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Editorial

In continuation to the pan-European survey to develop policies and strategic planning regarding river continuity restoration and European national river continuity restoration policies review was made. The purpose of the review was to identify similarities and differences as well as the completeness and the effectiveness of the single policies to determine if it is possible and useful to create a general policy framework for river continuity restoration. The conclusion of the study is that the development of such a framework would not coercively enhance the river continuity restoration process, but there is an evolving river continuity restoration policy process in the investigated countries.

At least in these countries and probably beyond water professionals work on the improvement of the barrier data base, the prioritization methods and the monitor-

ing and evaluation methods for enhanced river continuity restoration. Moreover, the EU Biodiversity Strategy 2030 with the objective of 25.000 km free-flowing rivers by 2030 and the (draft) EU Nature Law stimulates the development of river continuity restoration to river eco-system restoration.

The findings, conclusions and recommendations of this study together with EU guidance and support further enable efficient and effective alignment of national policies with this new goal and adapted characteristics.

On behalf of the ECRR Board I would like to thank the authors of the full report and this article, and all collaborators from the countries concerned and of the advisory group for their dedicated and professional work on the review. And of course a special thanks to the main supporter of the Dutch Foundation Applied Water Research (STOWA).

Martin Janes, Chairman, ECRR





A European National River Continuity Restoration Policies Review

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Introduction

The many placements of artificial barriers in rivers worldwide in the twentieth century have disconnected the upstream freshwater habitats from the oceanic habitats (Dynesius & Nilsson, 1994). Obstructing a river can vastly alter ecosystem properties such as water depth, flow regimes, channel morphology, sediment loads, chemical properties, and thermal conditions (Dynesius & Nilsson, 1994). The disruption of river continuity has been shown to result in a major decrease in species diversity, as well as population declines and even extirpation of freshwater fishes and mammals (Morita & Yamamoto, 2002). River barriers, including dams, weirs, culver, fords, sluices, and ramp or bed sills, are man-made obstacles that are installed in rivers for specific, mostly provision-related, ecosystem system services such as flow regulation, hydropower generation, water level control, or erosion reduction (AMBER Consortium, 2022).

Equipping river barriers with efficient fish passes, such as fish ladders or lifts, and installing bypass channels improves connectivity mainly for fish migration, whilst removing the barrier completely restores the entire river continuity. River continuity restoration will help to prevent the extinction of diadromous fish species and to achieve the relevant water legislation targets and UN Sustainable Development Goals. However, to reach the goals of the respective legislations, it is of importance how they are translated into actions in practice. Therefore, the current situation in different countries must be understood. National legislations can differ among countries, even within a collaboration overarching various countries, such as the European Union.

In 2021, the Dutch Foundation for Applied Water Research (STOWA) conducted a study commissioned by the European Centre for River Restoration (ECRR). The study was a pan-European survey to investigate the current situ-

ation regarding the **policies and strategic planning of river continuity restoration in the Greater Europe**. The aim of the ECRR/STOWA survey was to create an overview on the status and potential of longitudinal river continuity restoration within Europe including the availability and use of national policies (Verheij, Fokkens, & Buijse, 2021)

This STOWA/ECRR study, has the goal to investigate selected **national European river continuity restoration policies in-depth** providing various country organisations information and

knowledge for making, improving and updating concerning new requirements, the laws and regulations for river continuity restoration. Similarities and differences as well as the completeness and effectiveness of the single policies were identified to determine if it is possible and useful to create a general policy framework for river continuity restoration. Existing issues as well as successful functions of the river (continuity) restoration policies of the single countries are analysed, discussed and recommendations on what an effective and complete policy should entail are given.



Method

The WFD requires continuity for all EU river water bodies insofar as necessary to support the achievement of good ecological status, but not necessarily the complete absence of barriers. In fact, river continuity is already a key aspect of good ecological status. Removal or adaptation of barriers is part of the measures necessary to fulfil the legal obligations under the WFD. River continuity is also necessary to achieve the objectives of other EU legislation. For example, the Habitats Directive protects the European sea sturgeon *Acipenser sturio*, which needs to migrate between the sea and freshwater. The European eel, protected by the Eel Regulation 15, also needs river continuity to survive. (EC, 2021)

