Geophysical Research Abstracts
Vol. 17, EGU2015-8973, 2015
EGU General Assembly 2015

Trade-offs Between Electricity Production from Small Hydropower Plants and Ecosystem Services in Alpine River Basins

Philipp Meier (1), Robin Schwemmle (1), and Daniel Viviroli (2)

(1) EAWAG, Surface Waters Research + Management, Kastanienbaum, Switzerland (philipp.meier@eawag.ch), (2) Hydrology and Climate Unit, Department of Geography, University of Zurich, Switzerland

The need for a reduction in greenhouse gas emissions and the decision to phase out nuclear power plants in Switzerland and Germany increases pressure to develop the remaining hydropower potential in Alpine catchments. Since most of the potential for large reservoirs is already exploited, future development focusses on small run-of-the-river hydropower plants (SHP). Being considered a relatively environment-friendly electricity source, investment in SHP is promoted through subsidies. However, SHP can have a significant impact on riverine ecosystems, especially in the Alpine region where residual flow reaches tend to be long. An increase in hydropower exploitation will therefore increase pressure on ecosystems. While a number of studies assessed the potential for hydropower development in the Alps, two main factors were so far not assessed in detail: (i) ecological impacts within a whole river network, and (ii) economic conditions under which electricity is sold.

We present a framework that establishes trade-offs between multiple objectives regarding environmental impacts, electricity production and economic evaluation. While it is inevitable that some ecosystems are compromised by hydropower plants, the context of these impacts within a river network should be considered when selecting suitable sites for SHP. From an ecological point of view, the diversity of habitats, and therefore the diversity of species, should be maintained within a river basin. This asks for objectives that go beyond lumped parameters of hydrological alteration, but also consider habitat diversity and the spatial configuration. Energy production in run-of-the-river power plants depends on available discharge, which can have large fluctuations. In a deregulated electricity market with strong price variations, an economic valuation should therefore be based on the expected market value of energy produced. Trade-off curves between different objectives can help decision makers to define policies for licensing new SHP and for defining minimum flow requirements. The trade-offs are established using a multi-objective evolutionary algorithm.

A case study on an Alpine catchment is presented. The position of water intake and outlet and the design capacity of SHP, and different environmental flow policies are used as decision variables. The calculation of complex objectives, as described above, relies on an accurate representation of the physical system. The river network is divided into segments of 500 meters length for each of which the slope is calculated. Natural incremental flows are calculated for each segment using the PREVAH hydrological modelling system. Trade-offs are established on the basin scale as well as on the sub-basin scale. This allows the assessment of the influence of different configurations of SHP on ecosystem quality across different spatial scales.