way forward, especially by partners who are only now starting to include this topic in their activities (BiH, PT, PL).

Local communities need to be further educated on how restoration measures are contributing to multiple goal achievement. This will enhance the dialogue as often some of the 'additional goals' next to biodiversity net-gain are those goals of interest to local stakeholders, especially concerning floods and droughts and at the same time this contributes to the goal of inclusivity. Looking for climate-adaptation solutions to floods and droughts should be sought together with stakeholders, such as for example potential role of paludiculture and other climate-smart agricultural solutions. Clear decision-making guidelines that underline the multiple goal objectives will be helpful to optimize this aspect.

4.1.2 Societal optimisation

Stakeholder involvement from the early onsets is crucial in the implementation of restoration measures. Specifically, the involvement and participation of landowners can be a make-or-break factor in implementing measures. In Denmark this involvement and participation is solely voluntary which is communicated from the earliest onsets of the project. This appears to be a useful approach as no pressure is put on people, which gives them more ownership on the decisions. The availability of land consolidation opportunities further helps negotiating the freeing up of lands for restoration. For this the responsible authority Naturstyrelsen has been buying up some farmland from farmers that were keen to sell, and this land is used in the land consolidation negotiations with other local farmers. Also, in Kampinos National Parks (PL), Forth (UK) and Lima (PT) the local land owners play an important role in the speed of the process for implementation. Here, there are additional

challenges due to the lack of clarity of responsibilities between landowner and tenant, and cadastral ownership challenges may limit the progress. For example, often a larger scale process is limited due to some very small plots still in hands of private partners that might not be open to change.

Floods and droughts directly affect local communities and may be a good reason for people to start being interested in restoration of wetlands, floodplains and peatlands. It is clear that bringing these aspects into the conversation, next to a pure biodiversity restoration goal, makes people more interested to join in the dialogue: there are benefits to gain for them from the restoration project. However, lack of correct knowledge on these processes and how restoration through re-wetting may influence floods and droughts may create mis-informed discomfort and resistance with local communities. It is paramount that people are sufficiently taken on board in the process of coming to the restoration plan and are explained about the system functioning in a way they understand and can relate to. This provision of knowledge should include information on both services and disservices (incl. methods to overcome potential disservices).

To enhance dialogue with stakeholders it should be considered if the core-team responsible for the implementation of a restoration project is sufficiently diverse: are social scientists/governance specialists/communication experts on board who can help in creating the right setting and atmosphere for co-design and co-management?

Broadening the group of stakeholders beyond the 'standard group' is seen as a good way forward in working towards upscaling. The various EU projects that use the case studies are seen as very beneficial to increase opportunities for long term relationship building and exchange of ideas.

4.1.3 Technical optimisation

For many of the case studies in the peatland-wetland cluster carbon sequestration and reduction of GHG emissions is high on the agenda next to biodiversity goals. Re-wetting methods ranging from stimulating beaver dams, blocking drains, clearing inflows to the wetlands from debris and inundation of damaged peatlands are the most common strategies to work towards this goal. However, there is still a strong lack of good understanding and prove of how these re-wetting efforts have an impact on carbon sequestration and emission processes. Questions exist on how these chemical processes can be best monitored, quantified and put into longer term perspectives, e.g. under changing climate and the effects of extreme droughts and floods in years to come.

It is unclear under which conditions re-wetting is beneficial for reduction of GHG emissions, and the role of water quality in this is not well specified yet. It is known from literature that poor water quality will induce more GHG release especially in waterlogged situations, which may counter some of the perceived benefits from the re-wetting, but to what extent this may occur is unclear and difficult to quantify at present. In the Finnish case re-wetting is associated with a potential risk of increasing GHG emissions (especially directly after the restoration works have been implemented) while in the other case studies in the cluster it is expected that measures will help wetlands to be a sink for carbon. Additionally, the seasonal fluctuations in these processes are not yet well understood and further scientific work is needed to fill these knowledge gap.

A good understanding of the hydrological functioning is not present in all cases. Some cases will benefit from further working on getting a wider understanding of the current functioning and the hydrological functioning under both further climatic change and as results of the measures implemented. Further linkage of water quantity analysis also with water quality models is a logic additional step to be taken, providing that sufficient monitoring data on this becomes available. Several case studies indicate the need to establish a better long-term monitoring to start working towards such quantified system understanding.

In many cases not all green deal indicators are being monitored. This is partly due to lack of expertise and partly due to financial challenges. The WP1 efforts of MERLIN are helping to overcome some of these obstacles and pave the way for future integration of this knowledge into regular monitoring programs.

For technical optimization it is also important to establish proper plans for maintenance and after-use after implementation of the measures and discuss how this maintenance can be carried out as cost-effective as possible. Using system understanding helps in defining optimal design of the measure and reduce maintenance costs afterwards. The role of forestry industry in the overall catchment and impact on the ecosystem functioning, plus the potential negative feedbacks of re-wetting on forestry is to be further explored.

4.1.4 Economic optimisation

For many of the case studies in the peatland-wetland cluster there is a high interest to gain more insight in the potential use of carbon crediting as a source of financial support to restoration efforts. There is still a large unclarity on how this is to be initiated and how this can be beneficial for both the entities running the restoration efforts and those owning the land (public-private cooperation in restoration projects).

Next to carbon crediting as a potential source for financing of peatlands and wetland restoration also biodiversity/habitat banking (BiH/PT) and nutrient trading (UK) are mentioned as options to create financial means to further the restoration efforts.

In general, there is a lack of understanding on how to engage private financing entities in restoration activities as additional financing next to the public funds available for restoration. There private entities may also be companies in the direct vicinity of the restoration sites who are using ecosystem services for operating their business (PL, PT). Guidance from MERLIN partners specialized in this topic will benefit case study partners.

In several cases follow-up monitoring after implementation of the measures is not accounted for in financial terms. Because of the lack of funds this leads to uncertainty about the success of the implemented measures and actions are needed to improve this situation.

4.1.5 Policy/regulation optimisation

Law enforcement may be weak and result in stakeholders not being checked sufficiently frequently resulting in uncontrolled developments in the area (PL, BiH).

Several cases have or have had a formal status of being a RAMSAR site/ protected habitat under Natura2000 etc., which helps to further work on restoration efforts.

Understanding landownership is an important aspect in being able to start an implementation process for restoration measures. Unclarity in this domain may hamper the implementation process. For example, in the UK there is a system of landowners and tenants. It may occur that either one of them is in favour or against a development but the other has the opposite opinion or cannot easily be engaged, slowing down progress. Also, if the cadastral administrative system is not up to date this may make it difficult to trace owners of cadastral plots, hampering the implementation process (PT).

Uncertainty related to future changes in policies, and complications due to contradictory or changing regulations may hamper stakeholder willingness to participate. Over-complicated application requirements, and unclear rules and limitations often putting off landowners from engaging. Discussions on ‘who does the work’ vs. ’who benefits’ may be linked to either ownership/tenure arrangements or to upstream/downstream neighbourhood relations.

Policy optimisation lies in creating flexible regulatory systems at administrative level that are agile enough to permit for shifts in priorities without compromising the timetable and goals of the European Green Deal.

4.2 Small streams and basins

4.2.1 Multiple goal optimisation

Table 6 Relevant green deal indicators for the case studies on small streams and basins. Please note that the scoring may differ between case studies whether the indicator already has been or could be or become relevant and whether the indicator is an explicit main goal or implicit side goal.

