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A novel bias correction algorithm for simulation of hydro-climatic extremes

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Changes in hydro-climate extremes have a greater negative impact on the natural environment than changes in the mean climate. Therefore, hydro-climatic extremes must be precisely reproduced to provide reliable information for the formulation of climate change impact adaptation and mitigation strategies. However, there are few studies on the impact of climate change on hydro-climatic extremes, with low attention paid to the precise reproduction of different aspects of the hydro-climate extremes. Moreover, the existing bias correction algorithms have major drawbacks as they are not able to reproduce the climate extremes since they use similar transfer functions for all quantiles. Therefore, in this study, we proposed a new method called categorized quantile mapping (CQM), in the view of reproducing the different phases of precipitation. The capability of CQM was assessed with respect to standard QM, detrended QM, and quantile delta mapping to replicate the meteorological, agricultural, and hydrological extremes consistently with the observation-based extreme indices in the selected basins from Ethiopia and South Korea. The overall reduction in root mean square error with the CQM in reproducing the precipitation extremes were found to be 29% and 50% in the selected basins of Korea (the Geum River Basin, GRB) and Ethiopia (the Lake Tana Basin, LTB), respectively. The CQM preserved the climate model projected relative changes in the mean of different precipitation phases. Furthermore, the CQM outperforms the other algorithms in reproducing the observation data based meteorological, agricultural, and hydrological extremes. Consequently, the CQM-based outputs of the hydro-climatic variables from the soil and water assessment tool were used to assess the climate change impacts on meteorological, agricultural, and hydrological extremes in the GRB and LTB. Climate change resulted in an overall increase in meteorological, agricultural, and hydrological droughts in the LTB and decrease in the GRB in (2070–2099) under both RCP4.5 and RCP8.5, except for the agricultural drought increase in the GRB under RCP8.5. In general, the climate change impact on the extreme wet and drought conditions of the meteorological, agricultural, and hydrological systems are more dramatic than on the other category. Hence, this study recommends that significant efforts be devoted in a timely manner to minimizing the vulnerability of agricultural and hydrological systems to climate change, owing to the increase in the extreme wet and dry conditions.

Keywords: Climate Change; Hydro-Climatic Extremes; Categorized Quantile Mapping

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