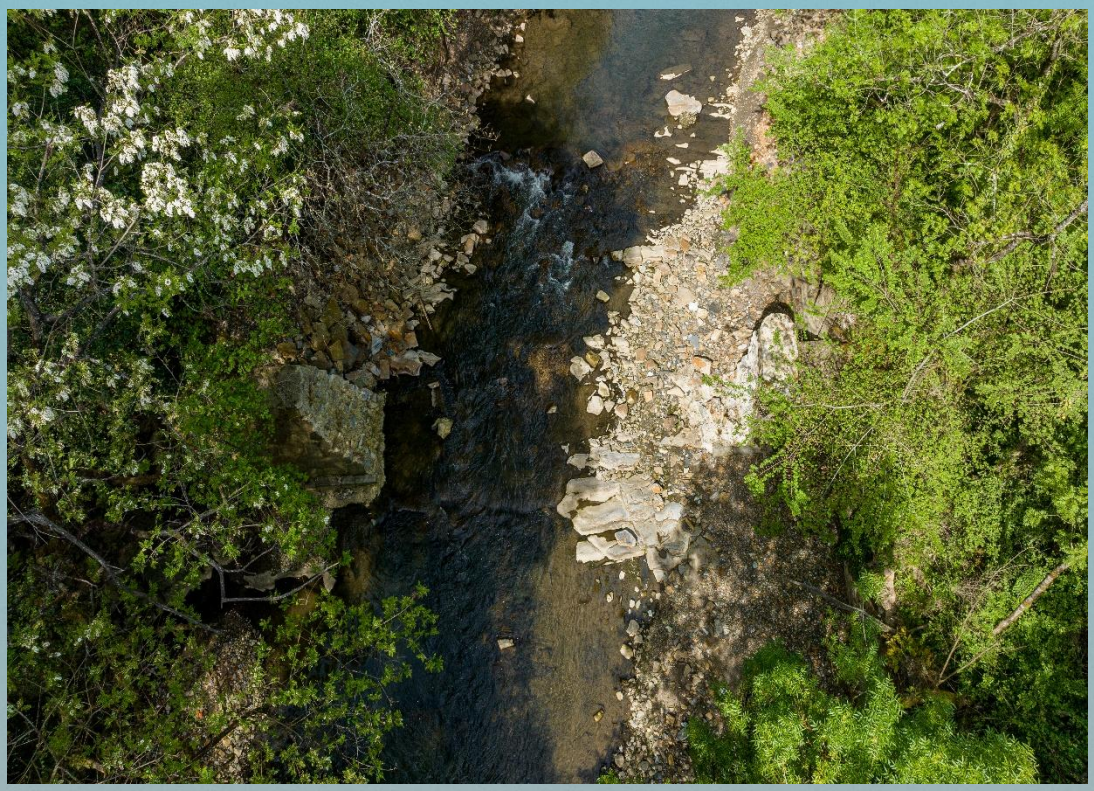
MERLIN



Executive summary – CS02, Deba Case Study

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: University of the Basque Country (UOV/EHU)

Contributors: Arturo Elosegi & Miriam Colls

Due date of deliverable: September 2026

Actual submission date: September 2026

MERLIN Key messages

1. Removing obsolete river barriers is an effective Nature-based Solution for restoring river connectivity and ecological functioning, while also contributing to wider societal objectives such as flood-risk reduction and climate-change mitigation.
2. MERLIN enabled the removal or partial removal of eight obsolete barriers in the Deba River, reconnecting nearly 20 km of river and naturalizing several hundred meters of formerly impounded habitat.
3. Ecological recovery after barrier removal is gradual and spatially dependent. Formerly impounded reaches recover faster than downstream reaches, highlighting the need for sufficiently long post-removal monitoring.
4. River barriers can act as greenhouse-gas emission hotspots. Methane produced and accumulated in impounded reaches is released at waterfalls and other turbulent zones, increasing the overall climate impact of barrier-affected reaches.
5. Ecological conditions in the Deba improved during MERLIN, particularly for macroinvertebrates and some physicochemical variables. Fish communities have not yet shown a clear response, showing that different ecosystem components recover at different rates.
6. Barrier removal is as much a social and governance challenge as an ecological one. Misconceptions about river functioning and the effects of barriers can strongly influence public acceptance, making participation, environmental education, transparent communication and scientific rigor essential.
7. Engaging economic sectors can create new opportunities for scaling-up river restoration. Collaboration with the hydropower and insurance sectors identified links between barrier removal, ecological compensation, flood-risk management and climate-change adaptation.
8. The Deba case study demonstrates the potential of barrier removal to deliver multiple environmental and societal benefits. Of the seven Sustainable Development Goals assessed, six showed positive or very positive effects, supporting the wider integration of river restoration into environmental, climate and socioeconomic policies.

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 Presentation of the MERLIN project 5

2 Deba River Case Study 6

3 Work carried out and main results 8

3.1 Social participation and stakeholder perceptions 8

3.2 Engagement with key economic sectors 10

3.3 Meta-analysis of the ecological effects of barrier removal 11

3.4 Effects of barriers on river ecosystem functioning 13

3.5 Effects of barriers on river communities 16

4 Conclusions 17

5 Bibliography 20

1 Presentation of the MERLIN project

MERLIN (Mainstreaming ecological restoration of freshwater-related ecosystems in a landscape context: innovation, upscaling and transformation) is a European H2020 project that investigates and develops innovative approaches aimed at making the restoration of inland water bodies a routine activity across Europe. MERLIN promotes **Nature-based Solutions (NbS)**, understood as actions that protect, sustainably manage and restore natural or modified ecosystems while simultaneously addressing societal challenges such as climate change, biodiversity loss and water management, and generating benefits for human well-being and biodiversity. In this context, MERLIN has promoted NbS as strategies for climate-change mitigation and adaptation, seeking transformative change in how ecological restoration is conceived and implemented at European scale. To achieve this, the project has **actively engaged local stakeholders and communities**, created incentives for investment in restoration, and explored ways of scaling restoration far beyond individual projects. Unlike other restoration projects, whose success is often assessed using metrics of naturalness or biodiversity, MERLIN has evaluated the outcomes of its activities and their potential implementation at European scale using indicators (Fig. 1) linked to 14 of the 17 **Sustainable Development Goals (SDGs)**[1].



Figure 1 - Diagram of the indicators developed in MERLIN in relation to the Sustainable Development Goals.

