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Illustrating a New Global-scale Approach to Estimating Potential Reduction in Fish Species Richness due to Flow Alteration

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Changes in river discharge due to human activities and climate change would affect the sustainability of freshwater ecosystems. To globally assess how changes in river discharge will affect the future status of freshwater ecosystems, global-scale hydrological simulations need to be connected with a model to estimate the durability of freshwater ecosystems. However, the development of this specific modelling combination for the global scale is still in its infancy. In this study, two statistical methods are introduced to link flow regimes to fish species richness (FSR): one is based on a linear relationship between FSR and mean river discharge (hereafter, FSR-MAD method), and the other is based on a multi-linear relationship between FSR and ecologically relevant flow indices involving several other flow characteristics and mean river discharge (FSR-FLVAR method). The FSR-MAD method has been used previously in global simulation studies. The FSR-FLVAR method is newly introduced here. These statistical methods for estimating FSR were combined with a set of state-of-art global river discharge simulations using latest outputs of 11 coupled atmosphere-ocean general circulation models to evaluate the potential impact of climate- change-induced flow alterations on FSR changes. Generally, future reductions in FSR with the FSR-FLVAR method are greater and much more scattered than those with the FSR-MAD method. In arid regions, both methods indicate reductions in FSR because mean discharge is projected to decrease in the future, although the magnitude of reductions in FSR is different between the two methods. In contrast, in heavy-snow regions a large reduction in FSR is shown by the FSR-FLVAR method due to increases in the frequency of low and high flows. Although we cannot determine only by this study which this prediction is more reliable, it can be argued that efforts to take plural ecologically relevant flow indices into account would lead to more appropriate methods for estimating potential changes in fish species richness. We believe this study is one of such efforts at an early development stage.