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Modelling runoff generation of a small catchment in the context of climate change by using an ensemble of different climate model outputs and bias correction methods

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Due to climate change, meteorological extremes affect the environment and our society in the past decades. But not only the extremes are piling up, the average temperatures and the precipitation regimes have changed in recent decades. The change in meteorological conditions also affects the water balance and thus also the generation processes of runoff. The aim of this work is to estimate this future change for a small low-mountain catchment in central Germany using climate projections and hydrological modelling.

As input to the hydrological model HBV Light, climate data from seven different combinations of global and regional climate models are used. However, due to their substantial bias it is necessary to apply bias correction. For each of the three climate input time series used by HBV Light, different bias correction methods are tested: Precipitation (Linear Scaling Multiplication, Quantile Mapping, Power Transformation, Distribution Mapping Gamma), Temperature (Linear Scaling Addition, Quantile Mapping, Variance Scaling, Distribution Mapping Normal) and Potential Evapotranspiration (Linear Scaling Multiplication, Linear Scaling Addition, Quantile Mapping). The corrected climate model outputs are compared to the observed timeseries and rated based on three different efficiency criteria. Overall, the combination of different climate models and bias correction methods generates 63 future hydrological projections. Based on this ensemble, the future water balance of the catchment is assessed. The results show that (1) the biggest uncertainties in the hydrological simulation were generated by uncorrected climate model outputs; (2) the uncertainties in hydrological simulations increase till the end of the century; (3) Power Transformation and Quantile Mapping perform best for precipitation, Linear Scaling Addition and Quantile Mapping for temperature, Linear Scaling Addition and Quantile Mapping for potential evapotranspiration; (4) the total annual outflow increases till 2070 because of an increase of the outflow in winter and spring; (5) in the future, interflow will increase in spring and winter and reduce in summer and autumn; (6) till the end of the century the baseflow will rise in spring and in the rest of year the baseflow will decrease. This study shows that even if changes in the annual total discharge for small catchments have no significant trend, the generation processes and the seasonal values may change in the future.