Water use and environmental pressures

Tracking barriers and their impacts on European river ecosystems

The importance of free-flowing rivers that allow free movement of water, sediment, fish and other organisms is increasingly recognised by EU environmental policy, in particular the Water Framework Directive and the biodiversity strategy for 2030. However, the large number of barriers on our rivers has resulted in a loss of river continuity. This briefing addresses the following questions: What is the density of barriers on rivers? What do we know about their impacts on rivers? How can we improve the European knowledge base on barriers in rivers?

Key messages

River continuity is key to achieving good status of European waters under the Water Framework Directive. The EU biodiversity strategy also aims to restore at least 25 000 km of free-flowing rivers by 2030 by removing barriers and restoring floodplains and wetlands.

Recent research concludes that the number of barriers on European rivers is well over 1 million, while there are very few free-flowing rivers in the river network. The majority of barriers are small structures, and thousands of them are obsolete.

According to the information reported for the second river basin management plans in accordance with the Water Framework Directive, barriers consititute significant pressures for about 20% of European surface water bodies. They are one of the main reasons for rivers failing to reach good ecological status.

To monitor progress towards achieving European targets for restoring river continuity, we should improve our information base on river fragmentation. Regularly updating a European database on barriers is necessary to keep track of new, existing and removed barriers, as well as barriers made passable for migrating fauna, along with water and sediment flows.

Impacts of barriers on river ecosystems

Healthy rivers require a high degree of continuity to support the complex life cycles of many aquatic species and a functioning ecosystem. However, for several decades, human interventions have disrupted river continuity and degraded river ecosystem functioning. Evidence from research shows that the continuity of most rivers in Europe is affected and that few free-flowing rivers remain in Europe.

Barriers alter a river's natural flow. They can block the migration routes of fish and aquatic species both up- and downstream, with habitats becoming isolated through fragmentation. Disrupted continuity affects the reproduction patterns of migratory fish, such as salmon, eel and sturgeon. The transport of sediments in rivers is also blocked by barriers. This leads to accumulation of sediments

upstream and a lack of sand and gravel downstream. As a result of all these factors, ecosystems and their processes can be severely affected and the habitat of aquatic flora and fauna can be dramatically altered.

In addition, the build-up of organic material and nutrients in reservoirs and in backwater from smaller dams often leads to a decrease in water quality, changes in temperature and the capacity to dissolve oxygen, and eutrophication (Gough et al., 2018).

The impacts of barriers vary according to their height and location. Barriers on rivers can differ significantly in size: small barriers may be only 10-50 cm high, while large dams can be higher than 15 m (Box 1). A major impact on a river may arise from a single, very damaging large structure or from the cumulative effects throughout the course of the river of a series of small structures, each of which may have only a small impact individually (EEA, 2018). The cumulative impact of a large number of river barriers in Europe is one of the leading causes of the more than 80% decline in freshwater biodiversity and the loss of 55% of monitored migratory fish populations (Birnie-Gauvin et al., 2018; Gough et al., 2018; Moberg and Singler, 2020).

Types of barriers

There are many different types of barriers on rivers. Dams are one of the common and well-known types. The others are weirs, sluices, culverts, fords and ramps.

- **Dam:** a structure that blocks or constrains the flow of water and raises the water level, forming a reservoir
- **Weir:** a structure that regulates the flow and level of water but often allows water to flow freely over the top
- **Sluice:** a movable structure that aims to control flow rates and water levels
- **Culvert:** a structure that allows water to flow under an obstruction
- **Ford:** a structure that creates a shallow place with good footing where a river or stream may be crossed by wading on foot or by vehicle
- **Ramp:** a ramp or a bed sill aimed at stabilising the channel bed and reducing erosion; it can be recognised by its stair-like shape.

