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Evaluating the response of Lake Prespa (SW Balkan) to future climate change projections from a high-resolution model

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The Mediterranean stands out globally due to its sensitivity to (future) climate change. Projections suggest that the Balkans will experience precipitation and runoff decreases of up to 30% by 2100. However, these projections show large regional spatial variability. Mediterranean lake-wetland systems are particularly threatened by projected climate changes that compound increasingly intensive human impacts (e.g. water extraction, drainage, pollution and dam-building). Protecting the remaining systems is extremely important for supporting global biodiversity. This protection should be based on a clear understanding of individual lake-wetland hydrological responses to future climate changes, which requires fine-resolution projections and a good understanding of the impact of hydro-climate variability on individual lakes.

Climate change may directly affect lake level (variability), volume and water temperatures. In turn, these variables influence lake-ecology, habitats and water quality. Land-use intensification and water abstraction multiply these climate-driven changes. To date, there are no projections of future water level and –temperature of individual Mediterranean lakes under future climate scenarios. These are, however, of crucial importance to steer preservation strategies on the relevant catchment-scale.

Here we present the first projections of water level and -temperature of the Prespa Lakes covering the period 2071-2100. These lakes are of global significance for biodiversity, and of great regional socio-economic importance as a water resource and tourist attraction. Impact projections are assessed by the Regional Climate Model RCA4 of the Swedish Meteorological and Hydrological Institute (SMHI) driven by the Max Planck Institute for Meteorology global climate model MPI-ESM-LR under two RCP future emissions scenarios, the RCP4.5 and the RCP8.5, with the simulations carried out in the framework of EURO-CORDEX. Temperature, evapo(transpi)ration and precipitation over the Prespa catchment were simulated with this high horizontal resolution (12 $\times$ 12 km) regional climate model. Lake temperatures were derived from surface temperatures based on physical models, while water levels were calculated with the lake water balance model.

Climate simulations indicate that annual- and wet season catchment precipitation does not significantly change by the end of the century. The median precipitation decreases, while precipitation variability increases. The percentage of annual precipitation falling in the wet season increases by 5-10%, indicating a stronger seasonality in the precipitation regime. Summer (lake) temperatures and lake surface evaporation will rise significantly under both explored climate change scenarios. Lake impact projections indicate that evaporation changes will cause the water level of Lake Megali Prespa to fall by $\sim$5m to 840-839m. The increased precipitation variability will cause large inter-annual water level fluctuations. Average water level may fall even further if: (1) drier summers lead to more water abstraction for irrigation, and (2) there is a reduction in winter snowfall/accumulation and thus less discharge.

These findings are of key importance for developing sustainable lake water resource management in a region that is highly vulnerable to future climate change and already experiences significant water stress. Research paves the way for innovative management adaptation strategies focussed on decreasing water abstraction, for example through introducing smart irrigation and selecting more water efficient crops.