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Can water resources in the tropics be particular susceptible to climate change? The case of the Lake Malawi Basin, East Africa.

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Alterations in global/regional climate conditions lead to changes in the hydrological cycle due to close inter-relations with the energy budget. In this perspective, evapotranspiration (ET) is the direct and most important link between the energy budget and the hydrological cycle since latent heat (energy flux) is equivalent to ET (water mass flux). Regarding the anthropogenic use and management of water resources, freshwater availability in rivers and lakes plays a crucial role for water supply, irrigation farming, and hydropower production for instance. In this perspective, hydro-systems with scarce water availability are particularly prone to climate change since water scarcity may be aggravated by decreased precipitation and/or increased ET.
Here, we have analyzed the Lake Malawi Basin situated in semi-humid East Africa, sharing borders with Malawi, Tanzania, and Mozambique, regarding the susceptibility to climate change. Lake Malawi is the 9th largest lake on Earth (is in terms of water volume) and has only one outlet in the south, the Shire River which is intensively used for hydropower production. The installed electricity capacity and generation of hydropower accounts for 80.2 % and 98 %, respectively, of the Malawi's total electrical grid power generation.
Analyzing data for the last five decades, it shows that annual inflow into the lake ($\sim$620 m^3/s) is significantly compared to the annual outflow to the Shire River ($\sim$490 m^3/s). This difference between in- and outflow is due to lake evaporation that exceeds average rainfall in the basin ($\sim$1,400 mm) by 20 to 30 %. In this perspective, water resources and electricity production are endangered by two phenomena: (1) Intra-annual variability of rainfall and ET may strongly affect discharge in the Shire River, which is only a small fraction of the basins′ overall water budget, meaning that small changes in rainfall or ET will lead to larger relative changes in Shire River discharge. Moreover, during drought years with low rainfall rates, lake evaporation will be on particular high levels, instead. (2) Global/regional warming will impact both the catchment- and lake water balances. Although trends in catchment rainfall over the last decades are not consistent and/or significant (yet), there is strong evidence that lake evaporation has already increased and will further increase in the future.
Applying a catchment hydrology- and lake water balance model including sensitivity- and uncertainty analyses, we (i) show first results regarding changes in the water balance of Lake Malawi under recent and future climate change, and (ii) discuss the effects of these changes on streamflow in the Shire River and its consequences for water availability and (future) hydropower production. The results show that the water balance of the Lake Malawi Basin is particular sensitive to climate change, and similar conditions might occur in other semi-humid catchments in the tropics, too.