With a budget of more than EUR 22 million, MERLIN ran from 1 October 2021 to 31 March 2026. The project initially involved 44 organisations, ranging from research centres and government agencies to NGOs and companies, and this number increased over the course of the project. MERLIN worked through 18 specific case studies in which different NbS were used to implement **demonstration restoration actions**. These actions were systematically assessed to support their planning[2], optimisation[3] and monitoring[4,5]. The demonstration cases were subsequently expanded through **larger-scale implementation actions**, including the design of **regional- and European-scale upscaling plans**[6,7]. The project also explored the **transformative potential** of NbS to contribute to the SDGs, with strong emphasis on establishing **collaborative networks**[8,9] and training tools[10]. In the work packages dedicated to upscaling and transformation, MERLIN collaborated with

representatives of key **socioeconomic sectors**, agriculture, peat extraction, water supply, navigation, hydropower and insurance, to identify mechanisms through which these sectors could become interested in implementing ecological restoration at European scale[11, 12, 13]. MERLIN also maintained **continuous contact with managers and regulatory actors across** Europe to promote the use of NbS and integrate ecological restoration into European policies.

The 18 case studies were grouped into three clusters: small streams and catchments, wetlands, and large transboundary rivers. Different types of NbS were implemented, including floodplain reconnection, riparian vegetation restoration, peatland restoration, barrier removal and beaver reintroduction. Each case study involved at least one **research partner** (a research centre or university) and one **implementation partner** (a company or organisation carrying out restoration projects), as well as a monitoring panel involving local stakeholders and interested organisations.

2 Deba River Case Study

MERLIN Case Study 2 ultimately focused on the Deba River. Before the project began, the MERLIN coordinators contacted Arturo Elosegi (UPV/EHU) to identify the types of restoration actions being implemented in Basque rivers and the actors involved. Their interest was not centred on a single restoration project, such as removing one barrier or reconfiguring one meander, but on identifying restoration typologies that could be replicated at multiple locations so that patterns and regularities in ecosystem responses could be assessed. After evaluating different possibilities, **collaboration** was agreed between **UPV/EHU**, as the **research partner**, and the **Provincial Council of Gipuzkoa (DFG)**, as the **implementation partner**, focusing on the removal of obsolete barriers (weirs) in the Deba River. The budget was EUR 250,000 for UPV/EHU and EUR 800,000 for the DFG. It should be stressed that, unlike programmes such as LIFE or INTERREG, MERLIN funded restoration works at 100%, including indirect costs. MERLIN also required a **particularly strong component of social participation** and the assessment of restoration effects using **SDG indicators**.

In the Deba River, the proposal involved the total or partial **removal of all obsolete barriers** without an active concession downstream of Arrasate: Barrena Errota and San Prudentzio (Arrasate-Bergara), Central de Bergara and Matxiategi (Bergara), Zuloaga, Olea, Malmero and Igarate (Soraluze), Altzolabehea (Elgoibar), and Santa Ana (Mendaro). Barriers without archaeological or heritage value were to be completely removed, whereas structures classified as being of interest were to be partially removed, allowing river connectivity to be restored while preserving part of the archaeological remains. Within its **Barrier Permeabilisation Plan**, the **DFG** already had relatively advanced demolition projects for the Deba River dams. In addition, the DFG **monitoring network**, covering both **water quality and biodiversity**, provided an excellent baseline for determining the pre-restoration status and subsequent evolution of the Deba River. Nevertheless, the network was complemented with **additional sampling stations** to improve attribution of observed changes to the restoration actions. **UPV/EHU** committed to **detailed analysis** of the **monitoring-network data**, assessment of the effects of barrier removal on other variables such as **greenhouse-gas emissions** and **self-purification capacity**, and evaluation of the results in relation to the **SDGs**. UPV/EHU was

also responsible for **coordination** with the wider MERLIN project and for providing information for **project outputs**, including deliverables and the MERLIN Academy.

The initial plan for the Deba was to implement a **BACI (Before-After/Control-Impact) monitoring design**, considered one of the most robust approaches for this type of intervention. BACI compares a control reach and an impacted reach before and after the impact - in this case, a control reach and a barrier-affected reach before and after dam removal, and evaluates the statistical significance of the interaction, i.e. whether the difference between the control and impacted reaches changes after barrier removal. However, this apparently simple design presents several difficulties. In the impounded reach upstream of a barrier, for example, the physical habitat is clearly affected, but identifying an appropriate control reach is not straightforward, particularly in rivers such as the Deba, which consist almost continuously of barrier-affected reaches. Likewise, the reach immediately downstream of a barrier can have a high fish density because of the barrier effect, potentially leading to misleading interpretations if the ecological context is not properly considered. In any event, the post-removal component of the BACI **design cannot be completed until the barrier has been removed** and sufficient time has elapsed for the river to stabilise14, for example allowing fish to pass the formerly impounded location.

This proposal could only be **implemented partially** and with a **substantial delay** relative to the original schedule. There were two main reasons: **opposition** from the **Culture Department** of the Basque Government to the partial removal of barriers designated as being of cultural interest, and opposition from **part of the population of Soraluze** to the demolition of the Olea, Malmero and Igarate barriers. During the first project year (2022), the Santa Ana, Altzolabea, CH Bergara and San Prudentzio barriers could be removed. It was not until autumn 2025 that four of the six remaining barriers were completely or partially removed (Barrena Errota, Central de Bergara, Zuloaga and Olea), while Malmero and Igarate remained untouched. The delay in removing the barriers causing the greatest modification of river habitat, and therefore potentially the greatest impact (Barrena Errota, Olea, Malmero and Igarate), requires **monitoring to continue at least until summer 2026**. Consequently, **only partial results** on the effects of removing these barriers are available to date.

3 Work carried out and main results

3.1 Social participation and stakeholder perceptions

One of the first activities was to **identify the main social actors** in the catchment and organise participatory meetings with them. **More than 30 meetings** were held throughout the project with municipalities, organisations such as DEBEMEN and the Alto Deba Commonwealth, local associations, the general public and educational centres.

Because one of MERLIN's objectives was to understand stakeholder perceptions of the status and restoration of aquatic ecosystems, Joserra Díez's group (Faculty of Education of Bilbao, UPV/EHU) conducted **structured interviews** with five **politicians**, twelve **environmental technicians** and twelve students from the UPV/EHU **Master's Degree** in Secondary Education. Participants were asked to describe a river ecosystem and list its components and processes, the services provided by rivers, and the river-related problems that came to mind. Responses were recorded and subsequently analysed by comparison with a conceptual map derived from the scientific literature. The results showed a **simplified view of river ecosystems** among most respondents, with a notable **absence of aspects related to ecosystem functioning and associated services** (Fig. 2). Their level of knowledge was classified as medium-low, indicating that improved environmental education is needed if managers and politicians are to make well-informed decisions and society is to accept them.