Case study	2	11	13	15	16	17
Green Deal indicators	Deba River- Basque country (ES)	Emscher (DE)	Sorraia (PT)	Tzipori (IL)	Scheldt (BE)	Forth (UK)
Biodiversity net gain	Yes	Yes	Yes	Yes	Yes	Yes
Climate regulation	Yes	Yes	Yes	Yes	Yes	Yes
Flood resilience	Yes	Yes	Yes	Yes	Yes	Yes
Drought resilience	No	Yes	Yes	Yes	Yes	Yes
Health & well-being	Yes	Yes	Yes	Yes	Yes	Yes
Zero pollution goals	Yes	Yes	Yes	Yes	Yes	Yes
Sustainable food systems (F2F)	No	Yes	Yes	Yes	Yes	No
Sustainable energy	Yes	Yes	Yes	No	Yes	No
Sustainable transport	No	(Yes)	Yes	No	No	No
Inclusivity	Yes	Yes	Yes	Yes	Yes	Yes
Circular economy	No	Yes	Yes	No	Yes	Yes
Financing the transition	No	Yes	Yes	Yes	Yes	Yes
Green growth	Yes	Yes	Yes	Yes	Yes	Yes

It is acknowledged that the presence of other stressors may limit the effect of restoration (ES) yet at the same time may also help in raising awareness of the multi-stressed nature of freshwater streams. By putting the spotlight on restoration efforts through dam removal other stressors may be brought up too and explained to the wider audience. Yet, due to the multi-stressed nature of the system, the dam removal measure may not provide sufficient results to show success and be a threat to the overall enthusiasm for restoration efforts.

Implementing a single measure will not benefit the full catchment and the scale of implementation should be in line with the expected impact on the overall catchment. Long-term and overarching visioning is therefore needed for the restoration of streams within a larger catchment. In this it will also help prioritize and demonstrate societal benefits of such an overarching vision on restoration. In such visioning the focus should be on multiple goal achievement and include not only, for instance, floods or droughts, but go beyond water quantity and include sediment dynamics, water quality and ecology. For this a good system understanding is needed and cooperation between implementation and scientific partners will be beneficial to help draft such long-term plans in a multidisciplinary team.

When defining long-term plans for multiple goal achievement there is a need to also include plans and funding for good monitoring to evaluate the multiple goal achievement - where needed in combination with modelling techniques. This will help optimizing design of the measures and overarching plans to show how best to work at scale. Increasing the scale of the NbS measure can be also a way forward so that noticeable benefits of the multiple goals can be observed.

Collation of comprehensive evidence on multiple benefits may be used to demonstrate importance of rigorous monitoring. Unlike MERLIN, most national funding schemes do not support monitoring costs (or if they do, they are small) so these data could help to change the funding landscape accordingly and maximize the impact of the case study. This is of real importance given the emergence of e.g. carbon credits, nutrient trading where quantitative data is needed to back investment.

Climate change will deeply influence the Sorraia area: there will be less water available for crops and the ecological flows, in a short time span. This will drive changes in land use, including the decrease in water demand by increasing efficiency, changes in crops, crop cultivars and farm practices. Although there will be less water used per area, the stress caused by droughts and resulting water supply decline will affect the aquatic systems. Especially the floods and flooding will decrease in number and magnitude of events affecting ecosystem functioning.

4.2.2 Societal optimisation

The dialogue on multiple goal achievement should use the language of the people in the catchment. Discussing economic losses due to floods or droughts will help in co-development of strategies that aim at this multiple goal achievement. Also, the use of target species that are easily monitored can also help in gaining support for multiple goal achievement as people normally relate easier to these species and will be interested to look out for them.

Increasing digital literacy of stakeholders (achieved through workshops and organised activities) even among older people can increase awareness of the importance of a healthy environment for a sustainable way of life. Singe restoration measures such as the demolition of a dam (ES) can draw attention to other problems that will force public-private entities to invest in its improvement, improving the health and well-being of the population.

There is a generally stronger need to communicate the benefits of restoration also on what is not directly visible (e.g. new sewers and wastewater treatment plants). Being part of a large European project benefits communication with stakeholders on implementation of restoration measures. It may make people think that the restoration measure may be a good idea after all, which can build trust between local communities and administrations. In this, implementing 'open days' for citizens at construction sites and citizen science projects can also help to actively involve local stakeholders in the monitoring of streams and -at the same time- communicate important environmental topics to them.

The Emschergenossenschaft/Lippeverband (DE) is based on a cooperative model and as such has a long history of stakeholder involvement which has a strong foundation how the water board is organized by the municipalities being members. Communication with residents is, however, mostly informative.

Among parts of the stakeholders there is a resistance to change, and even strong arguments are not convincing. Social media may have been used to spread disinformation. Local politicians are sensitive to opinions, in particular during electing times.

Involving stakeholders in the planning will help in creating a supported long-term visioning. For example, when working on wetland zoning plans, stakeholder should be integrated in the active management of these areas and the division of competences among different level authorities should be harmonized (PT). By discussing openly with landowners, a better understanding of their needs is gained to create 'win-win' situations. For example, the KRDA (IS) can improve service roads for the farmers in exchange for larger riparian buffer strips.

Sharing successful examples and organizing field visits to successful examples will help create a community of practise and increase the interest in other areas in the catchment to also join in restoration efforts. In this the relationship between 'upstream' and 'downstream' neighbours should be acknowledged: how does the work of one affect/benefit the other. This might even include dialogue regarding the financial aspects of 'who does the work' and 'who gains from the restoration works' in order to provide a level playing field.

4.2.3 Technical optimisation

There are many aspects for technical optimization in the small streams and basins cluster. Many partners emphasise the need for a holistic long-term monitoring plan that is wider than only the location of the measure, and that includes multiple Green Deal Indicators. This will help evaluation of implemented measures at the catchment scale, rather than at the individual locations of implemented single measures. For example, barrier removal can have many more benefits compared to building fish passage facilities near barriers. This movement started in the US, but in recent years have gained a strong momentum in Europe (see https://damremoval.eu/).

When defining restoration strategies for small streams and basins more emphasis can be placed on the linkage between the rural and urban areas within the catchment and provide understanding of the respective influences of them on the ecosystem. Understanding the multiple benefits from restoration and using the full list of green deal indicators will help in harmonizing this. A digital twin – such as the one proposed for the Forth-ERA project (UK) – will help optimise investments in NbS and also demonstrate the return on investments of such investments. The benefits of NbS can be determined if there are standardized and integrated multidisciplinary data (e.g. environmental, human well-being, economics) and collaboration with experts from different fields such as economists and social scientists, which is a way forward to the assessment and adaptive management of the NbS measures important.

The large-scale Emscher restoration (DE) is a good example on how to improve an entire basin in a predominantly urban context with a stepwise implementation over the course of 30 years serving multiple

goals. Over the years it has to become adaptive to address new challenges (climate change) and opportunities (cooperation with other stakeholders such as agriculture and forestry sectors).

Extremely arid regions benefit from rethinking water sources for irrigation, combining both green and grey measures to achieve this. For example, in the Tzipori (IS) treated wastewater is used for irrigation, thereby limiting the pressure of agriculture on the Tzipori stream. In addition, by technical measures, such as the construction of terraces, soil run-off is limited and rain has more time to infiltrate towards the groundwater. Limiting cattle from stream banks by active fencing and providing alternative access to drinking water for the cattle can help reduce bank erosion and limit impact on water quality.

Disservices of the ecosystem due to poor ecological functioning and lack of correct management have been indicated as additional aspects to consider when discussing the long-term restoration and management of streams. For instance, in order to avoid nuisance to residents by mosquitos, restoration measures need to be designed in a way that allows for biological competition. Also, the role of management of invasive species (both flora and fauna) is mentioned as a potential threat to the restoration efforts especially in areas that are also suffering from poor water quality (e.g. PT, DE).

4.2.4 Economic optimisation

It is generally acknowledged that talking to the land users/owners in their preferred “language” must be done more warily to convince them to implement restoration measures. Often for landowners the economic costs and benefits of the measures are the most important aspect and come before the gain in for instance biodiversity. Expressing the costs and benefits also in terms of a risk reduction is part of such communication. Using green finance such as carbon credits or green bonds, next to governmental funds can help sustain and upscale restoration. This will provide a long-term economic income for landowners, in contrast to current situation where they often only receive capital funding for the actual implementation of NbS.