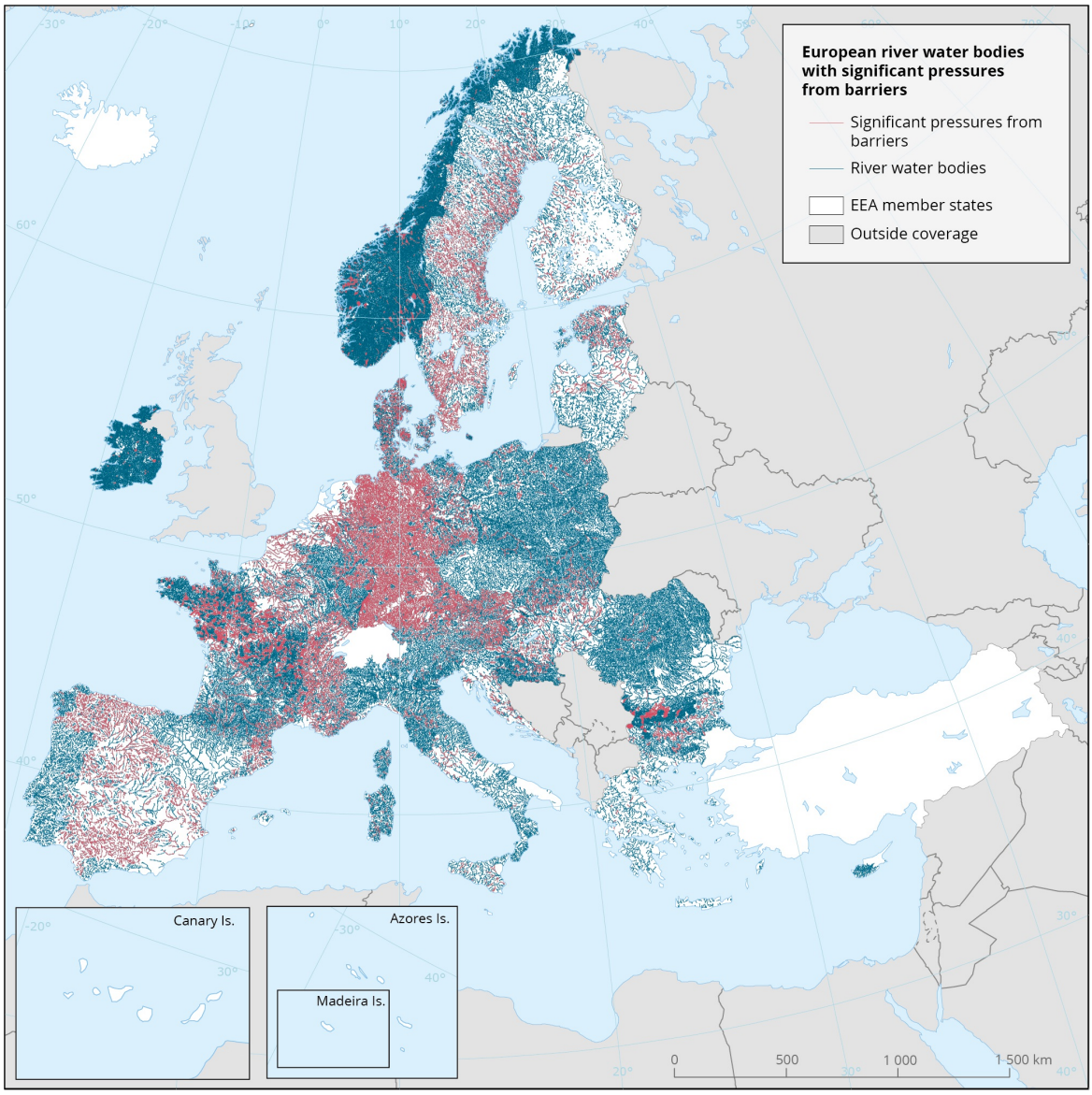
Source: AMBER (2020).

What is the pressure on rivers from barriers in Europe?

River continuity is one of the hydromorphological quality elements assessed under the Water Framework Directive (WFD), and barriers are one of the main hydromorphological pressures on river continuity. Hydromorphological pressures were found to be among the main reasons for failing to reach good ecological status in the second river basin management plans (RBMPs), acting as significant pressures for 34 % of European surface water bodies in 29 countries (EU-28 and Norway). Of those 34 % surface water bodies, 20 % failed to reach good ecological status because of the presence of barriers (Map 1).

Water and marine environment

Map 1. European river water bodies under significant pressure from barriers



Reference data: @ESRI

Note: 'Significant' means that the pressure contributes to an impact that may result in failing to meet the WFD objective of achieving at least good status. Each redish line on the map indicates a river water body affected by barriers according to the country-specific system used to assess significant pressures.