Finally, the Biodiversity Strategy calls for a focus primarily on obsolete barriers. This term refers to barriers that no longer fulfil their original purpose or that are no longer needed. This could be, for example, a dam that is no longer useful for hydropower generation, water supply or flood protection, or a weir that no longer acts as a riverbed stabiliser because it is damaged or because the river has changed its geomorphological configuration and such infrastructure is no longer useful. When prioritising barriers for their possible removal, it will indeed be important to evaluate the role they might still be playing (although in this case the possible benefit of such future use needs to be assessed against the benefits of removing it for the sake of nature restoration), or the otherwise beneficial effect that such barriers may have (e.g., for biodiversity). This is to consider the need to maintain different important uses such as inland navigation, renewable energy generation or agriculture. The WFD already integrates provisions for such uses and sets rules to ensure the integration of different objectives. (EC, 2021)

Based on the result of literature research as well as on the results of the 2021 survey by the

ECRR/STOWA, a list of categories and sub-categories that a complete policy should contain was created and used to perform a detailed investigation of the received national policies.

On request amongst countries participating in in the 2021 survey policies were received from the following countries:

- Austria
- Finland
- France
- Germany
- Lithuania
- The Netherlands
- North Macedonia
- Norway
- Slovakia
- Spain



From the 2021 ECRR/STOWA study, survey conclusions and recommendations were drawn for three different stakeholder target groups; those who are dealing with policies and planning, the implementers, and the researchers. The recommendation for the policymakers and planners is used together with the ‘Australian policy’ created by (Althause, Ball, Bridgman, Davis, & Threfall, 2022) to come to the following categories and sub-categories for the analysis of each national river restoration policy:

- (1) **Issues identified** – recognising a problem and defining it as an agenda for public policy
 - a. Goal definition
 - b. River (continuity) restoration definition
 - (2) **Policy prerequisite** – gathering information to frame the issue and help decision-makers understand the problem
 - (3) **Policy instruments** – identifying appropriate tools and approaches to address the problem
 - a. Planning of measures
 - b. Barrier data base (existing, planned, removed, function, equipment)
 - c. Prioritisation method catchment (protected site, natural diversity and ecological condition, other social benefits)
 - d. Prioritisation of one or more barriers (largest environmental or ecological impact, easy to implement measures, lacking an operative fish passage, obsolete structures, relatively small barriers)
 - e. Available plans and measures to be used (adding a fish passage, barrier bypass channel, barrier removal, structural modification)
 - f. Technical knowledge and expertise
 - (4) **Consultation** – discussions and interactions with relevant agencies and interest groups to test ideas and gather support
 - a. Public participation
 - b. Awareness raising
 - c. Stakeholder forum
 - (5) **Financing** – ensuring funding is available to implement policy
 - a. Private funds
 - b. Regional/local government budget allocations
 - c. National government budget allocations
 - d. (Special) National funds
 - e. European funds
 - f. Principles and tools (e.g., Cost-benefit-analysis (CBA), Multi-criteria decision analysis (MCDA), polluter-pays-principle)
 - (6) **Decision** – confirmation of policy by government
 - (7) **Implementation** – legislation and/or a programme designed to achieve the goals agreed on by the government
 - a. Technical guidance and support
 - b. Top-down; Bottom-up; synthesis
 - (8) **Evaluation** – reviewing the effects of the policy and adjusting or rethinking its design
 - a. Monitoring
 - b. Evaluation
 - c. Adjustment
 - (9) **Linkage to EU WFD** – and other EU directives
 - (10) **Policy effectiveness** – ensuring that mechanisms, calibrations, and objectives display coherence, consistency, and congruence with each other
- To get a better insight into the single river restoration policy situations of the participating countries, interviews with representatives of the water management sectors were organised. Preferably, at least one representative from the stakeholder group of policymakers and planners and one representative from the policy implementers group for each participating country was interviewed concerning the existing national river continuity restoration policy. The main aim of the interviews was to gather information as a basis for a discussion on the process of designing a complete and comprehensive policy and what mechanisms are necessary for it to be effective. Furthermore, the interviews had the purpose to investigate how the policies work in practice.

