Physical environmental impacts on a hydropower reservoir under different operational modes

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ABSTRACT: The world is facing a climate, energy, and biodiversity crisis. Norway, with almost half of Europe's reservoir hydropower storage capacity, can contribute to reaching the renewable energy targets by providing balancing services to the European market. Pumped hydropower storage (PHS) is the largest energy battery available worldwide and allows better integration of the volatile energy output of wind and solar power plants. In addition, refurbishment and retrofitting conventional storage power to PHS is being considered a profitable solution in today's market due to the high electricity prices. However, environmental effects are in general understudied. Under the HydroConnect project, physical impacts linked to environmental response are being investigated through a medium-term hydropower scheduling model developed by NTNU in collaboration with SINTEF to simulate the changes in water level and energy production under a PHS plant connecting to Norwegian reservoirs and compare it with the current situation under a conventional power plant. Water temperature has been in situ monitored to set up and calibrate a hydrodynamic model (CE-QUAL-W2) to evaluate temperature and ice dynamics under the current and the PHS operational mode. Results show that water level fluctuations are more frequent but with lower amplitude under the PHS operation, particularly in the lower reservoir with smaller volume. Under the spatial distribution analyses of the reservoir shoreline, it is possible to identify areas more susceptible to being dry and wet with higher frequency, which is linked to the morphology of the shoreline. Temperature dynamics and ice formation are mostly impacted at the surrounding of the outlet/inlet. Expected results will show how far from these structures the changes are propagated. In addition, the impact of different ramping constraints is being investigated. Increasing the knowledge about physical environmental impacts to analyse and recommend potential environmental restrictions will allow to better manage reservoirs under PHS operations, particularly when it can be linked to biological data.