Source: EEA, the map was created from WISE-WFD data reported for the 2nd RBMPs under the WFD (EU-27, and Norway).

Read more here

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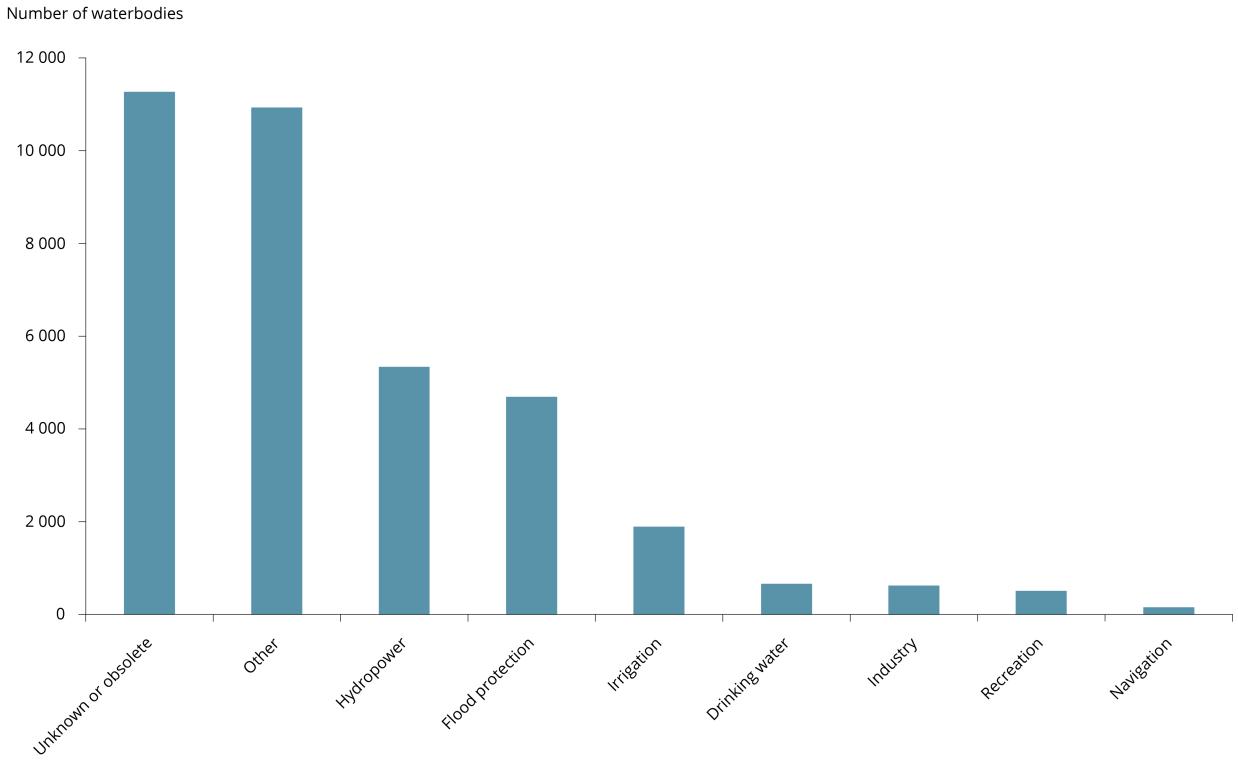
From the information reported under second RBMPs, barriers used for hydropower production and flood protection are the most common barriers on European rivers. These are followed by barriers serving to store water for irrigation, drinking and industry. However, the purpose of many barriers is reported as unknown (Figure 1).

Another category captured by the reporting are obsolete barriers. It is estimated that there are at least 100 000 obsolete barriers fragmenting and deteriorating Europe's rivers (AMBER, 2020).

Figure 1. Number of water bodies affected by barriers for different purposes



Source: EEA; results based on the Water Information System for Europe (WISE)-WFD (second RBMPs) database, including data from 29 countries (EU-28 and Norway) as at 22 May 2020).

A recent study, specifically aimed at mapping barriers in Europe, concluded that there are approximately 630 000 recorded barriers, including small barriers, in European rivers. However, through field validation, the researchers estimated that the actual number could be well over 1 million barriers (AMBER, 2020).

