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## Small isn't beautiful: the impact of small barriers on longitudinal connectivity of European rivers

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The extent of longitudinal river connectivity is largely unknown at the European scale. Currently the picture on river fragmentation is based on dams higher than 10 m (Vörösmarty et al., 2010), which from preliminary analysis on existing databases in Europe are likely to represent less than 3% of the total existing barriers. Indeed, the greatest impact on river sediment and ecological connectivity is likely to come from number of smaller barriers whose location, density, and typology are unknown for most European countries. Here, we present the first pan-European ATLAS of all existing barriers across Europe built by integration of data from existing national databases validated within this work with an ad-hoc field-based designed procedure. Validation of the existing databases is necessary in order to allow valid comparisons among different databases. This is essential to derive meaningful assessments of river fragmentation and relate these to impacts on river connectivity, including sediment, water flow, and biota. The validation procedure is based on field surveys for barrier mapping along several 100 km stretches of representative river length in 10 EU countries. We surveyed nearly 1,000 km of rivers across Europe covering different geographical and socio-economic contexts. We then compared the barrier density obtained from the field work with the national databases included within our ATLAS, and other existing databases at regional or pan-European scale built for different purposes or with different methodologies (e.g. based on existing information, on remote sensing or existing GIS layers, etc.). The density of barriers surveyed in the field was found to be much higher than indicated by available databases and was comparable to the density obtained from the most detailed national databases (e.g. in France or Switzerland). Estimates from the field validation suggest that on average there might be up to one barrier each one river km. This information has been generated for the first time, largely deviates from existing layers of information, and provides a more realistic estimation of the real extent of river fragmentation in Europe. This type of knowledge is nowadays mandatory for member states and European institutions to better inform the development of effective barrier mitigation programs. This study is developed within the H2020 AMBER project (<https://amber.international/>). AMBER addresses the issue of river fragmentation in European rivers and seeks to apply adaptive management to the operation of barriers in order to achieve a more efficient restoration of river connectivity.

Vörösmarty CJ et al. (2010). Global threats to human water security and river biodiversity. *Nature* 467:555-61. DOI: 10.1038/nature09440