River discharge extremes in Norwegian regulated catchments: hydrologic model simulations including human interventions

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ABSTRACT

In the coming years and decades, Norway will likely be affected by more frequent and severe extreme weather events, including both intense precipitation and drought. Predicting how these hazards will result in extreme high and low river discharge in a changing climate requires robust hydrologic models representing all relevant physical and human processes. While hydrologic modelling in catchments affected by human activities is more challenging than in pristine environments, it is mainly in the former that water-related natural hazards have the largest societal impacts. Therefore it is crucial to test and refine hydrologic predictions in human influenced catchments.

We apply the spatially distributed hydrologic and water resources model LISFLOOD to regulated Norwegian catchments, aiming to evaluate, and possibly improve, the simulation of high and low discharge conditions under the influence of human interventions. LISFLOOD simulates hydrologic processes on several sub-grid land use and cover classes, routing discharge along river networks. It can also simulate lakes and reservoir regulation, as well as human water abstractions, consumption and return flows.

We focus primarily on the Drammen catchment, which is heavily regulated and serves several water users, with the possibility to extend the analysis to other catchments in Norway. Land use, vegetation, soil and river data are derived from the LISFLOOD setup at 5 km resolution used in the European Flood Awareness System. The model is forced with daily SeNorge_2018 and European Meteorological Observations atmospheric data at, respectively, 1 km and 1 arcminute spatial resolution. Detailed information for the Drammen catchment, in particular regarding human water use and regulation, is available through collaboration with the STARS4Water research project, which focuses on how climate change affects water resources availability at catchment scale and the potential impacts on ecosystems and society. Model evaluation is based on observed river discharge and reservoir water storage time series obtained from the Norwegian Water Resources and Energy Directorate. We aim to assess the ability of the model to reproduce extreme high and low discharge conditions, and whether representing human interventions improves model performance.

Keywords: hydrologic modelling; discharge extremes; human water use; reservoirs.