It is important to analyse if the local stakeholders attribute a good value to a riparian cover conservation, or to an improvement on water quality. In fact, in several scenarios in Portugal, stakeholders (such as the farmers’ association, municipalities) willingness to pay for modest and moderate wetland improvement may outweigh the potential cost of the restoration projects, especially for modest restoration objectives, and even under conservative assumptions regarding the benefits and costs of restoration.

The costs of water abstraction for irrigation or other human use are different per country. Good arrangements on these costs and awareness of why these costs exist and how the money is used to keep providing good quality water to the users is needed. For instance, in Portugal the National Water Authority is involved as water is not free and agreement on fees needs to be made.

4.2.5 Policy/regulation optimisation

The Emscher master plan has a vision and long-term agenda, but sometimes experiences delay due to legal barriers. Currently, the risk of delay or stop of river restoration programmes forces operators to scare off protected animals before settling down. Agreements with agencies will be addressed to classify areas reserved for later use as “areas for temporary nature”. The project “Beleidslijn Tijdelijke Natuur” from the Netherlands shows that the concept of temporary nature is compatible with EU law (https://www.tijdelijkenatuur.nl/; staatscourant-29016-vertaling-beleidslijn-tijdelijke-natuur-en.23b6e5.pdf). Solutions applied in pilot projects, local agreements with municipal agencies as well as discussions with higher level agencies are planned to modify the static idea of nature protection from a legal point.

When different aspects of water management are the responsibilities of multiple institutions this may also slow down restoration efforts. Good institutional policy arrangements need to be made to clarify the role of the individual institutions and the potential different viewpoints on the water management in the basin. This is clear in the Tzipori where there is both a water authority (responsible for water allocation to different users) and a river authority (responsible for the restoration). Also, in the Polish wetland restoration case a similar issue is occurring where a water authority is responsible for the management of weirs in the main channels in the Kampinos National Park, and where the National Park management has little influence over these weirs, which limits re-wetting potential in some areas.

If grants for restoration and maintenance afterwards have a limited time of existence, there are great uncertainties to long lasting success of the project after such financial schemes end. For example, the Scheldt example of flower strips grants only last 4 years (BE). It is expected that most likely landowners/farmers will stop with blue-green services if there is no related monetary benefit to be gained from it anymore.

In the Scheldt case study, it is suggested to develop or adapt a clear, good and decent legal framework that provides stability to the farmers and sustainable adoption of the NbS measures which has a long-term view and not a short-term (i.e. 2 - 3 years). It is important to consider and contemplate the incompatibilities between legislations as well as the trade-off between varying goals, e.g. also in relation to the CAP. Furthermore, another strategy for optimisation is to perform research-based analyses of existing policies and recommendations to improve these policies so that more local users/actors will be encouraged to implement NbS measures. Raising awareness of the existing policies to the potential implementors of the measures is to be ensured.

4.3 Large transboundary rivers

4.3.1 Multiple goal optimisation

Table 7 Relevant green deal indicators for the case studies on large transboundary rivers. Please note that the scoring may differ between case studies whether the indicator already has been or could be or become relevant and whether the indicator is an explicit main goal or implicit side goal.

Case study	4	7a	7b	8	9	10
Green Deal indicators	Room for the Rhine branches (NL)	Danube (AT)	Danube (HU)	Danube (RO)	Tisza (HU)	Blue Belt (DE)
Biodiversity net gain	Yes	Yes	Yes	Yes	Yes	Yes
Climate regulation	No	Yes	Yes	Yes	Yes	Yes
Flood resilience	Yes	No	Yes	Yes	Yes	Yes
Drought resilience	Yes	No	Yes	Yes	Yes	Yes
Health & well-being	No	No	Yes	Yes	Yes	Yes
Zero pollution goals	No	Yes	Yes	Yes	No	Yes
Sustainable food systems (F2F)	No	No	No	No	Yes	(No)
Sustainable energy	No	No	No	No	No	No
Sustainable transport	Yes	Yes	Yes	No	No	Yes
Inclusivity	No	Yes	Yes	No	Yes	Yes
Circular economy	No	Yes	No	Yes	Yes	(No)
Financing the transition	Yes	Yes	Yes	Yes	Yes	No
Green growth	No	No	Yes	Yes	Yes	Yes

Interactions and collaboration between sectors are required to implement restoration on a larger scale and for this the ideal spatial dimension needs to be defined from a multisector perspective. The most likely outcome is an integrated planning process at a large spatial scale, such as the entire Hungarian Danube section downstream from Budapest to the Croatian border, that needs to be implemented. Case studies for the free-flowing Danube downstream Vienna in Austria and the Dutch Room for the Rhine branches are already such good examples, though also these must consider broadening their scope to include more aspects.

To take care of all relevant functions, all critical sectoral players should be on board from the start of each project's planning phase and remain involved throughout the project's timeline. Stakeholders should be actively contacted to ensure that all interests are represented and conflicts are avoided. This is possible when roles and functions are defined and stakeholder expectations are managed transparently.

To make large rivers more resilient in the future, they should be viewed as a single system with multiple interests such as flood protection, river nature, navigability, freshwater availability, and recreation. Other Green Deal goals, such as health and well-being and sustainable food systems, should be integrated into the planning process to broaden the perspective and place river and floodplain restoration in a broader spatial and societal context. More consideration should be given to the impact of climate change, particularly the role of drought risks, in scenarios for the resilience and robustness of large rivers, as well as the selection of restoration measures.

It may increase public/social relevance by strengthening links to climate change-related action programs or strategies regarding agricultural changes and economic sectors. Connecting good river ecological status to human health and well-being goals can also help citizens understand and appreciate the benefits of restoration.

Rewetting floodplains may come along with a potential for paludiculture. How can retaining water in floodplains be of benefit during water shortage periods for agriculture?

The description of the case studies shows that there is great potential to thoroughly exchange useful experiences within the large river cluster and that time needs to be allocated for this. This was already identified in the proposal phase between the partners working on the Austrian and Hungarian sections of the Danube, but it is now clear that this applies to all case studies. For example, there is a strong similarity between the Tisza and the Romanian Danube case study, as both have a lot of agriculture in the floodplain. In the follow-up, it is important to identify the similarities and differences and exchange views on what are promising avenues for floodplain restoration.

For the management of the Rhine (and also the River Meuse) the original 'Room for the River' programme already embraced multiple goals, but particularly in the light of the impact of climate change on discharge patterns the scope has been widened to address the consequence of low discharges in combination with the ongoing riverbed incision resulting from normalisation works in the 19th century.

The largest "Blue Belt" programme of the case studies currently has one goal, which is to establish a functioning habitat network in federal waterways on a voluntary basis. Restoration measures must not impede navigability. The projects within the programme are independent of each other. The SWOT was made for the programme's strategy, as this was not possible for the individual projects. Climate change is currently not taken into account in the selection and design of measures. Based on these SWOT characteristics, the way forward for achieving multiple objectives is to broaden the biodiversity focus of the Blue Belt programme and integrate river and floodplain restoration into a broader spatial context, such as river landscapes, and into the system of urgently needed societal objectives. By linking the programme more strongly to climate change-related action programmes or strategies related to changes in agriculture and to economic sectors, it can increase its public/societal relevance and step out of its "biodiversity navigation bubble" (without, however, losing that focus) and place restoration on a broader basis.

4.3.2 Societal optimisation

It is believed that a more inclusive, communicative, transparent and equitable approach is needed for societal optimisation. A wide range of stakeholder groups should participate early and actively to achieve widely known and approved outcomes. Regular stakeholder mapping allows relevant stakeholders to be involved at an early stage of project development and implementation. Stakeholders should have the opportunity to influence decision-making. Therefore, the stakeholder council should have feedback and grievance procedures in place. Study tours can help stakeholders become more familiar with the benefits of rehabilitation in general and of NbS in particular.