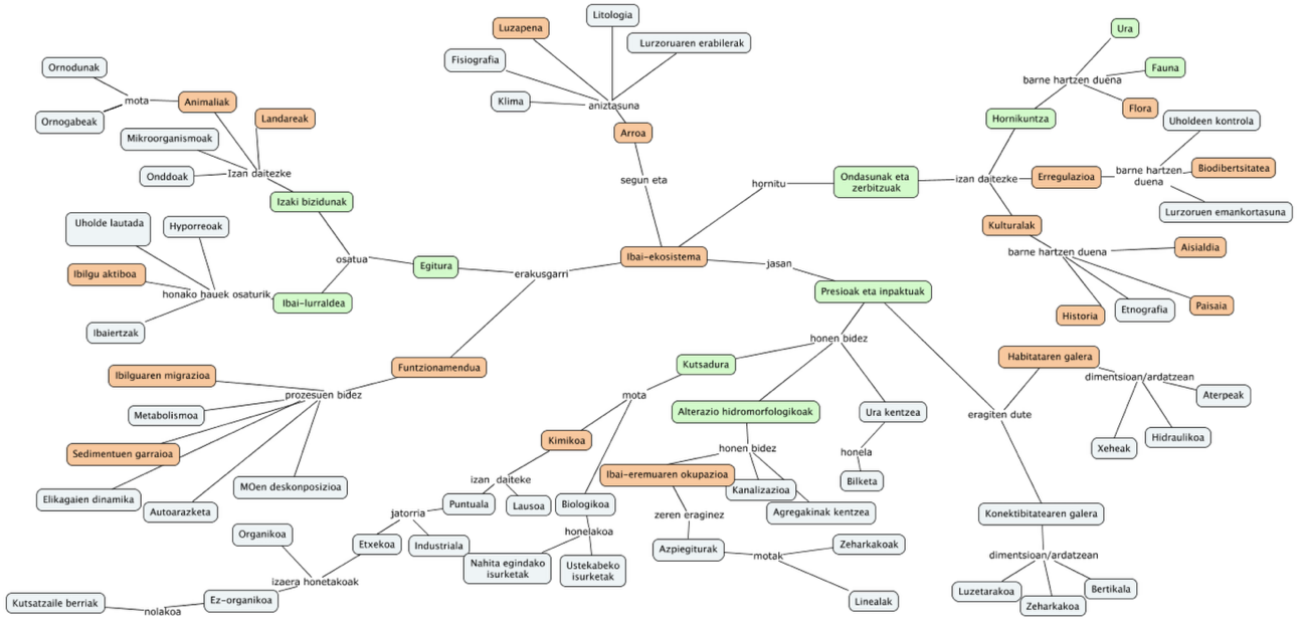


Figure 2 - Conceptual map of river ecosystems used for comparison with descriptions provided by interviewed stakeholders. Green colour indicates concepts mentioned very frequently, orange concepts mentioned with intermediate frequency, and blue concepts rarely mentioned.

In addition, **interviews** at the main **secondary schools** in the catchment were used to evaluate **mental models** of rivers among 155 students and 46 secondary-school teachers. Only 4% of students and 15% of teachers showed a complex, catchment-scale conceptualisation of the river ecosystem; overall, perceptions were excessively hydraulic and included numerous conceptual

errors. In particular, interviewees had a markedly inaccurate view of the benefits and impacts of barriers in the Deba catchment (Fig. 3). Again, these results suggest that **environmental education needs to be improved** so that society can better understand the values and risks associated with river ecosystems.

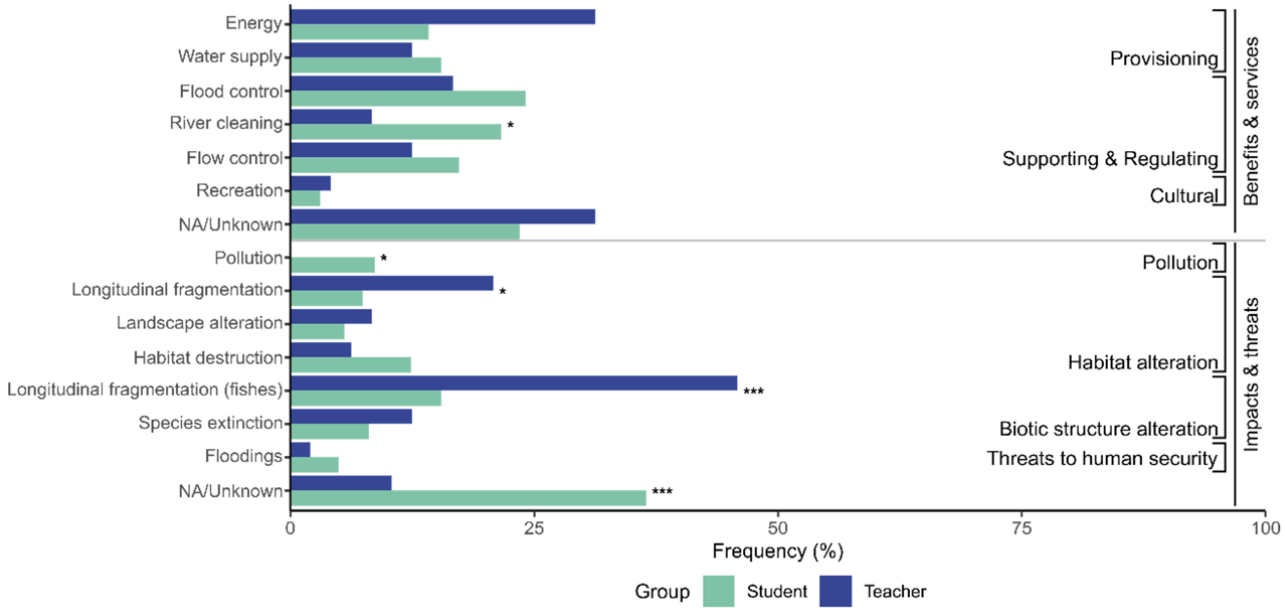


Figure 3 - Perceived impacts and benefits of barriers in the Deba catchment according to secondary-school students and teachers. Asterisks indicate statistically significant differences between the two groups.

Open meetings were also organised **at municipal scale**, to which all identified social actors were invited. The objectives were to present the MERLIN project, collect potentially relevant information and seek support from local society. A **structured participation protocol** was also designed for these meetings. In a first phase, information was collected on how stakeholders perceived the status of the river and their relationship with it before demolition, the problems they identified, and their perceptions of the ecological and social effects of barriers. In a second phase, technical information was provided on the negative effects of barriers and the potential improvements resulting from total or partial removal, including ecological improvement and reduced flood risk.

These **meetings showed** that throughout the Deba catchment, **society** as a whole, from municipal managers to the general public, has an **inaccurate perception of the status of the Deba River and the effects of barriers**. People are often unaware of the improvements that have occurred in both water quality and faunal communities, while emphasising features such as plastics trapped in riparian vegetation which, despite their strong visual impact, are less damaging to the ecosystem. There is also a **widespread misconception regarding barrier effects**, with a common belief that although barriers obstruct fish movement, they mitigate flooding, oxygenate the water and provide high-quality fish habitat. Nevertheless, the **workshops** proved effective and the **general perception** of barrier-related problems **changed markedly**.

