Effects of planned hydropower dams and barriers on river connectivity in the Balkan region

Mauro Carolli[a], Carlos Garcia de Leaniz[b], Joshua Jones[b], Barbara Belletti[c], Helena Huđek[d], Martin Pusch[d], Pencho Pandakov[e], Luca Börger[b], Wouter van de Bund[f]

[a]SINTEF Energy Research; Norway, [b]Swansea University, UK; [c]Politecnico di Milano, Italy; [d]Leibniz Institute of Freshwater Ecology and Inland Fisheries (IGB), Germany; [e]Forestry University, Bulgaria, [f]European Commission Joint Research Centre, Italy:

Email corresponding author: mauro.carolli@sintef.no

ABSTRACT: Hydropower is at the forefront of renewable energy production and will strongly contribute to decarbonise energy production. However, dams have different impacts on the river system, including the disruption of river continuum and the alteration of the natural connectivity. Most of the unexplored hydropower production capacity in Europe is in the Balkan region, home of some of the best-preserved rivers in the continent. The construction of approximately 3000 hydropower dams is planned in the area in the near future, which leads to a conflict between different societal needs, environmental laws, sustainable development targets. In this work we analysed the effects of the planned hydropower dams on river connectivity (or fragmentation), with the aim to produce reliable information that can assist in minimizing conflicts and impacts. We applied four metrics: barrier free length (length between pairs of consecutive barriers in each basin), I_{max} (longest barrier free segment in each basin), BFL_{Max} (I_{max} divided by the total length of the basin) and the DCI (dendritic connectivity index) for potadromous fish. We analysed the existing fragmentation of the Balkan region and of other European areas using ground-truthed data, highlighting how barriers of any type are 2.2 times lower in the Balkan region. We compared the existing fragmentation with 8 different dam construction scenarios and observed that any scenario would result in loss of connectivity, with the largest loss corresponding to the construction of all barriers (~47% of the barrier free length). Interestingly, building only dams for large hydropower plants (> 10MW) will lead to the smallest loss in connectivity, and the largest increase in hydropower production, while small dams will cause a large increase in fragmentation that will not correspond to a large increase in hydropower production (see figure 1). We discuss the indications derived from our scenario analysis based on river connectivity, but a comprehensive analysis should consider that large dams might also have other physical/ecological consequences.

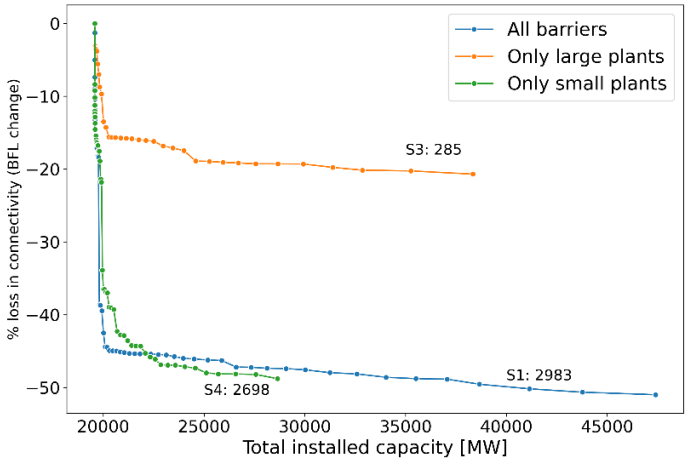

Figure 1 Loss in river connectivity (expressed as % loss in BFL) with increased installed hydropower capacity under three different scenarios: all barriers are constructed; only large plants are constructed; and only small plants are constructed.

We also analysed the contribution of individual plants and barriers to energy production, and their effect on river connectivity, which helps to identify the most impacting and less productive barriers which construction should be avoided. With our work we want to encourage decision and policy makers to consider the river connectivity dimension, and to assist in the identification of which plants and barriers should be prioritized, in order to maximize production and minimize the impact on river connectivity to improve hydropower sustainability.