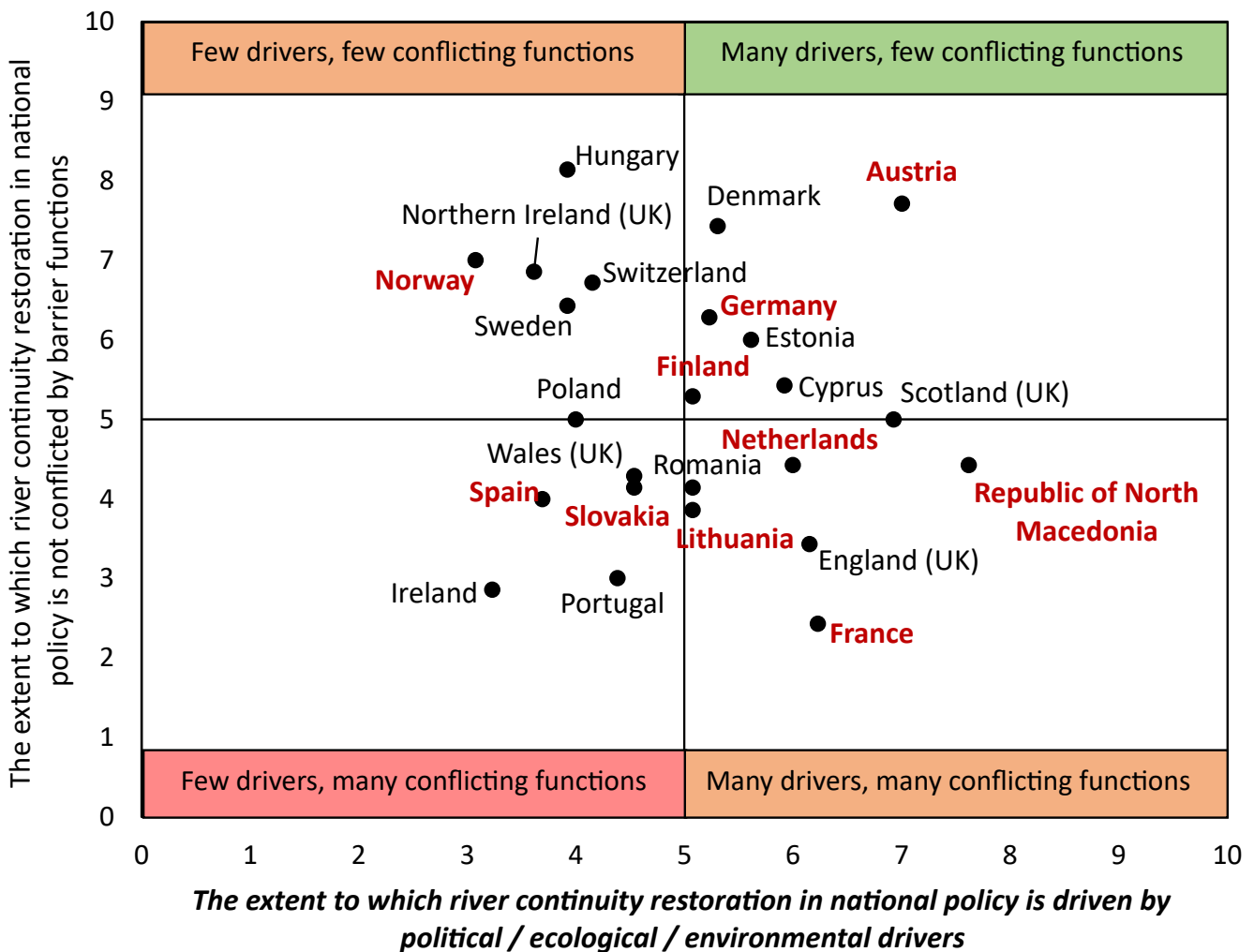


FIGURE 1 Four-quadrant matrix chart from 2021 study by ECRR/STOWA (Verheij, Fokkens, & Buijse, 2021), with in red the countries considered in this study as well.

The four-quadrant matrix chart in Figure 1 shows the extent to which river continuity restoration in national policies is driven by political, ecological, and environmental drivers, and the extent to which river continuity restoration in national policies is not conflicted by the barrier functions. Figure 1 is a result of the survey conducted by the ECRR/STOWA in 2021. To obtain a broad overview of the policy situation in countries with different circumstances, the aim was to interview countries from all four quadrants.

After discussion the findings of the interviews, based on the preceding analyses were reported along to the following categories:

1. Policy background and design
2. Policy effectiveness
3. Restoration tools
4. Stakeholder involvement
5. Financing
6. Monitoring and evaluation

For the Netherlands River continuity restoration could not be identified as an essential part of the National Water Plan 2016–2021, nor of the National Water Plan 2022–2027. The topic is not mentioned in the documents. However, the Netherlands have a Fish Migration Strategy which entails the equipment of barrier with fish passes and the reconnecting the waterway network, but since it seems not to play a big role on the national planning and policy level, the Netherlands were not further investigated for the purpose of this study.