Social acceptance of the interventions was also found to be heterogeneous. In Soraluze in particular, part of the population opposed barrier removal. In some cases, this opposition moved

beyond technical debate and led to challenges to the scientific validity of the work and the professionalism of both DFG and UPV/EHU staff. This situation became one of the central elements of the deliberables developed within the project and of internal meetings[9]. Managing this opposition required sustained efforts in communication, transparency and technical rigour, and was rated very positively by the project coordinators.

3.2 Engagement with key economic sectors

Throughout the project, work was carried out with two key economic sectors in relation to barrier removal: the **hydropower sector** and the **insurance sector**. These sectors play a central role in river-barrier removal, **both** as **potentially limiting actors and** as **key facilitators of the process**. Regarding hydropower (Fig. 4), we participated in a process aimed at identifying how the sector could be involved in river-barrier removal. Although the Deba River served as a case study, the analysis was framed more broadly through meetings and workshops with sector representatives at European scale. Discussions considered how many obsolete or low-profit infrastructures continue to generate significant impacts, creating **opportunities** for their removal **as compensation for impacts caused by barriers** that remain in operation. Together with other project partners, we are also leading work exploring **mechanisms for integrating** the sector and proposals for addressing **common conflicts** that may arise during removal projects.

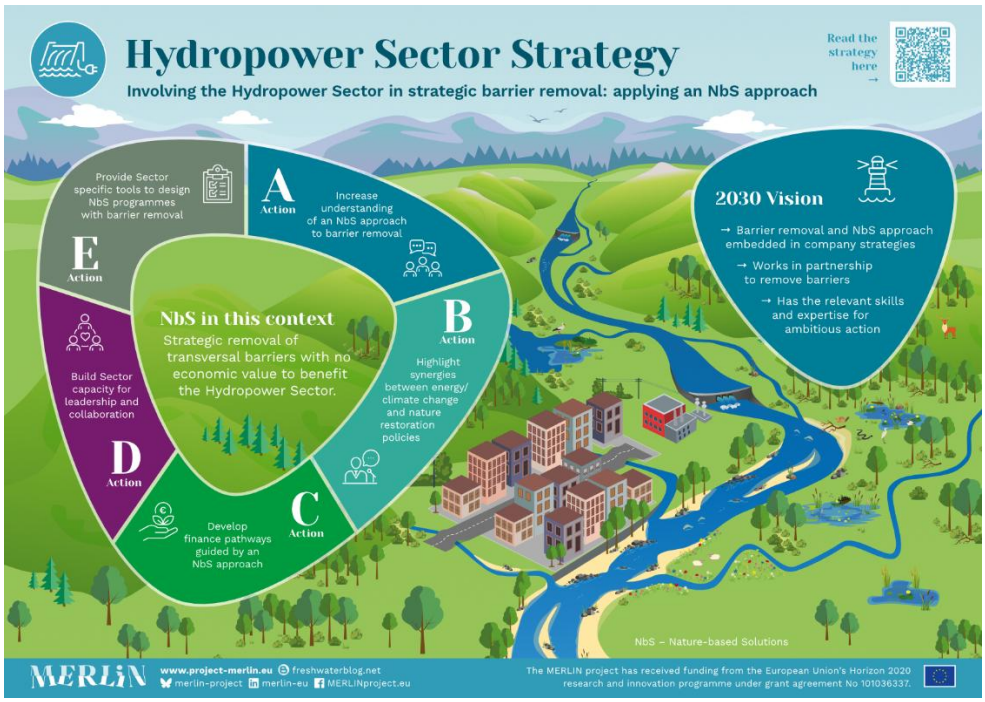


Figure 4 - MERLIN strategy for river barrier removal co-designed with the hydropower sector.

The **insurance sector**, for its part, showed strong interest in the potential contribution of barrier **removal to reducing flood damage** (Fig. 5). In the geographical viewer of the Spanish Insurance Compensation Consortium, **Gipuzkoa** appears as one of the **Spanish provinces with the highest economic flood damage per inhabitant**[15, 16]. Reducing flood risk associated with barriers in urban environments would therefore be highly relevant to this sector. These interactions were used to

explore how the insurance sector could incorporate such measures into **risk-assessment models** and European-scale strategies.

The collaboration and participation of both economic sectors within MERLIN, particularly in relation to barrier removal, highlighted the **potential of Nature-based Solutions to generate synergies between sectors** that have traditionally been disconnected, integrating ecological restoration into broader frameworks of risk management and climate-change adaptation.



Figure 5 - MERLIN strategy for river barrier removal co-designed with the insurance sector.

3.3 Meta-analysis of the ecological effects of barrier removal

To determine the general effects of barrier removal on river ecosystems, we conducted a **meta-analysis** reviewing the available scientific literature on the ecological effects of barrier removal14. A Web of Science search initially identified 773 studies apparently related to barrier removal (Fig. 6). Of these, 29 ultimately met the required methodological criteria: studies comparing control and restored reaches upstream or downstream of barriers. In total, **803 independent comparisons** were obtained, because individual studies generally reported multiple variables and almost always included several time periods or several barriers.

