18th Swiss Geoscience Meeting, Zurich 2020

Modelling the impact of climate change on hydrological processes in the Volta river basin

Moctar Dembélé[1,4], Sander Zwart[2], Natalie Ceperley[1,3,4], Grégoire Mariéthoz[1] & Bettina Schaefli[1,3,4]

[1]Institute of Earth Surface Dynamics (IDYST), Faculty of Geosciences and Environment (FGSE), University of Lausanne, Lausanne, Switzerland (moctar.dembele@unil.ch)
[2]International Water Management Institute (IWMI), Accra, Ghana
[3]Institute of Geography (GIUB), University of Bern, Switzerland
[4]Oeschger Centre for Climate Change Research (OCCR), University of Bern, Switzerland

This study evaluates the impacts of climate change on water resources of the Volta River basin located in West Africa. In total, 43 combinations of global climate models (GCM) and five regional climate models (RCM) from CORDEX-Africa are considered under three representative concentration pathways (RCP2.6, RCP4.5 and RCP8.5). The R2D2 multivariate bias correction method is applied to the climate datasets before using them as input to the fully distributed Hydrologic Model (mHM) for hydrological projections over the twenty-first century. The mHM model is constrained with a novel multivariate calibration approach based on the spatial patterns of satellite remote sensing data (Dembélé et al., 2020).
Results reveal contrasting changes in the seasonality of precipitation depending on the RCPs and the future projection periods (2021-2050, 2051-2080 and 2071-2100) as compared to the historical period (1991-2020), while a clear increase in the seasonality of temperature is expected. A clear intensification of the hydrological cycle during the twenty-first century is expected only under the RCP8.5 scenario. In this case, an increase is foreseen for the long-term annual estimates of precipitation (+6.2%), average temperature (+9.5%) and potential evaporation (+5.0%). These changes in climatic variables will lead to changes in actual evaporation (+4.2%), surface runoff (+42%), streamflow (+84%), groundwater recharge (+37%), soil moisture (+2.3%) and terrestrial water storage (+3.2%). Consequently, recurrent floods and droughts could weaken the water-energy-food security nexus and amplify the vulnerability of the local population to climate change. These findings could serve as a guideline for decision makers, and contribute to the elaboration of adaptation and mitigation strategies to cope with dramatic consequences of climate change on various sectors including agriculture and hydroelectricity, and strengthen the regional socio-economic development.

REFERENCES

Dembélé, M., M. Hrachowitz, H. H. G. Savenije, G. Mariéthoz, and B. Schaefli (2020b), Improving the Predictive Skill of a Distributed Hydrological Model by Calibration on Spatial Patterns With Multiple Satellite Data Sets, Water Resources Research, 56(1), https://doi.org/10.1029/2019wr026085.