The use of NbS in river basin management should always be considered and be the preferred option wherever possible. This requires raising awareness of the benefits of NbS among both the general public and experts in integrated river management. The cost-benefit trade-offs associated with NbS intervention should be disclosed and acknowledged.

In Romania the Danube and in Hungary both the Danube and the Tisza the initiative for floodplain restoration is led by NGOs. For upscaling it is necessary that the public sector adopts this because the NGOs lack the capacity and resources.

4.3.3 Technical optimisation

The current impact of the climate crisis coupled with the biodiversity crisis encourages the development of NbS. Therefore, it should be focussed more on NbS as a suitable or even preferred option in implementation and attention paid to raising awareness by clearly communicating the positive impacts of NbS to authorities and also to the public. Key actors should improve communication on the benefits of multifunctionality, improve monitoring workflows, strengthen adaptation and risk management, and establish learning procedures.

Further, they should spatially expand planning from local to catchment scale or at least section scale and ensure that professionals from different disciplines and fields work together from the start. NbS and drought mitigation technologies through water retention should be developed and demonstrated widely. These should focus on conservation values. The benefits of NbS and Natural Water Retention Measures (NWRM) for drought protection should be explored more thoroughly.

It is important to choose and design a proper monitoring programme and study and evaluate appropriate NbS measures, provide continuous monitoring similar to that carried out in the initial phase before project

implementation. Methodologies and data collection should be developed and improved to identify GHG sinks of wetlands, grasslands and other habitats to include carbon sink financing.

A strength of several case studies (NL, AT/HU and DE) is that they are not single projects, but programmes of multiple projects covering large river stretches. The case studies for the Austrian Danube and Dutch Rhine show the complementarity of the projects within the programme to jointly achieve a larger goal. The Blue Belt in Germany has by far the largest spatial scale but has not yet been worked out in such a detail as the Austrian and Dutch case studies. They serve already as good examples for regional upscaling.

Large integrated programmes need to become tangible and manageable in a series of smaller projects. The experience along the Austrian Danube shows that the 'large river engineering project' became a reality only after it was broken down into separate smaller projects. Similarly, the Room for the Rhine tributaries programme consisted of 24 separate projects, all of which had their own realisation path.

There has not yet been an exchange on the diversity, efficacy and sustainability of measures applied in the large river cluster. This is worth pursuing as this may reduce the cost-benefit ratio (less costs or larger benefits).

Climate change may create such shifts in the discharge patterns of large rivers that negatively affects the efficacy of existing restoration projects (e.g. stagnating flow in side channels during prolonged periods of low discharges).

4.3.4 Economic optimisation

Economic aspects should be addressed in the proposal phase, for example with a decision support tool and economic assessments. Economic optimisation is the development and implementation of complex local economic development plans based on the NbS, involving as many local stakeholders as possible. Costs and benefits should be presented to local stakeholders and decision-makers responsible for government funding, banks, investors, insurance companies to direct funds to the projects.

It is recommended that scientifically (not just financially) sound CBAs are made mandatory, and that costs and benefits are identified as accurately as possible. Available methods and approaches for conducting CBAs should be improved to better incorporate the benefit of nature and integrate ecosystem services to evaluate the effects of a given/planned restoration project on a multitude of societal goals. A prerequisite is to collect the missing data and information, which is a big task because they are difficult to monetise. Communicate the results of such general social CBAs to relevant sectors, including the financial sector, helps provide powerful arguments for preparing and achieving transformative change. It is proposed to develop practical guidance for this purpose.

NbS proposals should strongly consider cost-benefit aspects to make them attractive to others beyond public funds. There are many aspects that come along with healthy rivers and these aspects should be given an important place in proposals to make them interesting for private sector investment. For fundable NbS, the benefits and advantages should be reflected to attract the private sector.

Large river restoration is very costly. Therefore, the large river case study partners consider private funding not to become a substantial source for the restoration of floodplain along large rivers. There are some exceptions, e.g. i) the border Meuse between the Netherlands and Belgium where sand and gravel extraction covered a significant part of the project budget to increase flood protection and improve the river-floodplain ecosystem and ii) the worldwide cooperation between WWF and the Coca Cola Company since 2007 amongst other for floodplain and wetland restoration along the Danube.

There are more services or Green Deal goals which can benefit from floodplain restoration than flood risk reduction, navigation and biodiversity. So, there may be less to win on cost reduction, but more on increased benefits.

Floodplain farming initiatives: both the Tisza and Romanian Danube case studies serve as example where the economic use of the floodplains is taken seriously to make the projects also economically attractive for the local communities.

The case study descriptions reveal a general lack and need for cost-benefit analyses. A difficult question is to what extent CBAs can or will help in decision-making and provide convincing arguments. A choice to be made is whether CBAs should be carried out on a wide range of services, which can be labour-intensive and difficult due to the lack of data and complexity to quantify the benefits for most services, or whether they should be limited to a small selection and then be more cost-effective.

4.3.5 Policy/regulation optimisation

Develop a clear legal framework that provides stability for stakeholders and has a long-term vision and clear, unquestionable objectives for nature. Moreover, potential implementers should be made aware of existing policies.

Harmonisation of implementation of activities to achieve policy goals is necessary and essential. This is a missing element that can also bring the sectors together. This harmonisation process is a long learning process that requires openness from the sectors and incentives from the policy and decision-making levels.

Establish ecosystem services as a key evaluation criterion for major infrastructure projects (e.g. at the level of strategic environmental planning), but also implement such strategies in planning processes for other ministries (e.g. ministries of Transport, Economy, Climate, Food, Agriculture, Health). Data and results from monitoring and evaluation should be summarised in an easily understandable way to make clear to policy and decision-makers the need for further action and cooperation with other sectors.

A thorough analysis of EU and national strategies, policies and actions should be conducted to identify how sustainability objectives can be integrated into the development of upcoming proposals for recovery projects. For example, a targeted CAP subsidy system is needed for NbS and NWRM to make these alternatives realistic for land users and encourage changes in land use. Sharing experiences across borders is another recommendation.

The design and implementation of NbS and lessons learned from our projects and previous experiences should be shared with stakeholders from related sectors, e.g. water management, shipping, drinking water supply, ecotourism. A prerequisite for this is that not only the conservation sector, including NGOs, push through the restoration needs, but that other sectors, which have political power and influence, also participate.

The case studies differ in what extend there already is an integrated approach for river-floodplain management and which aspects are taken into consideration (flood and drought risk management, navigation, biodiversity, agriculture, freshwater supply, recreation). Several case studies indicated that present management is still too sectoral. Carbon sequestration is thus far hardly considered in floodplain management. There is thus more to gain.

NGOs aim to fulfil a pioneering and catalysator role to implement NbS with well-thought strategies for stakeholder involvement and much attention to communication (HU).

5 Conclusions & recommendations

5.1 Eye-openers and main strengths

5.1.1 Conclusions and eye-openers from individual case studies

MERLIN partners were asked what they found the most important conclusion or eye-opener from their case study. In this paragraph we have collected some of these responses to highlight how aspects -after carrying out this optimisation exercise- were actually eye-openers during the process of drafting the optimisation plan. For instance, for many participants it was an eye-opener to think beyond the 'bubble' of the restoration partners they were normally working with. Including a larger diversity of stakeholders opens new ways of thinking and approaching restoration of freshwater ecosystems. This does require 'thinking out of the box' and the process of making the optimisation plan has helped in starting this process. This also relates to thinking about opportunities for new financing mechanisms, for example related to emerging topics such as carbon sequestration and related carbon crediting schemes.

