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Expected climate change impacts on extreme flows in Vietnam: The limits of bias correction techniques

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We investigate possible impacts of climate change on future floods in the VuGia-ThuBon river basin, central Vietnam using a multi-model climate ensemble. An ensemble of regional climate projections (SRES) derived from different combinations of global and regional climate models in combination with different emission scenarios are used. In order to correct for the biases between the modelled climate variables and the observations, different bias correction techniques such as linear scaling, local intensity scaling, and quantile mapping are applied to the RCM outputs. Bias-corrected and raw climate data are then used as input for the fully distributed hydrological water balance model WaSIM-ETH to reproduce discharge data at NongSon station. Annual maximum discharges are extracted from the modeled daily series from the control period (1980-1999) and the future periods 2011-2030, 2031-2050, and 2080-2099 for subsequent extreme frequency analyses. To derive flood frequency curves for the four time periods, the generalized extreme value probability distribution is fitted to the data.

Our analysis shows that actually none of the bias correction approaches applied to the control runs of simulated precipitation data can satisfactorily correct their distributions towards those of the observations. Therefore, this study builds further on the delta change approach, which adjusts the observed extreme values by the derived signals from the hydrological simulations fed by raw future climate projections. Adjusted return periods of e.g. HQ100 values are calculated based on the delta change method. The results inhibit a remarkable variation among the different climate scenarios in representing extreme values. Results show that MRI-MRI, ECHAM3-REMO, HadCMQ10-HadRM3P and HadCMQ13-HadRM3P models always exhibit a positive signal for all considered time slices and climate change scenarios. On the other hand, CCSM-MM5 frequently shows a negative signal for all time slices. On average, an increase of 4%, 65%, and 94% HQ100 is estimated for 2011-2030, 2031-2050, and 2080-2099, respectively. Albeit there is a large spread of simulated peak magnitudes, a tendency towards positive future peak flows can be concluded. Due to the obtained large spread of simulated peak magnitudes, we stress the need for combined climate and hydrological ensemble simulations.

This inherently large spread of future peak magnitudes is further increased by the inflated distributions obtained from the bias corrected meteorological input variables. The wide spread of future expected magnitudes remains a crucial problem for decision makers in climate change assessments, as demonstrated here for the VuGia-ThuBon river basin.