The Water Strategy for the Republic of Macedonia (2010) does not include longitudinal river continuity restoration. The documents also declares that the competent authorities of Water Management conduct all national water policy in professional, administrative, regulatory, and supervisory sense. Water management is achieved within the jurisdiction of state administrative and professional institutions, as well as cooperation with other authorities, regional administration and local self-government, economic sectors, scientific and professional institutions. Although, they are very interested in the topic of river continuity restoration since the country is a candidate for accession to the EU which if they are accepted would require the transposition of the WFD into national law, North Macedonia was no further investigated for this study.

Due to time constraints, it was not possible to interview representatives of all the remaining countries. The following countries were selected for interviews based on the result of the first findings of reading the national policies and the results of the 2021 study which are partly depicted in Figure 1:

- Austria
- Finland
- France
- Norway
- Slovakia

In the study report the reporting is done extensively and with a summary table per country. This article is a summary of the report with an emphasis on the general findings, conclusions and recommendations. To get insight in the type of information that was obtained from the analyses and the interviews the summarised information for Austria is presented below.

Summary of the main river continuity restoration policy characteristics of Austria

GOAL Maintaining and restoring continuity; creation of upstream fish passability by renovating existing migration obstacles.

INSTRUMENTS

- Barrier data base (total of 28,435 barriers, approx. 80% in catchment areas < 100 km²)

	Existing	Planned	Removed	Function	Obsolete	Equipped
	X	-	-	X	-	-

- Prioritisation Water Body
 - larger catchment areas (>100km²) and Hyporhithral and Epipotamal fish regions of high priority
 - catchment areas (<100km²), where cost-effective continuity with high impact on fish biocenoses can be implemented
- Prioritisation barrier
 - On lower reaches of water courses, specifically where improvements are expected to have high ecological impact (accessibility of habitats and spawning grounds)
 - joint implementation with other measures (e.g., use of synergies with flood protection projects)

- Plans and measures
 - Fish pass construction at existing and new hydropower plants
 - Conversion of weirs into ramps, build bypass channels

IMPLEMENTATION River basins are assigned to the three (international) river basin districts Danube, Rhine and Elbe, which serve as an administrative body for coordinated water management.

- Austria divided into eight hydrological defined (national) planning areas
- Implementation of measures ranked according to ecological criteria
- A pro-active planning of river restoration including river continuity restoration measures but with limiting resources (finances)

EVALUATION Distinction between overview-, operational-, and investigative-monitoring.

Findings and discussion

This chapter analyses and integrates the obtained information from the single countries on their national longitudinal river continuity restoration approach and the observations which are emerging across countries into a bigger picture. Therefore the main findings are presented first and later discussed in relation to a broader context.

GOAL

- For almost all countries river continuity restoration is not the topic of a separate policy but part of the national water policy and are up to date from 2022
- The terminology used in the laws differs very much in its interpretation between the different countries.

- All policies identify issues regarding river fragmentation and define goals for river restoration, but differ in specification. Austria, France, Germany and Spain mention specifically river continuity / connectivity restoration
- All policies evolved through the years or were newly induced by the development of the implementation of the WFD

(BARRIER) DATA BASE

- Almost all countries maintain a data base with information on water bodies / barriers / restoration projects
- Austria, France, Germany, Lithuania and Spain have a specific barrier data base
- The data base of France and Spain is also used for barrier removal / equipment / bypass planning and progress tracking
- Since the data collected from the dams by the countries are not unambiguous and are also recorded in different ways, they can hardly be compared between the countries. A certain degree of harmonization is desirable for this

PRIORITISATION OF WATER BODIES

- Half of countries prioritize Water Bodies restoration
- Common prioritization criteria are: Fish migration, fish biocenoses, protected areas (Natura 2000, Ramsar sites, Red List species etc.)
- Hydromorphological aspects are only sometimes mentioned

PRIORITISATION OF BARRIERS

- More than half of the countries prioritize barriers
- (Highest) ecological impact is the main criteria
- Other criteria are km of river length opening, (spawning) habitats, obsolete dams, hydromorphological aspects, climate adaptation / mitigation

- Combination with implementation of other measures, flood protection, flood-plain restoration, technical construction works
- Sediment transport, (ecological) flow regimes, nutrients etc. are hardly mentioned

PLANS AND MEASURES

- (Available) plans and measures (e.g. WFD implementation) to be used are included in some policies
- If they are mentioned they differ very much in details
- How to gain and share technical knowledge is only described in a few policies