Some projects, such as the Blue-Belt in Germany, and the Room for the Rhine project in the Netherlands were already focusing on two goals (biodiversity and navigation, flood risk and landscape values respectively) which was seen as a great strength of these demonstration cases. Due to the dialogues in the MERLIN optimisation plans it was realized that more goals play a role in the area of interest – such as drought management, navigation, agriculture, human well-being etc. and that new dialogues on continuation of the projects will benefit from the inclusion of these additional goals and related sectors. The provided list of Green Deal Goals and Indicators is a good starting point for identifying how these multiple goals can be achieved within one overarching framework.

It was acknowledged that many cases have to work in the context of long-term developments, and in that light a continuous dialogue, open mind and eagerness to learn is needed to truly progress. This requires solid policies that also aim at providing support for such long-term developments (rather than short-term programs which risk sudden stops in development after a program finishes). Confusion and delays happen when there are upcoming changes in the policy domains, as stakeholders likely wait for clarity before making decisions. Unexpected and frequent changes in policies bog down or demotivate their willingness to participate.

Next to long-term developments being needed to implement measures at scale it is also acknowledged that proper evaluation of these measures is needed to be arranged with a long-term perspective in mind. Natural developments take time, and monitoring should be designed in such a way that it will be able to continue for a sufficiently long period to draw correct conclusions. More effort is needed already during the planning phase of projects to discuss how this is best guaranteed (incl. the needed funding and institutional responsibilities).

Engaging stakeholders is a job on its own and can take up to one-third of the project efforts if done correctly and from the early onsets. Not always is the capacity or expertise available in a team to organise this. It was an eye-opener that talking about floods and droughts management through nature-based solutions may be a way to engage stakeholders in restoration activities, especially if they are not directly enthusiastic to contribute to improving biodiversity values. Often the increasing risks of floods and droughts create direct threats to stakeholders, which makes them more inclined to join the conversation and learn about potential benefits for them. For this the availability of correct information on impacts of restoration measures related to floods and droughts must be made available in understandable terms. Acknowledging the needs of individual landowners and working towards 'tailor-made' solutions is seen as a good, yet slow process to work towards overall goals.

"The MERLIN project reinforced our belief in non-standard measures, but thus better suited to the needs of the local community and nature conservation goals. It can be said that it makes the process of designing technical solutions more difficult and takes a very long time, but it fundamentally changes the approach of farmers to the Park's activities. We can venture, even at this preliminary stage, that some farmers we have gone from being strong opponents of our restoration efforts to curious observers who are beginning to feel like co-authors of some ideas. The process of building trust is ongoing."

The process of 'simply' carrying out a structured SWOT analysis made participants aware of the strengths and weaknesses of their case. It also enabled them to see the restoration measure betting in view of the wider catchment. For instance, in the Finnish case study, it was realised that the overall catchment is a multi-stressed system and the peat-extraction site (the focus in MERLIN) is only a smaller area within the overall basin. As such this optimisation exercise was very insightful, as it gave the starting point to thinking broader

than just the restoration measure at hand. It became apparent that it was not always easy for participants to define opportunities and threats, given that the future developments are often rather unpredictable. Yet being aware of them also opened avenues for further broadening the dialogues. For instance, the new interest in carbon crediting, the upcoming restoration law and the growing public environmental awareness are creating new opportunities to strengthen existing restoration projects. At the same time the current energy-crisis and related unexpected external events are perceived as a threat that is not easy to deal with on the local level as they may have a profound influence on daily decisions.

5.1.2 Main strengths of the individual case studies

MERLIN partners were asked to highlight the main strength of their case studies focusing on the aspect that can also benefit others if they would know about this strength. Partners acknowledged that taking stakeholders on board from the earliest onsets of new programmes is essential for the success of the programme, especially when these stakeholders have a different set of goals or opinions. Looking for synergies may help to establish long-term relationships and willingness of stakeholders to keep cooperating. Long-term relationships are deemed essential in truly getting restoration activities adopted by the local communities.

> "So, our advice would be to 'take the enemy on board' as early as possible and co-develop attractive future visions with cooperative role allocation. This imposes not only an often necessary and fruitful change in mutual perception but is also a valuable foundation for designing NbS and advocate restoration/NbS as a solution-tool to a wider audience."

Measures that can easily be replicated elsewhere are found to be a strength as they can serve as showcases to help convince new stakeholders through sharing successful experiences from these earlier projects. (Long-term) monitoring results help to justify the positive impacts of the restoration efforts and in case any negative impacts exist the monitoring will also bring them about. Measures that have quick and visible results are seen as very beneficial for communication and help the upscaling dialogue. However, in this dialogue also the long-term perspective must be mentioned.

In some cases (e.g. HU) reference is made to the traditional management of the floodplains, which was lost over time but could when reinstalled create benefits for both human well-being and biodiversity values. Referring to such traditional approaches of landscape management can resonate well with the local society. Good and strategic land consolidation practices may also help in the dialogue of how to manage the landscape together with stakeholders in a most optimal way. Having a good institutional, financial and policy framework in place is needed for implementing land consolidations practices (e.g. DK, PL).

Good cooperation between a scientific and implementation partner is a strength in many case studies. Often the implementation partners know the study area and stakeholders very well and are up to date with socio-economic issues of the municipalities in the area. The scientific partner brings in the needed scientific knowledge to evaluate the effectiveness of the restoration actions in a clear and objective way.

> *"The good relationship between the two (MERLIN) partners and their joint work allows us to move forward in a solid way and to obtain, as a result, holistic management and restoration tools and experiences."*

5.2 Generic highlights selected from the optimisation strategies

In this paragraph we summarise some of the generic highlights based on the findings in the individual optimisation strategies. This is a continuation of the summary of results in Chapter 5.1 but has been put together by the authors of this document and is not based on the direct input from the individual partners.

Working on freshwater ecosystem restoration under an uncertain future

Freshwater ecosystem restoration requires mid-to long-term planning, but unexpected societal changes that might occur cannot be predicted well. Former restoration projects took potential environmental and societal changes too little into consideration in the planning and choice for measures. The development of the frameworks on adaptation pathway strategies - which are commonly applied in climate change studies (e.g. Magnan et al. 2020; Werners et al. 2021) - provides new methods that can also be applied to freshwater ecosystem restoration to counter for working under deep uncertainty. For example, the role of the energy crisis and the resulting changing choices landowners make in their practises is something that we do not yet include

well in our optimisation plans. We know from discussions that for example in Greece farmers have reduced their fertilizer use because of the steep prices, and for the same reason have switched from conventional irrigation to drip irrigation. This had nothing to do with regulations or restoration plans but was a pure free market mechanism which proved beneficial for the overall ecosystem functioning.

Uncertainties related to the political choices taken during the energy crisis may cause countries to fall back on, for instance, peat as a fuel source, or focus more on hydropower dam operation and installation. Dialogue is needed to see how this can be done in the most sustainable way.

For climate change we see the direction of change, but we do not know the speed. The impact of the Russian/Ukrainian conflict on energy and food prices may cause altered discussions on Green Deal goal achievements and the ambition levels of related legislation. What is clear is that the changing world (e.g. climate, land-use, renewable energy transition) requires an adaptive strategy in the long-term restoration agendas.

The role of thorough system understanding

This is an open door but still needs to be said right upfront: restoration of freshwater ecosystems does require knowledge of the catchment hydrology as a basis. If this understanding of the hydrology is not present it is a first and foremost effort to start working on developing this basic system understanding.

The role of thorough system understanding is also reflected in the dialogue related to the interplay between water quantity and water quality processes, especially in relation to re-wetting peatlands and wetlands and the potential impact this has on GHG emissions which might be more delicate to manage than anticipated. Ensuring that sufficient monitoring data is available will help improve such system understanding strongly and may affect choices in the restoration efforts. Next to this, seeing the individual restoration measure in a wider catchment perspective is needed to evaluate if also elsewhere additional efforts are required to improve to overall state of the catchment.

