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Impacts of climate change on the water management system on the alpine Upper Isar river with regards to hydro power potential and residual flow

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The Upper Isar is a catchment located in Southern Germany at the northern edge of the Alps, where significant changes in the runoff regime due to a changing climate are expected. The major elements of the water management in this area are the mountainous Walchensee lake and the Sylvenstein reservoir. The former provides water to one of the largest storage power stations in Germany and the latter functions as an artificial dam for flood and low flow management. Both are part of a complex water transfer system, where water is transferred both inside and outside of the catchment.

This study is part of the project Q-BIC^3 (Québec-Bavarian International Collaboration on Climate Change), which investigates Climate Change impacts on water resources and management based on a chain of climate, hydrological and water management models.
An ensemble of climate projections consisting of two regional models (RCM) forced by various global climate models (GCM), mostly based on the emission scenario A1B are the climatic driving forces of the study. With the use of this climate model ensemble the uncertainty inherent in the selection of specific GCMs as well as RCMs can be assessed in the study. The use of three realizations of one of the GCMs (ECHAM5) allows to account for the effect of natural variability on the simulation results.
With regard to the modeling of the hydrological processes in the catchment the process-oriented model WaSIM-ETH was set up and calibrated. Furthermore the entire water management system containing the transfers and the reservoirs was implemented in the model, allowing for the assessment of different management options by simulating the related changes between the future (2040 - 2070) and the reference period (1970 - 2000).

The results of the study indicate a significant shift in the runoff regime of the Upper Isar. The increase of discharge in winter results in larger transfer amounts for the Walchensee power station, while the notable decrease in the summer months leads to a decline in water power potential. Further the amount of discharge, that can be transferred and used for power generation is limited not only by the natural availability of water but also by minimum discharges that have to be maintained at certain sites and gauges in the catchment. In this context the amount of transferrable water and the residual flows effect each other in a converse manner. With the management system integrated in the model set up diverse scenarios (economical, ecological etc.) are realized, showing the effects on transfer amounts and residual flows likewise. The management guidelines are developed in collaboration with the local water authority reflecting interests from the operator itself.