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Bias correction of precipitation for selected GCMs in Tamor River Basin, Nepal

Background

Climate change (CC) impact studies are conducted through the analysis of General Circulation Model (GCM) output. GCM output is associated with large uncertainties and biases. Precipitation is one of the key meteorological elements which has the largest uncertainties. Bias correction is needed to apply GCM output in hydro-meteorological studies. This study conducted a bias correction to the 4 GCM model output [CESM1(CAM5), ACCESS1.0, GFDL-ESM2M and MIROC5] of Coupled Model Inter-comparison Project Phase 5 (CMIP5) against observed precipitation at rain gauge stations in Tamor River Basin of Nepal (Fig. 1). GCM selection was carried out following the procedure given by Shrestha and Acharya (2021).

Materials and Methods

The past and future GCM raw precipitation data were corrected for bias based on the statistical relationship between the past GCM raw data and observed precipitation data. Bias corrections were performed by statistically separating precipitation into extreme, no-rain, and normal categories following Nyunt et al (2013). First, observed and GCM raw precipitation at the required location is sorted in descending order for the study period (1981-2000 in this study). Partial duration series (Bobée and Rasmussen, 1995) with Generalized Pareto Distribution (GPD) was used to correct the bias in the intensity and frequency of extreme events. Extreme events are considered a size greater than 99 percentile of the study period. The observed and GCM raw extremes were transformed to the GPD, and bias-corrected extremes were matched against observations using its inverse GPD function. Ranking order statistics was used to correct the frequency of wet days. The threshold value for a number of no rain days correction is identified based on the rank where observed precipitation is 0.0 mm. It is assumed that GCM precipitation has a same number of rainy days as the observations do. The rainfall intensities between the threshold of extreme and the threshold of no-rain days correction are classified as normal rainfall in both datasets. Normal rainfalls are then fitted to a two-parameter gamma distribution function. The corrected GCM normal rainfalls are the inverse of the fitted observed normal rainfall distribution. After correction of the GCM precipitation for the past period, the same functions for correction of extreme, normal and no rain day from the control period was transferred to projected GCM data to attain bias-corrected future precipitation (2081-2100). The biases in past and future GCM data for all 4 GCMs are corrected. Representative Concentration Pathways (RCP) 4.5 and RCP8.5 Scenarios are considered in this study.