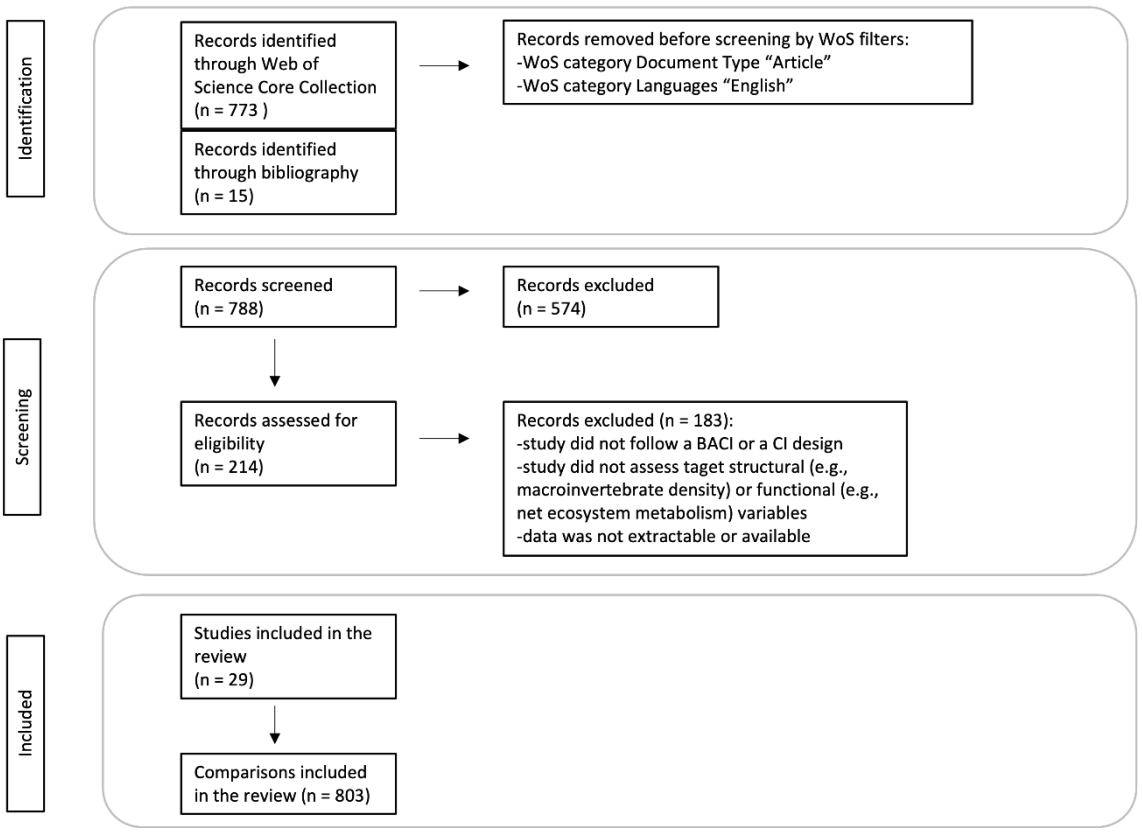


Figure 6 - Study-selection sequence for the meta-analysis of the ecological effects of barrier removal.

The meta-analysis showed that ecological responses following **barrier removal followed clear temporal trajectories**, with both formerly impounded and downstream reaches progressively converging towards control conditions over time. However, **the rate of recovery differed between spatial contexts**, with model-predicted trajectories **approaching control conditions after approximately 12 months in formerly impounded reaches and 60 months in downstream reaches** (Fig. 7)[14]. These results indicate that ecological recovery following barrier removal is a gradual and spatially dependent process, reinforcing the importance of allowing sufficient time after removal before assessing restoration outcomes.

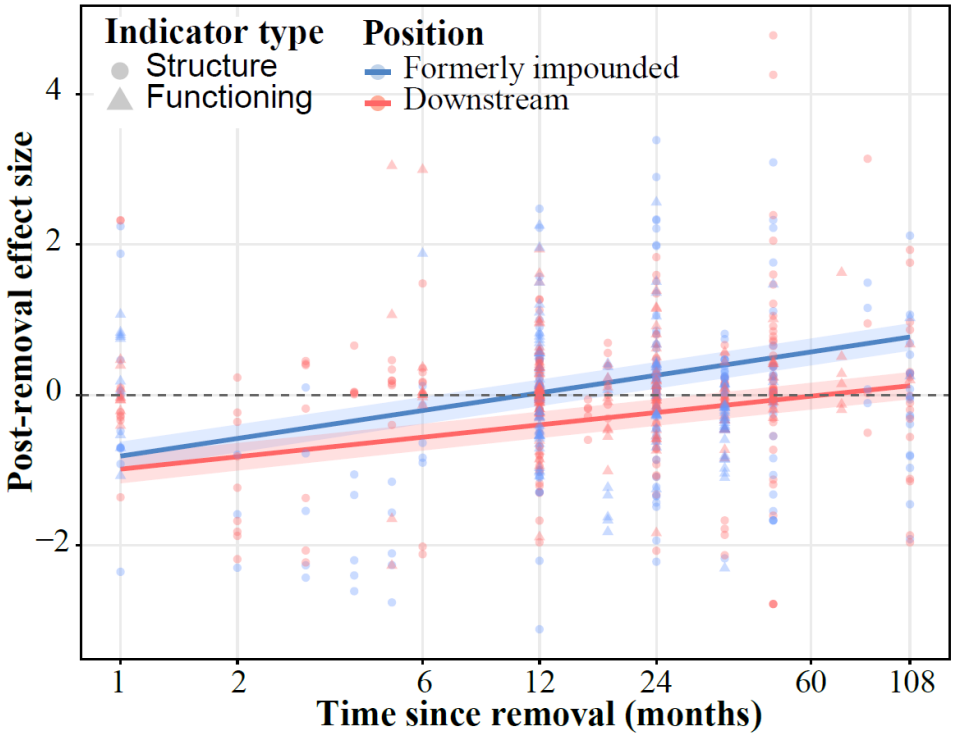


Figure 7 - Temporal trajectories of ecological recovery following barrier removal. Points represent comparisons between impacted and control reaches, and lines show model-predicted trajectories for formerly impounded (blue) and downstream (pink) reaches. Both progressively converge towards control conditions, approaching them after approximately 12 and 60 months, respectively.

3.4 Effects of barriers on river ecosystem functioning

Taking advantage of the planned removal of three of the largest barriers in the Deba at **Soraluze** (Olea, Malmero and Igarate), we designed a BACI study to assess the **effect of their removal on river ecosystem functioning**. Seven sampling stations were established: one upstream of the area affected by the first barrier, three in the reaches impounded by each barrier, and three in free-flowing reaches immediately downstream. Artificial substrates were deployed in each area to determine biofilm growth rate, **nutrient uptake capacity** (related to self-purification capacity), **metabolism** (photosynthesis and respiration), and microbial organic-matter **decomposition** rate. **Greenhouse-gas emissions** were also measured. Although the results have only been analysed preliminarily, pending post-removal sampling to complete the BACI analysis, the available data show increased **chlorophyll** concentrations in barrier-affected reaches compared with the control reach (Fig. 8).

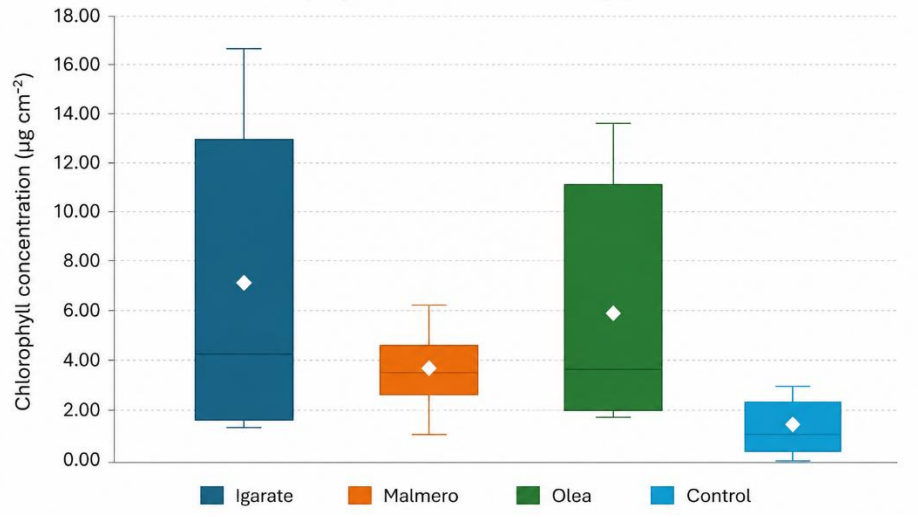


Figure 8 -. Chlorophyll concentration in reaches impounded by the Igarate, Malmero and Olea barriers in Soraluze, compared with the free-flowing control reach.