STAKEHOLDER INVOLVEMENT

- Public participation and stakeholder involvement is described in all policies
- In practice approaches differ from more to less top-down

FINANCING

- Sources of finance are included in all policies but to different sources
- Distinguishing between regional, national and European funds. Private funds were not mentioned
- The funding amounts are highly dependent on the political constellation and circumstances and are not examined

MONITORING AND EVALUATION

- Monitoring and evaluation is part of all policies, however, adjustment of policy is only mentioned in two policies

The first point of discussion needs to be on a very generic level about the terminology. During this study it has become clear that all countries possess a legally binding document (usually in form of a water law) entailing river continuity aspects, but not all countries use the same clearly defined terms of “policy”, “strategy”, and “action plan” for additional guiding documents. A policy is a deliberate system of

guidelines to guide decisions and achieve rational outcomes (Wikipedia, 2023a). A strategy is a general plan to achieve long-term or overall goals and generally involves setting targets and priorities, determining actions to achieve the targets, and mobilising resources to execute the actions (Wikipedia, 2023b). An action plan is a detailed plan outlining actions needed to reach one or more goals, it can be defined as a sequence of steps that must be taken, or activities that must be performed well, for a strategy to succeed (Wikipedia, 2023c). Often, the respective distinction of the investigated information is not very clear especially since some countries utilise all three document types and others only two or one of them. Sometimes a document declared as a policy is a mixture of policy and strategy and in other cases a strategy also entails components of an action plan. However, all investigated countries possess a water law and at least one additional strategic document regarding waterway restoration. In this study, legally binding documents (laws) as well as guiding documents such as policies, strategies, and action plans of the respective countries were considered if they entailed any content on longitudinal river continuity restoration to gain an overview of the situation on the topic in each country with the aim to not disregard any valuable information. However, the term “policy” was used throughout this study (if no other explicit denotation was used for a document) to facilitate the understanding of the report and to focus on the content rather on the terminology.

As mentioned in the introduction of the report, this study concentrated on the longitudinal dimension of river continuity restoration. Since there are different aspects of longitudinal continuity the overarching question is how far do policies consider all aspects of longitudinal river continuity? Fish migration is an established motivator and the main driver for longitudinal river continuity restoration in all investigated countries but not the only reason. Other aspects such as sediment transport, habitat connectivity, and environmental flow are also

mentioned in some but not all policies. However, it cannot be argued against the fact that fish migration, especially of endangered species, receives special attention, sometimes even in the form of a separate Fish Migration Strategy. Furthermore, funding is often available (exclusively) for fish migration enhancing restoration measures which can be explained by direct revenues from the fishery and tourism sector. Nevertheless, other drivers such as sediment transport seem to gain more and more importance according to the interviewees.

Where opportunities exist to remove barriers alongside planned or existing restoration projects, or in connection with protected areas, these could be prioritised. Synergies can also be sought with other EU legislation or other initiatives. For instance, improving connectivity and

river habitats can greatly benefit the European eel, in line with Regulation No 1100/2007. When planning river restoration, it is important to consider possible synergies with the objectives and measures set out in the Eel Management Plans. The same goes for synergies with the objectives and measures of the Pan-European Action Plan for Sturgeons. In general, the migration routes of migratory species are taken into account when prioritising barrier removal. When prioritising barriers for removal, it is also important to consider existing uses in a river basin, including inland navigation, flood defense, energy generation or agriculture. This will help maximise the co-benefits of such operations and avoid significant adverse effects on important uses. The WFD integrates provisions for such uses and sets rules to ensure the integration of different objectives. (EC, 2021)



There exist very different historic backgrounds regarding water laws and the associated policy design in the single countries. In general, either the responsible authority, in most cases the Ministry of Environment, designs the river restoration policy which usually includes stakeholder consultation rounds, or the authority identifies stakeholder groups, states the status-quo, and creates working groups joined by stakeholder representatives which develop the policy. A couple of interviewees made the point that linguistic terms and clear definitions are sometimes a greater source of conflict than the overall steering direction of a policy in the making. To allege an example, the definition of “obsolete” barriers can be intricate since a barrier may be seen as obsolete as soon as it does not fulfill the function any longer that it was initially constructed for (e.g., hydropower generation) but has in the meantime obtained other functions (e.g., recreational use) or social value with a historic background.