Results

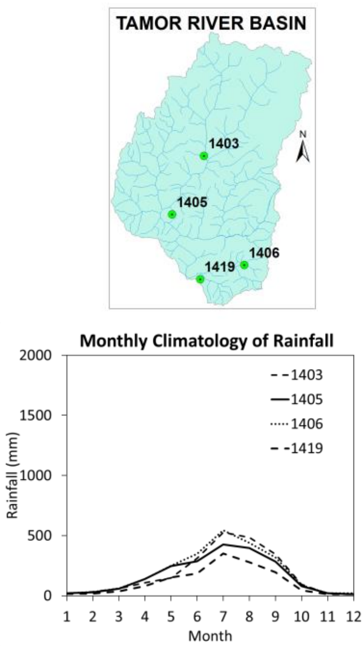

Figure 1: Studied Rainfall stations in Tamor River Basin

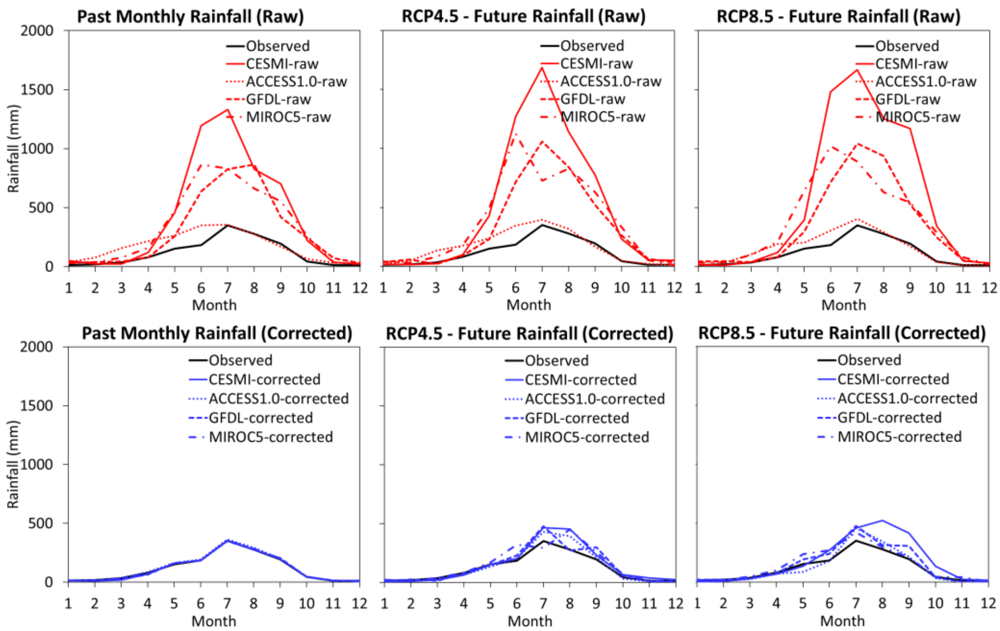

Figure 2: Monthly climatology for GCM raw and corrected rainfall for station 1419

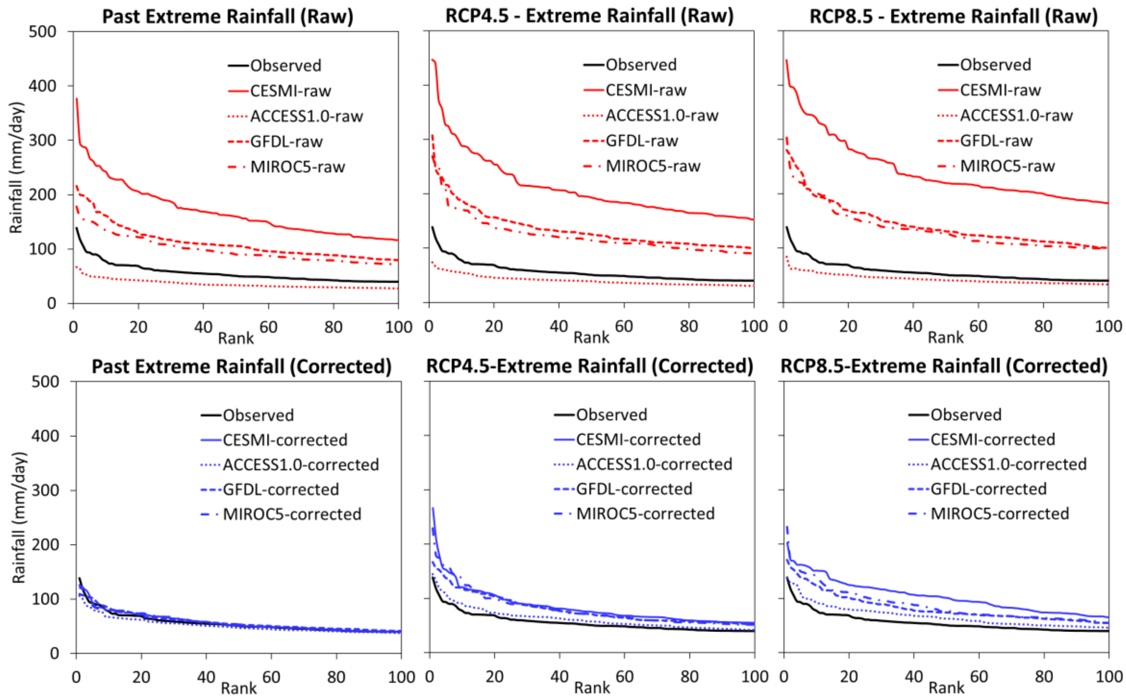

Figure 3: Extreme events (top 100 ranked)

The raw and bias-corrected monthly precipitation distribution for past (1981-2000) and future (2081-2100) – RCP4.5 and RCP8.5 scenarios are shown in Fig. 2. Likewise, the raw and bias-corrected top 100 ranked extreme rainfall for the same period and scenarios are presented in Fig. 3. The results for station 1419 is only presented here. It can be observed that the GCM raw output has a very large bias in climatology and extreme events. After bias correction, the climatology of GCM data matched perfectly with observed climatology. Results also showed that extreme rainfall is corrected well. It is found that monthly rainfall will increase in monsoon season in both scenarios have larger increase for RCP8.5 than RCP4.5. A remarkable increase in extreme events shows that big attention is needed to manage flood and flood induced disasters.

Conclusions

Three-step bias correction is performed to correct the bias in GCMs of CMIP5 at Tamor River Basin of Nepal. Results showed that GCM raw has significant biases and thus could not be applied directly in hydrologic analysis. Hydrologic modelling of the river basin with observed data and bias-corrected GCM output will be carried out in future to study the hydrologic response to climate change in the study region.

Acknowledgment

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Reference

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FOR FURTHER INFORMATION:

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