As a consequence, few free-flowing rivers remain in Europe. Furthermore, construction of new barriers continues. According to a report on hydropower pressure on European rivers (Schwarz, 2019), there are 128 barriers under construction and 5 734 barriers planned for hydropower

production in the EU. In addition, there are 4 105 proposed hydropower plants in the Balkans and Turkey, where many of the remaining free-flowing rivers in Europe are located, and some of the proposed plants are in protected areas (Schwarz, 2019).

EU policies relevant to river continuity

The environmental objectives of the Water Framework Directive (2000/60/EC) are a strong driver for restoring river continuity. To achieve the WFD's objectives, river fragmentation needs to be tackled with measures such as migration aids (for fish and other fauna) and barrier removal.

A number of other EU policies also support the restoration of river continuity, in particular the EU biodiversity strategy for 2030 (COM(2020) 380 final), the Habitats Directive (92/43/EEC) and the Eel Regulation (1100/2007). The biodiversity strategy for 2030 includes the target that 'at least 25 000 km of rivers will be restored into free-flowing rivers by 2030 through the removal of primarily obsolete barriers and the restoration of floodplains and wetlands'. This target underlines the need for additional efforts to achieve good ecological status, the objective of the WFD.

Solutions and restorations

In several parts of Europe, restoration and mitigation measures are being implemented or planned to improve river continuity and address the impacts of barriers. Common measures include removing barriers, constructing fish migration aids, such as fish passes, bypass channels and also fish screens and fish-friendly turbines, implementing ecological flows, and taking measures to re-establish the continuity of sediment transport.

Dam removal is one of the key solutions, especially for obsolete barriers. The biodiversity strategy for 2030 specifically targets the removal of obsolete barriers. Little information is available on barriers that have been removed. According to information collected by Dam Removal Europe, almost 5 000 dam removals had been recorded by October 2020, based on data from 11 countries: France, Sweden, Finland, Spain, Great Britain (England, Wales and Scotland), Denmark, Portugal, Italy, Switzerland, Estonia and Germany (DRE, 2020).

Overall, because of the very large number of barriers on rivers in Europe, there is a need to prioritise measures to restore continuity. Some national and international strategies for restoring continuity are already in place to ensure a coordinated approach to dealing with the impacts of barriers. For example, in 2019 Finland adopted a new national programme to support removing barriers and restoring migratory fish stocks in the next 4 years.

In contrast, a number of EU policies supports uses of water for which barriers are essential, especially for hydropower, navigation, flood protection and water supply. To meet the EU target of energy from renewable sources of at least 32 % by 2030, several European countries are expected

to increase their use of hydropower. For example, there are plans to expand hydropower pumped storage in Austria, the Baltic states and Portugal (IHA, 2020). Furthermore, river navigation depends on regulating flow via barriers, so EU policies aiming to shift some road freight to rail and waterborne transport need to be taken into account in plans for restoring river continuity.

Integrating water and biodiversity policy objectives into sectoral policy planning is a critical aspect of achieving a more coherent policy framework for restoring river continuity. Strategies promoting more sustainable growth in these sectors are particularly relevant. Examples include the guidance documents developed by the International Commission for the Protection of the Danube River (ICPDR, 2007, 2013).

Next steps in monitoring progress towards meeting river continuity targets in Europe

Restoring rivers and streams affected by disrupted continuity due to barriers is one of the main challenges that needs to be addressed to achieve good ecological status under the WFD and the new biodiversity strategy for 2030. One of the key steps in monitoring progress towards meeting these European targets is to improve the information base on rivers that are fragmented and in need of either restoration or protection to prevent deterioration. The recent mapping of existing European river barriers by AMBER is a major step in this direction.

Looking ahead, regular updating of this database is necessary, and the data sources and parameters to be considered need to be refined. An exploration of whether other attributes can be added is also required, e.g. barrier passability for migrating fauna and, water and sediment flow. The database should also be regularly updated with information on barriers that have been removed and on new barriers constructed. Such comprehensive information on river barriers, measured against a baseline (e.g. 2020), would allow an assessment of progress towards meeting river continuity targets set in the EU biodiversity strategy for 2030.

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