The disservices associated with restoration may deliberately be ignored to sell the overarching aim. Often this may lead to suspicion and a lack of stakeholder acceptance/trust. It is better to be clear about it from the beginning and look for mitigating solutions and education of the stakeholders.

MERLIN provides opportunities for partners to learn from other cases internationally and bring this knowledge into their own practise – especially the need for further training on monitoring of GHG emissions is recognised by multiple partners as an area that needs further work and development (PL, SE, BiH).

The role of developing policy arrangements and acknowledging the local context

There are high hopes related to the benefits that the upcoming restoration law may bring to the dialogues on ecosystem restoration. Especially in relation to the roles and responsibilities of public entities this is seen as an added value to speed up the process of large-scale restoration of ecosystems. Yet it is unclear which exact impact this new legislation may have, and how it will work in relation to existing other legislations such as the CAP and be influenced by other Green Deal ambitions.

Contextual aspects both in terms of relevant topics (e.g. invasive species, water management at the basin level) and in terms of political/cultural views are very relevant. Restoration actors need to identify these contextual aspects and address the relevant ones (e.g. the Sorraia basin has large irrigation reservoirs in the upper part of the catchment. As a consequence, drought is hardly perceived by the farmers as a problem unless it lasts for several consecutive years).

5.2.1 Multiple goal optimisation

The role of the impact of climate change (and planning for both floods and droughts in increasingly extreme events) and socio-economic/demographic change scenarios is often not yet considered in the current planning. Especially the upcoming climate change challenges related to increasing drought is still perceived much less of an issue than flood in many case studies. Addressing drought issues is new, both for the restoration teams and stakeholders in the area, and requires longer-term, broader visioning and thinking about alternative/additional measures, such as climate smart farming practises and identification of opportunities for measures outside the streams (Natural Water Retention Measures).

Sustainable energy is not often a goal that restoration is being extended towards. Yet, a good example of how this can be done is the hydropower-fish migration dialogue that may help stream restoration in Sweden: The new permits for hydropower dams require to show there is no net biodiversity loss.

Several of the larger scale cases were originally defined for one, or maximum 2 goals – predominantly spatial quality and flood risk reduction (CS4 Room for the Rhine NL), nature and navigation (CS7 Danube AT) or nature restoration to be not harmful for navigation (CS10 Blue Belt DE). Yet the Green Deal goals and climate change require a broader view on goals to be achieved within a catchment area: multiple goals play out in the same location and therefore planning needs to think about how to combine these individual goals much more clearly. This more holistic thinking is new and provides opportunities for a refreshing of the strategy along these broader goals.

Traditionally, the term restoration has been used in the MERLIN case studies to describe efforts aimed at improving ecological functioning and biodiversity. However, with accelerating climate change and widespread landscape modifications, returning ecosystems to a historical reference state is often unrealistic. As highlighted in Deliverable D2.2 (Pietilä et al., 2023), the concept of restoration should be reconsidered in favor of a more forward-looking approach. This includes integrating concepts such as adaptability and transformability (Walker et al., 2004) to acknowledge the necessity of novel ecosystems that can respond dynamically to environmental changes. Given the timescales involved in freshwater ecosystem management and the long-term visioning required for scalability plans, it is crucial that MERLIN's approach to restoration reflects these evolving perspectives.

5.2.2 Societal optimisation

Stakeholder engagement throughout the project cycle is essential and for a wide range of stakeholders, from early planning to full implementation. Besides project-based engagement, a long-term open platform of stakeholders for a wide area is also considered important to stay in touch with their awareness, views and wishes. Communicating success-stories is a power full tool to upscale restoration efforts to other areas. Showcasing successful examples also makes people proud and gives ownership.

Interviewing individual stakeholders and really listening to their needs from the beginning can provide a good start of the implementation process. For example: In Denmark (CS1 Kvorning) stakeholders are already approached in the earliest onset and explained about the potential ideas, emphasising that their participation is voluntary. This careful inclusion of all stakeholders is a process that takes a lot of time, and if needed the team to carry out the stakeholder involvement might need to be broadened to include people with a social sciences and humanities background to ensure a true inclusive process.

The voluntary contribution of stakeholders to the implementation process can be very helpful, as it limits the potential 'dislike/distrust' to the initiator and gives stakeholder an equal common ground for dialogue. Insight into power relationships amongst stakeholders is essential. For instance, in Sweden (CS3 Beaver reintroduction) forestry is a very strong sector which affects the potential for stream restoration, as re-wetting causes spruce forest mortality and therefore a disservice to the forestry industry. Solutions need to be sought in joint dialogue to limit such disservices. Another example is the UK (CS17 Forth) where landowners may have tenants working on the land and the relationship and arrangements between them may hamper the way forward.

Restoring wetlands may lead to a change in land-use, and this can conflict with the local stakeholders who do not want this change in land-use due to cultural reasons when for example properties have been handed down from generation to generation or because it requires to change the way of working for the landowners (e.g. from single species forestry to mixed forest practises).

It is not easy to change the minds of local actors regarding their current practices due to the potential losses of land, the lesser amount of manure that can be spread on their land and the fear that they might lose their land to biodiversity and nature. In general, those indirectly affected by the NBS are limitedly identified and consulted. It is challenging to bring all stakeholders together at the table for joint decision-making. Furthermore, the awareness and information of NbS provided to the public may be insufficient. It is recognized that inclusion of social scientist/communication experts in the team's leading the restoration project is beneficial for the overall speed and success of implementation. This was mentioned by CS16 Scheldt (BE) but considered generic.

5.2.3 Technical optimisation

System understanding

There is a need to improve the understanding of the impact of an individual restoration project within a larger river basin context: How much does the single restoration measure contribute to the wider area, e.g. in terms of retention of water for floods and droughts, carbon sequestration, improvement of biodiversity? At the same

time this knowledge will help to express the contribution from a single project to the overall larger national/regional/European objectives. For example, within highly urbanized/human-used systems that are affected by multiple pressures (CS16 Scheldt BE, CS 11 Emscher DE), and in river catchments a single measure for small sections will not solve the status of the overarching areas. There may be a need to define an overarching strategy to really address the multiple pressures. Also, in the Finnish case study (CS14 Oulujoki) a similar example can be found: Re-wetting former peat mining sites is the focus of the case study, yet these sites are located in a larger landscape with heavy forestry use, so those forested parts of the catchment might also benefit from further restoration efforts.

Climate change (especially, changes in discharge patterns and increasing temperatures) require an assessment of whether planned measures need to be adapted in view of these future changes and a realistic story needs to be told on the true extent to which a measure may be having a positive impact on goal achievement. For example: Re-wetting is only possible when there is sufficient water available. If future droughts become so extensive that this water is not available in sufficient amounts the measure as such will no longer be effective. Analyses to improve understanding of these changes under different scenarios is recommended.

In many of the MERLIN restoration plans there is insufficient understanding of the hydrological functioning of the wider catchment and the sub-system that is being restored. Especially for peatlands and wetlands the underlying analysis of groundwater-surface water interactions is lacking. For example, in the Lima (CS12 PT) a small plot is being restored within the MERLIN case, yet the case will benefit from improving the understanding of the full hydrological functioning of the basin.

Monitoring for evidence

The evidence base for some of the restoration measures is still very thin, especially on the potential carbon sequestration services, but also linking the restoration to the full set of Green Deal goals. Ensuring monitoring to evaluate and strengthen this evidence base is a large-scale and potential costly effort, yet very valuable in demonstrating the impact also to the wider audience and stakeholders in the area. Already in the planning phase further emphasis must be placed on the planning and financial arrangement for this monitoring and include also the responsibilities of relevant institutions in ensuring this long-term monitoring.