For *greenhouse gases*, a clear pattern was observed between impounded reaches and free-flowing reaches immediately downstream of barriers: **dissolved CH4 concentrations were high in impounded areas** and decreased markedly after water passed over the barrier (Fig. 9). These results demonstrate that **CH_4 is generated in impounded reaches** and subsequently released to the atmosphere when turbulence increases as water passes over the barrier.

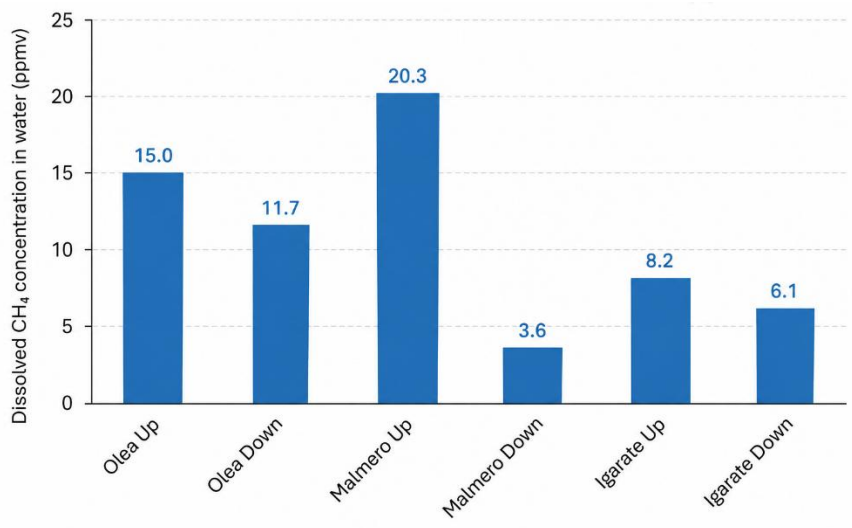


Figure 9 - Dissolved CH4 concentration in impounded areas (up) and immediately downstream of barriers located in the centre of Soraluze.

In summer 2023, given the delays in barrier removal, we conducted a **catchment-scale study across the Deba basin**, from downstream of Oñati and Arrasate to the beginning of the tidally influenced section. **Greenhouse-gas emissions** (CO_2, CH_4 and N_2O) were assessed at 10 barriers (Aitzetarte, Altzola, Barrena Berri, Barrena Errota, Bolubarri, Garibai Errota, Igarate, Itavex, Laupago and Zubilaga). Three zones were defined at each site: the **impounded zone, the waterfall/turbulent zone immediately below the barrier, and the free-flowing zone**. The results show that barriers strongly affect greenhouse-gas emissions (Fig. 10). In impounded areas, low current velocity significantly

reduces water reaeration, favouring the deposition and accumulation of organic matter in the sediment. During decomposition, this organic matter consumes dissolved oxygen, and microbial processes consequently lead to **CH_4 production**. The methane dissolves in the water and is released to the atmosphere downstream in highly turbulent areas, such as the waterfall or fast-flowing reaches immediately below the barrier. Overall, this process turns **barriers into greenhouse-gas emission hotspots**. Previous studies in other ecosystems suggest that after barrier removal, sediments and organic matter accumulated in the formerly impounded area are mobilised downstream. This may temporarily increase CO_2 emissions associated with decomposition under oxic conditions. At the same time, however, CH_4 emissions decrease, resulting in a clearly positive climatic balance of barrier removal because CH_4 has a much higher global-warming potential than CO_2.

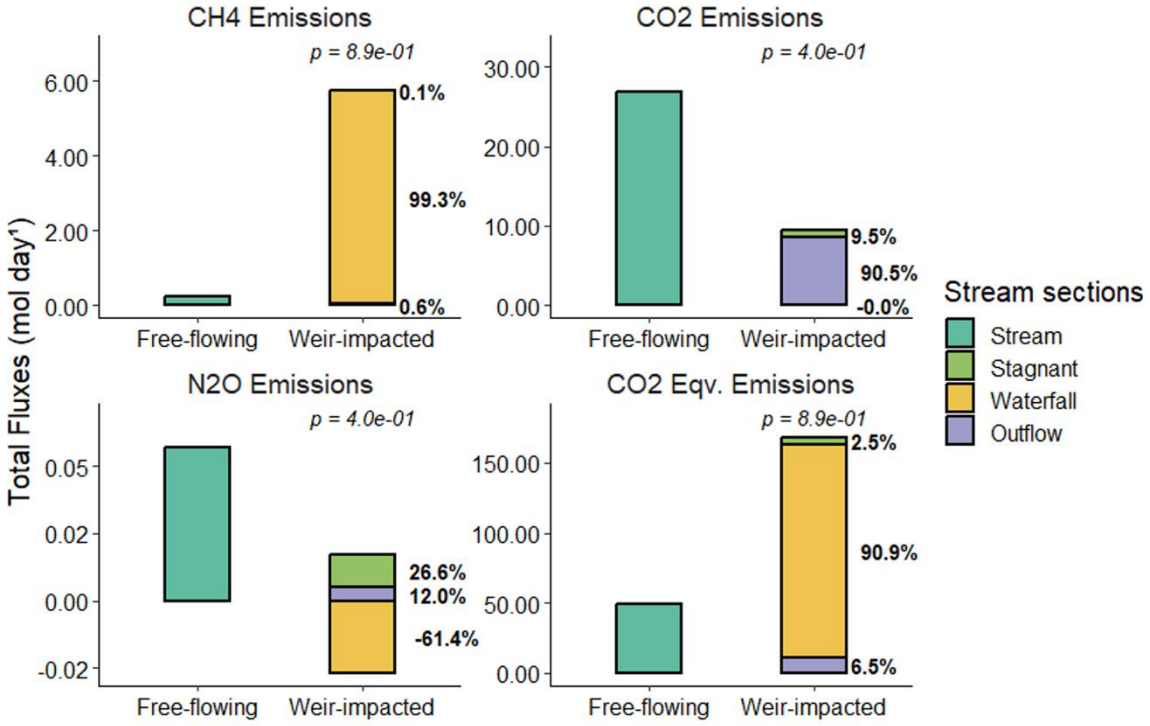


Figure 10 - Greenhouse-gas emissions from free-flowing and barrier-affected reaches in the Oñati and Deba rivers. Barrier-affected reaches show lower CO_2 but higher CH_4 emissions, resulting in a higher overall climate impact. Emissions peak at waterfalls, where accumulated CH_4 is released.

