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Climate Change assessment to quantify current and future hydrological behavior of a small Mediterranean catchment

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As a hotspot for climatic change, the Mediterranean basin is already struggling with the deficiency of available water resources which is expected to front with an important increase in temperature and a decrease in precipitation through the 21st century, according to the fifth report of the IPCC (Intergovernmental Panel on Climate Change). Effective assessments of climate change impact on flow regime require reliable climate model simulations and a robust hydrological impact model validated at catchment scale for variable current climate conditions.
We investigate, in this work, the plausible climate change impacts on the hydrological behavior at the Raghay catchment, one of the main catchments in the high Medjerda valley in the Northern of Tunisia. We implemented a modified version of a spatially distributed conceptual hydrological model available in the ATHYS (ATelier HYdrologique Spatialisé) platform for both current and future climate conditions, taking into account the antecedent soil moisture with the integration of the Potential Evapotranspiration (PE).
First, we calibrated the model using historical climate conditions and based on five accuracy criteria. An 18-year period (1990_2008) of daily rainfall, PE and discharge was used to catch a large range of past hydro-climatic conditions.
Afterwards, we developed a Multi-Model Mean (MME) approach for climate change and evaluated its influence on several hydrological indicators related to water balance, magnitude and frequency of the flow for the Raghay catchment using an ensemble of five Global Circulation Models (GCMs) dynamically downscaled with a Regional Climate Model (RCM) derived from the high resolution CORDEX projections framework. In the purpose to further minimize uncertainties related to the climate projections, we performed a comparison between two bias correction methods, such as the quantile-quantile mapping (QQ) and the linear scaling (LS), of the historical precipitation projections in order to select the best fitted correction technique compared to the observed data, proving that a simple method gave a better fitted precipitations for the studied catchment.
Then, we used the MME LS bias corrected high-resolution EURO-CORDEX dynamical climate simulations under two emission scenarios (RCP 4.5 and RCP 8.5), to force the calibrated model with the projected daily Precipitation and PE, in intention to assess momentous variations and uncertainty in the hydrological response for the projected period (2020-2100) compared with the historical one.
Simulations show a potential projected decrease in precipitation and increase in temperature compared with the historical period especially for the most pessimistic scenario, RCP8.5, predicting a decrease in precipitation varying between 25% and 35% for the six rain gauges. Therefore, flow regime in the Raghay catchment is expected to present a decrease in runoff however PE is projected to increase for the same scenario, anticipating an increase in PE for about 35% by the end of the century and a decrease in flows especially for the winter season with an expansion of the dry periods, going from April to October.