The fact, that in several countries more than one governmental authority are responsible for the water management of the country, leads to the situation that often different and opposing interests are prevalent. A common situation is, that the Ministry of Environment is in charge of the maintenance and the restoration of water-courses while the Ministry of Agriculture and Forestry has an special interest in the fishery sector which can cause a fruitful cooperation in regard to river continuity restoration but also provide situations of conflict when it comes to the decision which restoration measure is suitable (e.g., decision between a barrier removal or equipment) and which locations and facilities should receive priority. The same applies for the relationship between the Ministry of Environment and the energy sector regarding hydropower dams and their function as a river continuity barrier as well as a source of energy. In other cases, the state is not conducting river continuity restoration projects itself but only provides the necessary information and advice as well as financial tools. In general, it can be

said that the administrative structure of the water management sector is important for the implementation of river restoration since it determines on which level decisions are made, which stakeholders are involved, and what financial tools are available. Furthermore, the administrative structure seems to be dependent to some extent on the size of the country because rather small countries (e.g., Austria) have two administrative levels while big countries (e.g., France) can have up to four levels. However, the number of administrative levels is not important, if each level is organised in an effective way with the aim to have as less as possible administrative effort and burden. The different historically grown water management structures in each country lead to the conclusion that the development of a general policy framework might be less useful than general recommendations for effective tools and approaches under certain circumstances. This conclusion is underpinned by the fact that the various social, political, topographical, as well as climatical circumstances in the single countries all influence the approach of water management in general and the river continuity restoration in particular, respectively.



Nevertheless, country overarching guidelines and legislation such as the WFD are important to initiate progress and to provide a continent-

wide steering direction of the water management sector. The WFD has had an impact on all water restoration policies to a different extent. The link to the WFD ranges from “partially congruent” to “based on” to “oriented towards”. However, the WFD was the driver for an update of all national policies, most of them represent the transposition of the WFD but also other EU directives have had an impact on the respective national policies. The Biodiversity Strategy for 2030 (2020), the Habitats Directive (1992), Natura2000, and the Floods Directive (2007/60/EC) were all important guiding legislations in most of the investigated countries. Furthermore, the European Green Deal (2019), the Environmental Impact Assessment (EIA) directive as well as the Eel regulation (2007) were influential in some countries according to the interviewees. The different EU directives, strategies, and regulations influence what is decided, implemented, and monitored (or not) regarding river continuity restoration in each country, but this study could not incorporate all of them in detail due to time limiting factors. However, it is recognised that synergies with other directives which are affecting the water management sector (e.g., Flood Directive) are explicitly sought for in some national policies but not sufficient emphasised in others.

Most countries focus on the river continuity restoration of obsolete barriers. A prerequisite for this approach is an existing and maintained **barrier data base**. All countries maintain a barrier data base to a certain extent. While some possess a quite comprehensive and detailed barrier data base, others are still in the process of completing their partial data base by integrating already existing data or collecting additional information. Austria has a decided approach when it comes to determining restoration options considering the use of the barrier. There, hydropower generating dams are not being removed but rather equipped with fish passes, while urban flood protection dams are being deconstructed or modified where possible. The Slovakian policy states that bar-

rier removal is always the preferred option if possible but according to the implemented projects so far, barrier equipment is predominant. In France, equipping barriers is also the most applied solution after the law was changed in 2021. In general, it can be said that the choice of restoration option depends on the ecological aim of the restoration measure, the willingness of the owner as well as the available funding.



Considering the **prioritisation** of continuity restoration projects, the single approaches differ a little but not too much. Mostly, the prioritisation of barriers is based on the hydromorphological state and ecological criteria, with the focus being on the distribution of particularly endangered (migratory) fish species, followed by the willingness of the local community and the situation of ownership. More in detail, the ecological effect of the measure depending on the length of the to be restored continuity stretch of water and the accessibility of suitable habitats upstream in tributaries are considered. Often, the priority areas from the eel management plan (Eel regulation 2007/1100) are considered. Furthermore, some countries (e.g., Austria) prioritise from big to small in terms of catchment size and from down to upstream in terms of river stretches.