Finally, in 2025, once it became clear that the Barrena Errota barrier would be removed, and considering that the **Epele wastewater treatment plant (WWTP)** discharge is located immediately upstream of the impounded area, we designed a **BACI study to assess the effect of the barrier and its removal on the river's self-purification capacity**. Two sampling reaches were established: a control reach between the Eroski in Mekolalde and the WWTP, and an impact reach between the WWTP and the San Prudentzio gauging station. To characterise river metabolism and nutrient dynamics, oxygen sensors and automatic water samplers were installed at the inlet and outlet of each reach, as well as at the WWTP outlet. The aim is to perform a nutrient mass balance in three phases: before demolition (June-August 2025), during the intervention (September-October 2025),

and after barrier removal (June-August 2026). The first and second phases have been completed to date, and the samples are stored pending joint **analysis after completion of the final sampling phase**. This will allow a robust assessment of the effects of barrier removal on the system's self-purification capacity.

3.5 Effects of barriers on river communities

Within MERLIN, we produced annual reports documenting the evolution of the main physicochemical and biological variables monitored throughout the project. These results were integrated into a joint final deliverable assessing the contribution of freshwater ecosystem restoration to achievement of the SDGs[17].

In the Deba River, barrier removal and restoration of longitudinal connectivity **reconnected nearly 20 kilometres of river** and naturalised river habitat over several hundred metres. Although the observed changes cannot be attributed exclusively to these actions, because ecosystem status responds to multiple factors, **ecological status improved** between 2020 (pre-restoration conditions) and 2024 (intermediate conditions) in the upper, middle and lower Deba water bodies, shifting from moderate to good. This trend is also reflected in the IBMWP index, particularly in the upper and lower catchment, and in the **normalised river ecological-quality index**, which **increased** from 0.50 to 0.69 (Table 1).

Table 1 - Temporal evolution of the IBMWP index in reaches of the Deba River (2020-2024).

IBMWP Index	2000	2021	2022	2023	2024
Upper Deba	Moderate	Good	Good	Good	Good
Middle Deba	Good	Good	Good	Good	Good
Lower Deba	Moderate	Good	Good	Good	Good

By contrast, this **improvement was not reflected in clear changes in fish communities**, as both total density (N ha-1) and biomass (kg ha-1) of fish and eels showed irregular trajectories during the study period (Fig. 11). This result is consistent with expectations because the **2025**n, the year in which the highest-impact barriers were removed, **have yet to be integrated, little time has elapsed since removal**, and fish communities are often among the last ecosystem components to show significant recovery. The observed **improvement in ecological status** therefore appears to be **mainly associated** with changes in **macroinvertebrate communities** and in certain physicochemical parameters, such as reduced ammonium concentrations and a tendency towards lower mean water temperature.

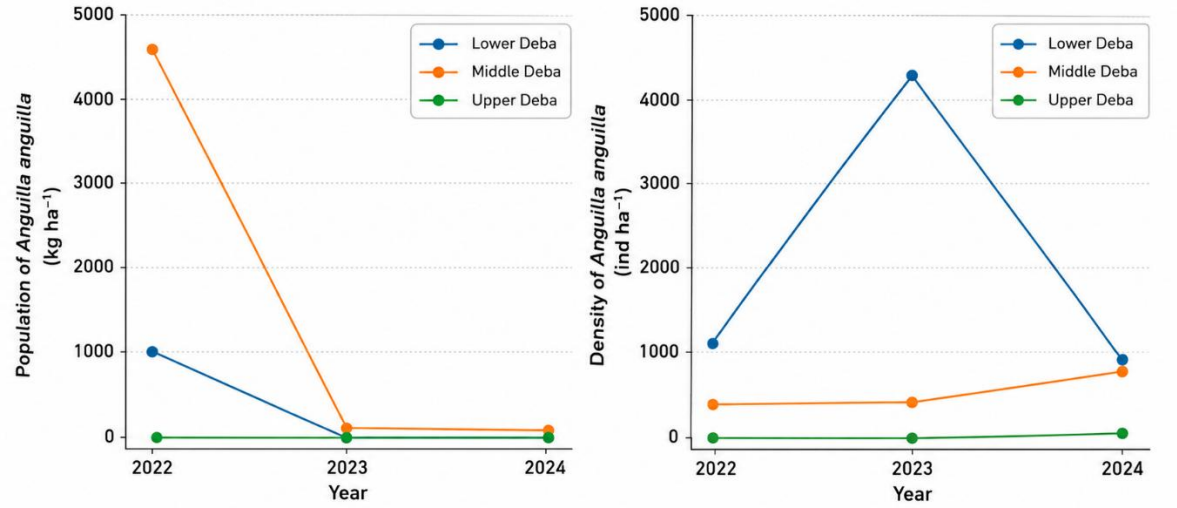


Figure 11 - Spatial distribution and temporal evolution of Anguilla anguilla density and biomass in the Deba River (2022-2024).

4 Conclusions

As noted above, the **objectives of MERLIN** extend far beyond the restoration of individual river reaches. The project has therefore been **evaluated at two scales**, the case-study scale and the European scale, always **from the perspective of the SDGs**.

At European scale, the **overall assessment** of the project, established at the final consortium meeting in Ghent on 11 March 2026, was **very positive**. Beyond the environmental benefits achieved in the case studies, MERLIN was highlighted for creating **synergies among a large number of actors** and **producing documents intended for use by policy designers at European scale**. This is **expected to contribute to legislation that further promotes Nature-based Solutions** as a means of addressing the **environmental and societal challenges** facing the European Union.

Regarding the **specific results** of the implemented work, **MERLIN's summary table**[17] (Table 2) provides an assessment based on the SDGs. All case studies showed a positive response for biodiversity, 11 for climate regulation, 16 for flood resilience, 13 for drought resilience, 13 for health and well-being, 6 for zero pollution, and so on. Overall, **positive outcomes were much more frequent than neutral or negative outcomes**. It should also be noted that for some SDG indicators, such as sustainable transport, data were unavailable, generally because the scale at which restoration projects are implemented differs greatly from the scale at which data are collected in many economic sectors.

Table 2 - Overall assessment of restoration work carried out in MERLIN based on SDG indicators.

Response	Biodiversity Net Gain	Climate Regulation	Flood Resilience	Drought Resilience	Health & Well-Being	Zero Pollution	Farm to Fork	Sustainable Energy	Sustainable Transport	Inclusive participation	Circular Economy	Financing Transition	Green Growth
Positive	19	11	16	13	13	5	1	3	2	13	4	16	16
No change	0	5	1	4	2	2	4	2		1	3		2
Negative	0	0				3	3			1			
Insufficient data		1							1				
NA or no data	0	2	2	2	3	9	11	13	16	4	12	3	2
Confident	19	1	12	13	10		8	4	2	11	5	7	13
Uncertain	0	16	5	4	5	10		1	1	4	2	9	5

For the **Deba River**, the effect of barrier removal could not be assessed (or assessment was not meaningful) for six SDGs. Of the **seven SDGs assessed**, the **effect was positive or very positive for six** and neutral for drought resilience (Table 3).

