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Modeling climate change induced hydrological extremes in the Kafue River Basin in Southern Africa

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Climate change impact projections in southern Africa suggest significant declines in flows in the major river basins. However, impacts of climate change on hydrological extremes (floods) in the region remain a grey area despite the threat they pose to human life and property. In this study, the impacts of climate change on extreme flows in the upper Kafue River basin, a major tributary of the Zambezi River, were investigated. Catchment hydrography was determined using the Hydro1k at a spatial resolution of 1 km resulting in an approximate registered area of 23,000 km2. The daily global WASMOD-M model was calibrated and validated during 1971 to 2001 with the WATCH Forcing Data (WFD) against observed discharge at Machiya gauging station from the Gridded River Discharge Data Centre(GRDC). Future climate change scenarios for extreme flows were derived by forcing the model with outputs from three GCM's (ECHAM, CMCC3 and IPSL) under the IPCC's SRES A2 and B1 scenarios from 2020 to 2100 at daily timescale. During calibration and validation, the NS coefficient value was above 0.80 and the Pearson correlation coefficient between observed and simulated flows of 0.9, suggesting acceptable model performance. Current and future extremes for each scenario were analyzed using the Peak Over Threshold (POT) analysis fitted to the Generalised Pareto Distribution (GPA), which provided less RMSE values as compared to Annual Maximum Series (AMS) fitted to the Generalized Extreme Value (GEV) distribution. The results show considerable departures from the reference period extremes for most of GCM scenarios considered, with both the A2 and B1 scenarios of the IPSL resulting in higher projected flows as compared to the other two models. On average, floods with return periods T=5,10,50,100,1000 years increased from Q (m3 s-1) = 626.6, 673.9, 767.1, 802.3, 903.7 during the reference period to Q (m3s-1) = 793.5, 873.4, 1046.2, 1119.2, 1364.8 respectively. The approach in our study has a strong potential for similar assessments in other parts of this data scarce region.