Robust prioritisation and planning of action requires robust data. In addition to mapping out the location of barriers to longitudinal and lateral connectivity, it would also be important to identify gaps in knowledge preventing the assessment of connectivity and to put in place processes to fill such gaps. It should be noted that addressing these data gaps could also support the correct implementation of other, related EU legislation. (EC, 2021)

Stakeholder involvement is widely recognised as very important but implemented in different ways. Next to stakeholder consultation rounds or their participation in working groups during the development process of a national policy, they are usually consulted and involved in indi-

vidual river continuity restoration projects, also. The participatory approach with the advisory boards of local public services as well as authorised board associations of private structures and landowners is prevailing in the investigated countries. Other tools for stakeholder involvement are so-called “river dialogues” and similar activities on social media, Water Round Tables for a face to face interaction and communication, annual national conferences and workshops organised for water professionals, or an existing country-wide water restoration network. The implementation of the stakeholder involvement is in most countries organised by the responsible ministry but in a few countries also in cooperation with local NGOs.



uirements can be very inhibiting, also. The problem in this respect is that institutions allocating permits are often not the same responsible for river restoration management. The hydropower lobby against and the lack of public support for river restoration measures are further constraints. A bad communication and cooperation between stakeholders can be an obstacle but does not seem to be the main problem.



Conclusions and recommendations

This chapter follows the same structure as the one above; starting with the situation of governance and administration, followed by the utilisation of prioritisation methods and a barrier data base, the stakeholder involvement, financing, and the monitoring and evaluation needs. The chapter closes with a conclusion on where further investigation is needed and a summary of the key messages of this study.

The **national river continuity restoration policy** of a country needs to be horizontally (synergy with other national policies and laws) and vertically (effective on all administrative levels)

integrated. In general, it is necessary to combine river continuity restoration with other aspects of water management such as flood control and drought management (especially in view of climate change adaptation), navigation, irrigation necessities for agriculture, hydropower generation. Furthermore, other functions that provide ecosystem services such as the maintenance of food webs and the transport of nutrients and sediments should be considered in view of financing strategies, prioritisation methods, or monitoring activities. To include all aspects of longitudinal river continuity or even all dimensions of river continuity can help to gain a holistic view and to find synergies more easily to conduct an effective restoration. Additionally, to agree on linguistic terms and their definitions will help to set clear targets shared by all stakeholders and facilitates communication processes.

In general, the **completeness of a policy**, although important, should not be overrated since circumstances can be more determining for the policy effectiveness. Rather, obstacles and drivers of river continuity restoration need to be identified and suitable and effective solutions be found. For example, unceasing water-use permits without environmental requirements need to be abolished. The allocation of permits should be used as a restoration tool and not constitute an obstacle to it. Therefore, an allocation of permits for a rather short period of time (30 to 20 years or even shorter) and with environmental requirements is beneficial. A requirement could be, to check every 10 years if the facility is still state of the art and if not so to update it accordingly. Awareness raising in and cooperation with local administrative departments is needed to explain why water-use permits should not always or at least not without environmental requirements be granted.

The investigation of the **administrative structure** of the water management sector and the interests of the responsible authorities can be helpful to improve the river continuity restoration situation. Compromises of different intere-

sts should be found on the highest level of authority (between the single ministries if there is more than one responsible for the water sector) to provide a clear steering direction and guidelines. Nevertheless, for the effective implementation of river restoration projects, tools must be in use to involve all stake holders and find specific solutions that follow the official guidelines but are somewhat tailored to the specific situation. This balance of clear objectives and adapted implementation can be expressed through the prioritisation on a national and/or regional level of necessary river continuity restoration projects and certain communication, suitable solution determining, ecological, and technical advice on the local level. Basically, this describes a synthesis of a top-down and a bottom-up approach as well as the combination of a centralised and decentralised structure. The top-down approach allows the prioritisation of restoration projects according to ecological criteria and the centralised part provides a certain overview of a whole catchment if not a whole country situation. The bottom-up and decentralised approach enhances the willingness and cooperation of all involved stakeholders.

The **prioritisation method** for river reaches as well as the single barriers within the river reaches should be standardised and include all important aspects which are of ecological, social, and economic nature. There should be an official method available to measure the ecological importance regarding the natural reproduction cycle of endangered migratory fish species, functioning ecosystems (food-webs), habitat connectivity, and the protection of other endangered species. But also, the sediment transport and the environmental flow should be considered. In general, all ecosystem functions and the ecological services need to be incorporated. The available project funding needs to be considered for prioritising purposes but preferably not be the determining factor since idealistically the funding should be regulated and be made available through the policy

as well. Once the Nature Restoration Law, which has been proposed by the EC as the first continent-wide comprehensive law of its kind and a key element of the EU Biodiversity Strategy, is finally adopted by the EU, every Member State will have to make a restoration plan not just for but also including aquatic ecosystem restorations, and thus will have to use some kind of prioritisation. This can be a good opportunity to design new and effective prioritisation methods. But for this there are also clear and practical metrics from the EU needed with additional guidelines and tools for in this case the free-flowing rivers.