There is at present no monitoring and therefore no data for relevant Green Deal goals in several case studies. Monitoring is often restricted to the project area and could benefit to be expanded to a larger spatial scale (e.g. all restoration projects along the Danube in Hungary CS7b) and beyond traditional domains (e.g. biodiversity, water levels).

Maintenance requirements of measures is too often overlooked and insufficiently considered in the planning and design. Restoration measures may lose their efficacy for the intended aims over time (e.g. Stoffers et al. 2021). This would then require a reset sometimes referred to as cyclic rejuvenation (Baptist et al 2004). Also, NbS may require this.

Interdisciplinarity research

Many of the MERLIN case study teams do not span the full width of disciplines needed for proper system understanding (both from the biophysical and socio-economic/governance aspects) and it is recognized by many case studies that widening the team's expertise will be beneficial for the implementation and upscaling of restoration efforts.

Selecting individual measures within an overarching strategy

In line with the need to look to the wider catchment for restoration efforts, it is recommended that overarching strategies are being created, considering multiple goals. In such strategies there may be a role for both NbS and grey solutions to improve the overall system functioning. In such situations it is recommended to use the underlying philosophy of 'green where we can, grey where we must', and allow for room to also define hybrid solutions between NbS and engineering.

5.2.4 Economic optimisation

Role of private financing

There is quite some expectation that private funding can be a substantial financial resource for restoration but there are also reactions that there are only limited possibilities. For large rivers the general impression is that public funding always will remain the main source. So, it is worthwhile to explore alternative funding mechanisms, which can become more likely to become available with a wider set of Green Deal goals but it is good to be realistic regarding the probability and relative contribution.

Acquiring private funding can be a strong opportunity to improve and upscale restoration in a given area. (Examples: CS9 cooperation between the Coca Cola company and WWF, CS15 Rothschildt foundation donates 30MEuro in 4 years for restoration of the Tzipori in Israel)

Developing strong business cases

In many of the MERLIN cases there is a lack of thorough cost-benefit analyses being made (almost if not all case studies state this: What is added value? How detailed should they be to become a convincing argument?).

The business case of restored sites and their maintenance is to be made clear and can benefit from innovative cooperation with the private sector: E.g. can you make waste material into a resource? (Examples: CS7a Danube AT stones from riprap and groynes, CS 11 Emscher DE mowing material, CS13 Sorraia PT water hyacinth and CS3 hunting of excess beavers in Sweden). Innovation contests may bring unexpected private initiatives to the table that benefit multiple parties.

What new business cases for farmers can be created, for instance 'meat from nature-areas' and water buffalo farming, paludiculture (especially for fibres and biomass – note this is not necessarily with a net-biodiversity gain)? Financing of blue-green services by farmers can initiate farmers' willingness to cooperate. Regulations for this and budgets must be ensured for the long-term. There are also voices that this might create a risk of 'addiction to subsidies'. An emerging question is whether similar blue-green services can also be made attractive for forestry.

Services and disservices

In Sweden (CS3) there are services and disservices originating from the presence of beavers. This illustrates that measures cannot simply be copy pasted to other locations, yet inspiration may be taken from them and adapted to the local context. For example, also very strict beaver regulations in other countries may benefit from a more flexible approach like in Sweden to some extent to help acceptance of the role of beavers within the wider landscape (e.g. Estonia, Poland and Germany were mentioned as countries where this may apply).

The question of who pays/does the work/lets the work be done on his/her land and who benefits (nature/downstream communities/specific enterprises) comes back in multiple cases.

5.2.5 Policy/regulation optimisation

Working under a changing policy environment

Restoration of freshwater ecosystems, whether peatlands, wetlands, small streams or large rivers, requires a long-term vision and strategy on a larger spatial scale. The long-term view is needed to cope with changing political winds and because planning and implementing restoration takes more time than expected beforehand. The larger spatial scale creates more flexibility in planning and implementation and also in the choice of type and location of measures.

Laws and regulation can be a back support, but also be an obstacle when interpreted and applied too strictly. Some 'No, unless…' instead of 'No!' example from Sweden (CS3): Protected species are allowed to be killed in case of problems. In other countries it is strictly prohibited which straitjacket may create conflicts and can polarise discussions.

New laws or unclarity of future change in laws and arrangements may overcomplicate existing arrangements (CS1 Kvorning DK, CS17 Forth UK) and hamper willingness of stakeholders to voluntarily participate in restoration projects, which slows down implementation.

Clear messages need to be communicated with landowners on what is expected from them after implementation, if the implementation takes place on their land: Whether they do need to maintain the measure, and what are the costs/benefits related to this work. The availability of for example blue-green service arrangements will help the willingness of landowners to participate.

Role of land consolidation and cadastral information

Fragmented land use can have large repercussions to accelerate and upscale restoration as it comes with either lengthy discussions with the many landowners, high costs to buy land, long planning trajectories to obtain all the required permissions, consensus, agreement or ownership rights.

Land consolidations (the swapping of plots of land between owners) regulations provide opportunity to exchange land for farmers and limit trade-offs for them. (Examples: CS1 Kvorning DK, CS9 Tisza HU, CS4 Room for the Rhine Branches NL and CS11 Emscher DE). The scale of the interventions needs to be sufficiently large to accommodate for land consolidation.

Availability of good administration of the cadastral information can be crucial in progressing restoration action. E.g. in Portugal (CS12 Lima) this is lacking and hampering progress as nothing can be done before the owners have been traced, also for very small plots of land that the owners do not manage actively. Similar issues were mentioned for CS9 Tisza in Hungary.

5.3 Recommendations

→ Restoration used to be a striving to static historic references, yet under current knowledge of changing climates we need to anticipate on changing boundary conditions for ecosystem functioning. Adaptation pathway strategies may be a help in defining such adaptive strategies for ecosystem strengthening.

→ "Restoration" is becoming a wrong and confusing term because we need to have a forward-looking approach which takes environmental and socio-economic changes into account, working with developing novel ecosystems that are responding to changes over time.

→ We recommend to do a SWOT analysis for your restoration case study area and to assess the IUCN SAT criteria for nature-based solutions and Green Deal indicators. This helps to step out of your bubble and opens up new ways of looking at the situation at hand.

→ Exchange of know-how, knowledge, ambitions and uncertainties between case studies provides excellent food for discussions for improving the focus of cases. There is an enormous potential for peer-to-peer learning within but also across the three clusters.

→ Specific topics for peer-to-peer learning are GHG emission and carbon crediting schemes. How to liaise with agriculture (e.g. floodplain farming approaches, land consolidation practises, blue-green services arrangements) is the key question in many areas.

→ Involve a wide variety of stakeholders from the very early onsets of projects, in true co-creation.

→ Acknowledge context /culture specific aspects e.g. the appreciation of natural values of floodplains differs substantially between countries.

→ Governments can benefit from partnering with NGOs as NGOs are often much busier with stakeholder involvement and engagements. Bilateral learning between NGOs and public organisations will be beneficial for the overall process. On the other hand, NGOs who have less capacity and resources need to partner with public bodies to upscale restoration significantly.

→ Investigate potential for private financing – yet recognise that in most / many cases public funding will be the core mechanism in initiating large-scale restoration efforts.

6 References

Baptist, M. J., Penning, W. E., Duel, H., Smits, A. J., Geerling, G. W., Van der Lee, G. E., & Van Alphen, J. S. (2004). Assessment of the effects of cyclic floodplain rejuvenation on flood levels and biodiversity along the Rhine River. River Research and Applications, 20(3), 285-297.

