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Effects of climate change on three flow regime-related ecosystem services in a highly-regulated Alpine river

Mauro Carolli, Guido Zolezzi, Davide Geneletti, Bruno Majone, and Alberto Bellin
Department of Civil, Environmental and Mechanical Engineering, University of Trento. Via Mesiano 77, Trento, Italy

River systems provide several flow regime-related ecosystem services (ES) to society. The flow regime of several Alpine rivers is often regulated by hydropower production, which represents one of the most relevant ES in the area. Climate change is expected to modify the flow regime of rivers, with possible relevant consequences on the suitability of related ES. In this work we applied an approach aimed at evaluating the variations of ES under different flow regime conditions and consequently, the possibility to quantify the effects of different climate change scenarios on river ecosystem services. The case-study is the Noce River, a gravel-bed river in the Italian Alps (Trentino, North East Italy) which hydrological regime is subject to daily alterations of flow regime (hydropeaking) induced by the management of large hydropower plants. Here we considered three ES indicators: habitat for adult marble trout as representative for habitat provisioning service, rafting for recreational services, and small hydropower production as provisioning service. In particular, we evaluated the daily variations of these indicators under three different operating scenarios: a reference scenarios (REF, from 1970 to 2000) and two future scenarios (from 2040 to 2070), with (FUT) and without (FUT CC) the inclusion of the required minimum environmental flow (minimum vital flow) recently implemented in the regional water resources policy. For each scenario, four climate models have been applied (see Majone et al., 2016). Future scenarios indicate a modification of the flow regime, with a direct effect on the suitability of related ES. The effects on ES differ according with climate models and management scenarios: as a general result and considering the comparison with respect to the reference period, the applied models predict a temporal shift from late to early summer in the rafting suitability, a decrease of the suitability for trout in spring months and an increase of the suitability for small hydropower production. Furthermore, we evaluated in detail the local effects of licensing new withdrawals in the river system under climate change scenarios by simulating three new water withdrawals for small hydropower production. The additional withdrawals have a major effect in comparison with climate change especially on rafting suitability, which will largely decrease with the increase of withdrawal capacity. Minor effects were detected on the quality of trout habitat. Our analysis showed as climate change could influence the suitability of the services and it showed as withdrawal licensing policy has to be taken into account to predict the future suitability of river ecosystem services.

Bruno Majone, Francesca Villa, Roberto Deidda, Alberto Bellin, 2016. Impact of climate change and water use policies on hydropower potential in the south-eastern Alpine region, Science of The Total Environment, Volume 543, Pages 965-980, http://dx.doi.org/10.1016/j.scitotenv.2015.05.009.