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Hydropeaking in Nordic rivers – combined analysis from effects of changing climate conditions and energy demands to river regimes

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Increasing national and international demands for more flexible management of the energy resources with more non-storable renewables being used in adapting to the ongoing climate change will influence hydropower operations. Damming and regulation practices of river systems causes homogenization of long term river dynamics but also higher temporal sub-daily flow variations i.e. hydropeaking. In Nordic countries, many major rivers and lakes are regulated for hydropower purposes, which have caused considerable changes in river biotic, hydrologic and morphologic structures. Due to rapidly changing energy markets in the Nordic countries (deregulation of the power market and adding of renewable but intermittent sources of energy like, wind, solar, etc.) sub-daily flow conditions are under change within regulated river systems due to the increased demand on hydropower for providing balancing power. However, holistic analysis from changes in energy markets and its effect on sub-daily river regimes is lacking. This study analyzes the effects of hydropeaking on river regime in Finland, Sweden and Norway using long term high resolution data (15 minutes to hourly time interval) from 72 pristine and 136 regulated rivers with large spatial coverage across Fennoscandia. Since the sub-daily discharge variation is masked through the monthly or daily analyzes, in order to quantify these changes high resolution data is needed. In our study we will document, characterize and classify the impacts of sub-daily flow variation due to regulation and climatic variation on various river systems in Fennoscandia. Further, with increasing social demands for ecosystem services in regulated rivers, it is important to evaluate the new demand and update hydropower operation plan accordingly. We will analyse ecological response relationships along gradients of hydrological alteration for the biological communities, processes of river ecosystems and climate boundaries together with considering the new energy demands and consumptions in the Nordic energy market. For assessing sub-daily flow data various already available indices will be used which measure the magnitude of hydropeaking and temporal rate of discharge changes. For the impact quantification, the hydropeaking pressure will be calculated and set for each of the impact class. Also work will be done to formulate some new indices which will specifically quantify sub-daily change in the boreal rivers. We select representative case-studies, future scenarios and develop optimization methods to reduce impacts on aquatic ecosystems and maximizing the economic benefits from hydropower generation for stakeholders.