To be able to make informed decisions, the status-quo needs to be known. Regarding longitudinal river continuity restoration, a comprehensive, maintained, and accessible **barrier data base** is the prerequisite. The Adaptive Management of Barriers in European Rivers (AMBER) project can give a good orientation for building up a national data base. The Amber Barrier Atlas includes the following barrier attributes: the date of entry, a barrier ID, a picture, the location (coordinates), the barrier type (dam, weir, culvert, ford, sluice, ramp, or other) and the subtype, the height (with a range from < 0.5m to > 10m), the barrier extension (fully or partially), if the barrier is in operation or not, barrier flow conditions, river width, river name, barrier fish pass type. The structure of the AMBER atlas can be a good starting point for building a national barrier data base which can include additional information such as ownership, restored barriers, presence of endangered species or other valuable information. The barrier data base should be used for the same purpose throughout the whole country to ensure its functioning and maintenance in the foreseen way. Keeping the data base up to date through a daily use of the water professionals or an inventory with each RBPM cycle can be an option.

In general, **stakeholder involvement** is inevitable which has been widely recognised already, but also the exchange of project experie-

nces, restoration data, and information on planned projects between the water professionals of a country can enhance the river continuity restoration process. There are several possibilities such as the implementation of a country-wide network system for water professionals, annual conferences, workshops, and field trips, or even an internal monthly newsletter.



The **financing** of river continuity restoration should be reviewed and if necessary improved to enable the implementation of all necessary measures and to ensure that the funding mechanisms act as tools to incentivise river continuity restoration. The funding regulations and processes must be transparent. A staggered funding system with a high subsidy rate in the beginning and the prospect of the restoration measure becoming legally mandatory at a defined point in the future can be an effective motivator to realise restoration projects. In general, fees for noncompliance with the policy or the law must be high enough so that to put up with it is not a viable option for (private) stakeholders.

A **monitoring and evaluation** system is necessary to be able to improve restoration measures, to keep an overview of the country-wide development, and to be able to adjust financial,

legal, or technical tools. There are two aspects of monitoring that need to be considered, the ecological result of the implemented restoration projects and measures as well as the policy implementation process itself. A separate budget for monitoring is necessary. Monitoring data and evaluation services can also be purchased from consultancies if the required resources are not available to the responsible authority. To facilitate and differentiate the monitoring methods, responsibilities, and financing of it, it can be distinguished between different types of monitoring as it is the case in Austria.

The introduction of an environmental energy label for hydropower generation granted through a transparent process by an official authority could be an option to add another driver to the river continuity restoration cause. The collaboration with regional/local NGOs for the advertising of the label in the public could apply social pressure on hydropower owners to remediate their environmental impact.

Further investigation is needed of the influence of other EU directives and regulations on the national policies regarding longitudinal river continuity restoration to identify useful synergies which can be applied by the project implementers. The MERLIN project funded by the EU is already taking this approach, however, it explores social, economic, and environmental factors that shape the success of freshwater restoration in general and not for river continuity restoration in particular. Funding mechanisms also should be further investigated since funding plays a decisive role for the prioritisation and choice of measures as well as their monitoring and evaluation after implementation. The scope of different funding mechanisms and budget allocations used in the single investigate countries could only be viewed abridged within the possibilities of this study, but a more detailed investigation may provide further insight on how to enhance longitudinal river continuity restoration.

In summary, the completeness of a policy is important to ensure that all necessary components (administrative structure, a barrier data base, prioritisation methods, stakeholder involvement, funding mechanisms, monitoring and evaluation system) for the implementation of longitudinal river continuity restoration are considered but is less determining for its effectiveness than the existing circumstances. Obstacles and drivers of river continuity restoration need to be identified to recognise windows of opportunities for either implementing river continuity restoration measures or to initiate a beneficial change of the prevalent circumstances (e.g., enabling legislation). Even though the conclusion of this study is that the development of a general policy framework

for river continuity restoration of European countries would not coercively enhance the river continuity restoration process, it cannot be denied that there is an evolving river continuity restoration policy process existing in the investigated countries. Water professionals in all countries that participated in this study and most probably beyond that are already striving for improvement of river continuity restoration within their means. Still, there are many problems (lack of barrier data base, prioritisation method, monitoring and evaluation system) that need to be addressed and conditions that need to be advanced (e.g., identifying synergies). Hopefully, this study will contribute and support the process.



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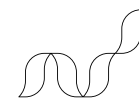


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