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Assessing the impact of climate change on water resources in a tropical West African catchment using an ensemble of CORDEX climate simulations (Dano, Burkina Faso)

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This study assesses the potential impact of climate change on water resources in the Dano catchment (Burkina Faso, West Africa). There is now essential consensus on the importance of performing multi (climate)-model assessments in order to estimate the response of the West African climate to global change. Taking advantage of the results of the COordinated Regional climate Downscaling Experiment (CORDEX-Africa) project, this study evaluates climate change impacts on water resources using an ensemble of six Regional Climate Models (RCMs) in a catchment that is potentially vulnerable to climate change and presents a low adaptive capacity.

The ensemble of RCMs was first evaluated to get an estimate of the historical simulated rainfall for the catchment by comparing RCM-based simulated historical rainfall to the observed rainfall data provided by the National Meteorological Service (DGM). In general, the simulated historical rainfall agrees within some degree of variability with the observed rainfall in regard to the mean annual cycle of precipitation. However, significant biases such as a double-peaked rainy season as well as the timing of the rainy season were exhibited by individual RCMs. A statistical bias correction (Quantile mapping) was then applied to the RCM-based simulated daily rainfall for the overlapping period of 1971-2000. The results confirm the effectiveness of the applied bias correction method for rainfall.

Temperature and bias corrected rainfall data from the ensemble of RCMs was used as input for the Water flow and balance Simulation Model (WaSiM) to simulate river discharge, soil moisture, evapotranspiration and groundwater depth. To take into account the concern of the potential alteration of the climate change signal due to bias correction, uncorrected climate data for a single RCM was also applied to the hydrological model. The simulated hydrological variables show a similar behavior under observed and bias corrected climate data for the historical period (1971-2000). The results further exhibit the necessity of bias correction for the simulation of historical discharge.

The mean hydrological variables for two periods (1971-2000 and 2021-2050) were compared to detect the potential impact of climate change on water resources by the middle of the twenty-first century under two greenhouse gas concentration scenarios, the Representative Concentration Pathways 4.5 and 8.5. The first results indicate that: (i) the ensemble average suggests an increase in total discharge for both RCP4.5 and RCP8.5; (ii) individual RCMs show opposite trends; (iii) the applied bias correction method only affected the magnitude of climate change signal. These results further underline on the one hand the need for a larger ensemble of projections to properly estimate the impacts of climate change on water resources in the catchment and on the other hand the high uncertainty associated with climate projections for the region.

Keywords: hydrological modeling, water resources, climate scenario, bias correction, West Africa.