IUCN (2020a). Global Standard for Nature-based Solutions. A user-friendly framework for the verification, design and scaling up of NbS. First edition. Gland, Switzerland: IUCN. https://doi.org/10.2305/IUCN.CH.2020.08.en

IUCN (2020b). Guidance for using the IUCN Global Standard for Nature-based Solutions. A user-friendly framework for the verification, design and scaling up of Nature-based Solutions. First edition. Gland, Switzerland: IUCN. https://doi.org/10.2305/IUCN.CH.2020.09.en

Magnan, A. K., Schipper, E. L. F., & Duvat, V. K. (2020). Frontiers in climate change adaptation science: advancing guidelines to design adaptation pathways. Current Climate Change Reports, 6(4), 166-177.

Pietilä, K., Penning, W.E., Buijse, A.D., Scholl, L., Alatalo, I., Álvarez, F., Andrzejewska, A., Anlauf, A., Anton, C., Arroita, M., Baattrup-Pedersen, A., Baker, A., Bañares, I., Birk, S., Boets, P., Cerqueira Correia, F., Colls, M., Dias, H., Díaz, J., Drexler, S., Ecke, F., Elosegi, A., Erős, T., Ferreira, T., Fonseca, A., Forio, M., Fuchs, E., Funk, A., Geerling, G., Gerisch, M., Gerner, N., Gruber, T., Hellsten, S., Hering, D., Hershkovitz, Y, Hunter, P., Ionescu, C., Kajner, P., Karnatz, S., Katz, A., Kempter, I., de Lange, M., Larrañaga, A., Lawrie, E., Matthews, K., Meissner, K., Nørgaard, M. N., Olszewska, J., Ortega, U., Palm, D., Pickard, A., Provan, N., Puiu, I., Rankinen, K., Ratner, T., Rodríguez-González, P., Ronkainen, T., Ronkanen, A., Rudziński, J., Sá, L., Samu, A., Santos, L., Schneider, A., Scrieciu, A., Sime, I., Siuta, M., Sommerhäuser, M., Stewart, S., Thorell, D., Trandziuk, P., Tögel, R., Udklit, L., Unzurrunzaga, A., Wilińska, A., (2023). MERLIN deliverable 2.2 Synthesis of the Interim Regional Scalability Plans. EU H2020 research and innovation project MERLIN. Syke, Helsinki. 130 pp.

Stoffers T., F.P.L. Collas, A.D. Buijse, G.W. Geerling, L.H. Jans, N. van Kessel, J.A.J. Verreth, L.A.J. Nagelkerke (2021) 30 years of large river restoration: how long do restored floodplain channels remain suitable for targeted rheophilic fishes in the lower river Rhine? Science of the Total Environment 755: 142931. https://doi.org/10.1016/j.scitotenv.2020.142931

Walker, B., Holling, C. S., Carpenter, S. R., & Kinzig, A. (2004). Resilience, adaptability and transformability in social–ecological systems. Ecology and society, 9.

Werners, S. E., Wise, R. M., Butler, J. R., Totin, E., & Vincent, K. (2021). Adaptation pathways: A review of approaches and a learning framework. Environmental Science & Policy, 116, 266-275.

6.1 References in the individual case study contributions

N.B. neither for the SWOT analysis nor for the optimisation strategy case studies have been asked for references. The list below is therefore incomplete and unbalanced. Some case studies did give references while most not.

CS2 Deba River Basque Country (ES)

Deemer, B. R., Harrison, J. A., Li, S., Beaulieu, J. J., DelSontro, T., Barros, N., ... & Vonk, J. A. (2016). Greenhouse gas emissions from reservoir water surfaces: a new global synthesis. BioScience, 66(11), 949-964.

CS4 Room for the Rhine branches (NL)

van Schaick, J., & Klaasen, I. (2011). The Dutch layers approach to spatial planning and design: a fruitful planning tool or a temporary phenomenon?. European Planning Studies, 19(10), 1775-1796.

CS11 Emscher river (DE)

Gerner, N.V., Nafo, I., Winking, C., Wencki, K., Strehl, C., Wortberg, T., Niemann, A., Anzaldua, G., Lago, M. and Birk, S., 2018. Large-scale river restoration pays off: A case study of ecosystem service valuation for the Emscher restoration generation project. Ecosystem Services, 30, pp.327-338.

CS12 Lima river (PT)

Bjelke, U., Boberg, J., Oliva, J., Tattersdill, K., McKie, B.G., 2016. Dieback of riparian alder caused by the Phytophthora alni complex: projected consequences for stream ecosystems. Freshwater Biology 61, 565-579.

Bogas, P. 2012. Qualidade da água no rio Estorãos na Área Protegida das Lagoas de Bertiandos e São Pedro de Arcos, MSc Thesis, Escola Superior Agraria de Ponte de Lima, Instituto Politécnico de Viana do Castelo, 170pp.

Cortina-Segarra, J., García-Sánchez, I., Grace, M., Andrés, P., Baker, S., Bullock, C., Decleer, K., Dicks, L.V., Fisher, J.L., Frouz, J., Klimkowska, A., Kyriazopoulos, A.P., Moreno-Mateos, D., Rodríguez-González, P.M., Sarkki, S., Ventocilla, J.L., 2021. Barriers to ecological restoration in Europe: expert perspectives. Restoration Ecology 29, e13346.

Ferreira, V., Figueiredo, A., Graça, M.A.S., Marchante, E., Pereira, A., 2021. Invasion of temperate deciduous broadleaf forests by N-fixing tree species – consequences for stream ecosystems. Biological Reviews 96, 877-902.

Ferreira, V., Larrañaga, A., Gulis, V., Basaguren, A., Elosegi, A., Graça, M.A.S., Pozo, J., 2015. The effects of eucalypt plantations on plant litter decomposition and macroinvertebrate communities in Iberian streams. Forest Ecology and Management 335, 129-138.

Jung, T., Orlikowski, L., Henricot, B., Abad-Campos, P., Aday, A.G., Aguín Casal, O., Bakonyi, J., Cacciola, S.O., Cech, T., Chavarriaga, D., Corcobado, T., Cravador, A., Decourcelle, T., Denton, G., Diamandis, S., Doğmuş-Lehtijärvi, H.T., Franceschini, A., Ginetti, B., Green, S., Glavendekić, M., Hantula, J., Hartmann, G., Herrero, M., Ivic, D., Horta Jung, M., Lilja, A., Keca, N., Kramarets, V., Lyubenova, A., Machado, H., Magnano di San Lio, G., Mansilla Vázquez, P.J., Marçais, B., Matsiakh, I., Milenkovic, I., Moricca, S., Nagy, Z.Á., Nechwatal, J., Olsson, C., Oszako, T., Pane, A., Paplomatas, E.J., Pintos Varela, C., Prospero, S., Rial Martínez, C., Rigling, D., Robin, C., Rytkönen, A., Sánchez, M.E., Sanz Ros, A.V., Scanu, B., Schlenzig, A., Schumacher, J., Slavov, S., Solla, A., Sousa, E., Stenlid, J., Talgø, V., Tomic, Z., Tsopelas, P., Vannini, A., Vettraino, A.M., Wenneker, M., Woodward, S., Peréz-Sierra, A., 2016. Widespread Phytophthora infestations in European nurseries put forest, semi-natural and horticultural ecosystems at high risk of Phytophthora diseases. Forest Pathology 46, 134-163.

Rodríguez-González, P.M., Pereira, J.S., Ferreira, M.T., 2008. Tree foliar δ15N and δ13C signatures in Ibero Atlantic forested wetlands. SIL Proceedings, 1922-2010 30, 391-394.

Rodríguez-González, P.M., Ferreira, M.T., Albuquerque, A., Santo, D.E., Rego, P.R., 2008. Spatial variation of wetland woods in the latitudinal transition to arid regions: a multiscale approach. Journal of Biogeography 35, 1498-1511.

CS16 Scheldt (BE)

Goethals, P., & De Pauw, N. (2001). Development of a concept for integrated river assessment in 0Flanders, Belgium. In O. Ravera (Ed.), Journal of Limnology 60, 7–16. Pallanza, Italy.