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Projecting the future levels of Lake Victoria

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Lake Victoria directly sustains 30 million people living in its basin and 200 000 fishermen operating from its shores. As the one of the two sources of the Nile River, it also supports natural resources that impact the livelihood of over 300 million people living in the Nile basin. The outlet to the Nile is controlled by two hydropower dams. The water balance of Lake Victoria is controlled both by climatic conditions (precipitation and evaporation) and human management (dam outflow). Future climate simulations reveal a decrease of the precipitation and an increase of the evaporation over Lake Victoria, which may have important implications for the water balance and resulting local and downstream water availability.

Here we present a water balance model based on state-of-the-art satellite observations, a high-resolution reanalysis downscaling and outflow values recorded at the dam. Comparison with observed lake levels reveal that the model is able to closely represent historical lake level fluctuations. Next, the ability of current-generation regional climate models to provide the input for the constructed water balance model is tested. It is found that they are generally not able to reproduce lake levels, due to the imperfect representation of evaporation and precipitation in the Lake Victoria basin, as mesoscale circulation in the basin is not well resolved. Only one regional climate model (CRCM5) provides a reliable representation of the climatology for the region. Future lake levels are projected for different outflow scenarios using the climate simulations of this regional climate model, following the Representative Concentration Pathway 4.5 (RCP4.5), a stabilization emission scenario. For the other CORDEX simulations, a bias correction is applied based on the observed water balance terms. Results indicate that the evolution of future lake levels is determined by both the driving global climate model and the outflow scenario. Only the scenario in which outflow mimics natural conditions provides sustainable lake level projections. This underlines the importance of dam management strategies as a climate change adaptation tool, and highlights potential conflicts with increasing demand for water and (hydro-)power.