Climate Change Impact Evaluation on Hydro-Meteorological Variables across a Semi-Arid Middle River Basin in India

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May 10, 2023

Abstract

To understand how semi-arid regions can respond to future climatic changes, it is crucial to understand how they often behave unpredictably regarding water resources. Middle Tapi Basin, an agricultural watershed in India’s central region, was the area of this study, where the SWAT model with a combination of SWATCUP software and the SUFI-2 approach was successfully implemented. This research examined how climate change will affect the basin’s water availability over the following century from 2010 to 2100. Statistically downscaled future projected data for rainfall and temperature for five different CMIP5 models (BNU-ESM, CCCma-CanESM, CNRM-CM5, MPI-ESM-LR, and MPI-ESM-MR) were used for two different RCP scenarios, RCP 4.5 or R1 and RCP 8.5 or R2, and were used. The model performed well for the baseline scenario according to the model performance criteria, ensuring accuracy and future predictability. A monthly analysis of several water balance variables for the baseline and future scenarios similarly revealed a rise in maximum temperature of 5.2% and 9.5% for R1 and R2, respectively, at the end of the century. The contribution of monsoonal rainfall and streamflow during the baseline period was also 89.3% and 90.6%, but for R1 these values tend to decline to 75.2%, and 57.8% and for R2 scenarios 70.8% and 54.7%, respectively. The study shows that less monsoonal rainfall contribution and more extreme rainfall events elevate the basin’s overall water availability. The rise in global temperature results in an increase in evapotranspiration and revaporization at the root zone and thus decreasing the percentage change in surface runoff and groundwater flow in future scenarios. Flow duration curves for all the GCMs and both RCPs gradually increase concerning their corresponding historical values for future periods, indicating increasing water availability in the basin during the close, mid, and distant future scenario.

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