Table 3 - Overall assessment of restoration work carried out in MERLIN based on SDG indicators.

Case study	Biodiversity Net Gain	Climate Regulation	Flood Resilience	Drought Resilience	Health & Well-Being	Zero Pollution	Farm to Fork	Sustainable Energy	Sustainable Transport	Inclusive participation	Circular Economy	Financing Transition	Green Growth
Peatlands and wetlands													
CS01 – Kvorning wetland rewetting DK	☺	NA	☺	☺	☺	NA	NA	NA	NA	☺	NA	☺	☺
CS03 – Beaver river engineering SE	☺	😐	☺	😐	☺	☹	NA	NA	NA	☺	😐	☺	😐
CS05 – Kampinos wetland rewetting PL	☺	☺	☺	☺	😐	☺	NA	NA	NA	☺	NA	☺	☺
CS06 - Hutovo Blato peatland rewetting BiH	☺	NA	NA	NA	☺	NA	NA	😐	☺	☺	😐	☺	☺
CS12 – Lima floodplain forest restoration PT	☺	☺	☺	☺	😐	☹	☹	☺	NA	☺	☺	☺	☺
CS14 – Komppasuo peatland rewetting FI	☺	☺	☺	☺	☺	☹	NA	NA	NA	☺	NA	☺	😐
Small streams and basins													
CS02 – Deba barrier removal ES	☺	☺	☺	😐	☺	☺	NA	☺	NA	NA	NA	NA	NA
CS11 – Emscher basin restoration DE	☺[a]	☺	☺	☺	☺	☺	NA	☺	NA	😐[a]	NA	☺[b] ☺[c] ☺[d]	☺

Overall, the results obtained in the Deba River case study demonstrate the **high potential of barrier removal as a river-restoration tool**, with positive effects on connectivity, flood-risk mitigation,

ecological quality and reduction of greenhouse-gas emissions. Despite the limitations inherent in the short monitoring period and the complexity of river ecosystems, **the observed trends are consistent with the available evidence** and reinforce the validity of **NbS** as an **effective instrument for addressing environmental and climate challenges**. The case study has also generated knowledge applicable beyond the local context and contributes to MERLIN's objectives of upscaling and integrating restoration into policy and socioeconomic sectors.

The project has also shown that **river restoration is not solely a technical or ecological challenge, but also a social, institutional and communication challenge**. The need to integrate multiple actors, manage diverse perceptions and respond to misinformation highlights the importance of **combining scientific rigour with effective participation and governance strategies**. In this respect, MERLIN has provided a solid basis, both in implementation and in interaction with local actors and European sectors, **for progressing towards restoration models that are more inclusive, replicable and aligned with the SDGs**.

5 Bibliography

1. Carvalho L., Schwerk A., Matthews K., Blackstock K., Okruszko T., Anzaldua G., Baattrup-Pedersen A., Buijse T., Colls M., Ecke F., Elosegi A., Evans C., Gerner N., Rodríguez González P., Grondard N., Grygoruk M., Hein L., Hering D., Hernandez Herrero E., Hoffmann C.C., Hopkins J., Ibrahim A., Rouillard J., Scholl L., Spears B., Williamson J. and Birk S., 2022. New framework for monitoring systemic impacts of freshwater and wetland restoration actions. EU H2020 research and innovation project MERLIN deliverable 1.2. 75 pp.
2. Gerner, N. et al. (2023). MERLIN deliverable 2.3 Case study implementation plans. EU H2020 research and innovation project MERLIN. Emschergenossenschaft-Lippeverband, Essen. 211 pp.
3. Buijse, A.D. et al. (2022). MERLIN deliverable 2.1 Case study optimisation strategies. EU H2020 research and innovation project MERLIN. Deltares, Delft. 126 pp.
4. Gerner, N. et al. (2023). MERLIN deliverable 2.3 Case study implementation plans. EU H2020 research and innovation project MERLIN. Emschergenossenschaft-Lippeverband, Essen. 211 pp.
5. Wenskus, F., Anzaldua, G., Buijse, T., Cooke, A.-K., Grondard, N., Hering, D., Hershkovitz, Y., Ibrahim, A., Katz, A., Kok, S., Penning, E., Birk, S., 2026. Reporting on implementation results from MERLIN restoration case studies. EU H2020 research and innovation project MERLIN deliverable D2.5. 45 pp.
6. Pietilä, K. et al. (2023). MERLIN deliverable 2.2 Synthesis of the Interim Regional Scalability Plans. EU H2020 research and innovation project MERLIN. Syke, Helsinki. 130 pp.
7. Colls M., Elosegi A. & Bañares I. 2024. Unchoke rivers, improve nature and society. Deba Barrier Removal ES Regional Scalability Plan (RSP). 18 pp.
8. Schulz, L. et al. 2025. Just transformations: Sectoral stakeholder engagement, processes and perceptions of mainstreaming Nature-based Solutions. 113 pages. EU H2020 research and innovation project MERLIN deliverable 4.2.
9. Ibrahim, A. et al. 2025. Just Transformations - Embedding stakeholder engagement in mainstreaming nature-based solutions within freshwater ecosystems. EU H2020 research and innovation project MERLIN deliverable D4.9. 49 pp.
10. Schmidt-Kloiber, A., Arreaga Espin, J., Birk, S., Hering, D., Strakbein, J., Andrez, P., Demus, Y., 2025. MERLIN Academy.
11. Blackstock K.L. et al. (2025). Cross-Sectoral Routemap for Mainstreaming Freshwater Nature-based Solutions in Europe. 84 pages.
12. Bérczi-Siket, A., Blackstock, K. and Nyírő, F. (2025). Focus Sectoral Strategies for mainstreaming freshwater restoration. EU H2020 research and innovation project MERLIN deliverable D4.5.
13. Chen J. et al., 2024. Value Chain Analysis in Key Economic Sectors. EU H2020 research and innovation project MERLIN deliverable D4.4. pp. 53.
14. Colls, M., et al. (2026). Spatially asymmetric and temporally dynamic ecological responses to river barrier removal: a global meta-analysis. Journal of Applied Ecology.
15. Espejo Gil, F. (2020). Representación del riesgo de inundación en España a partir de los datos del seguro de riesgos extraordinarios. Consorseguros Digital, 13, 47–52. Consorcio de Compensación de Seguros.
16. Consorcio de Compensación de Seguros (CCS). (2015). Estadística de riesgos extraordinarios. Serie 1971–2014. Consorcio de Compensación de Seguros, Madrid, 143 pp.

17. Schwerk, A. et al. (2025). Manuscript and policy briefing evaluating success of large landscape-scale restoration. EU H2020 research and innovation project MERLIN Deliverable D1.6. 135 pp.

MERLIN

MERLIN