Climate change in the context of Environmental flows and changed hydrology in three basin areas in Sweden

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ABSTRACT: Hydropower plays a key role in the conversion into renewable electricity systems, but affects ecosystems negatively, that call for environmental-flow assessments to enhance the ecological status of river systems. Environmental flow assessments need to consider for climate change in the context of changed hydrology that affects both hydropower operation and riverine ecosystems. In collaboration with the hydropower company Statkraft in Sweden, we assessed how environmental flow scenarios benefitting the regulated ecosystem along with changed electricity production in the basin areas of the Ume River, Ljungan River and Lagan River in Sweden. Runoff until 2040 was projected to increase in all basin areas (average per year 2.6%, 2.6%, 1.3% respectively) leading to a 2.2% increase in hydropower production until 2030 in the Ume River, 3.1% and 1% respectively in the Ljungan and Lagan river until 2040. We modelled environmental flow scenarios (12 in the Ume River, 13 in the Ljungan River and 12 in the Lagan River). All scenarios for each basin area covered ecological functions such as base flow, more natural water-level variation, opportunities for fish migration and minimum discharge to bypassed reaches. Our results show that implementing environmental flows will result in lower hydropower production losses in 2030/2040 than with present runoff (1981-2010). The most cost-effective environmental flow measures were introducing restrictions against zero flow events and start/stops of turbines. Restrictions against zero flow events caused an annual loss of 0.5% of hydropower production in the Ume River, a gain of 1% in the Ljungan River and 1-2% in the Lagan River, without consideration of effects on the balancing and regulating power. The environmental flow measures are projected to increase ecological function in lotic habitat, 348 ha in the Ume River, 321 ha in the Ljungan River and 362 ha in the Lagan. In addition, we argue that restrictions against zero flow events and turbine tarts/stops would decrease the intensity of hydropeaking and improve conditions for lotic species by voiding periods of standing water, which is an unnatural phenomenon in a river. To conclude, our example demonstrates the feasibility of introducing environmental flows with large benefits for riverine biodiversity, while sustaining hydropower production in a future climate.