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Impact of bias correction method on simulated runoff conditions under a large ensemble of climate change scenarios

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A common approach for assessing future runoff conditions is to drive hydrological models with downscaled, bias corrected data of climate models. In a previous study for the Upper Danube basin, Kling et al. (2012) used a large ensemble of regional climate models to analyse the uncertainty in future runoff projections due to choice of climate model. In this follow-up study we extend this work by also examining the impact of the bias correction method. We apply five different bias correction methods to monthly precipitation and temperature data of 32 recently published regional climate models of the ENSEMBLES and CERA climate data bases. The bias correction methods include delta change, linear scaling, moment scaling, quantile mapping and a de-trended version of quantile mapping. This yields 160 different climate scenario sets for runoff modelling until the end of the 21st century, showing distinctive changes in mean annual runoff, seasonality in runoff, distribution of runoff and low flows of the Danube River. In general the uncertainty due to choice of climate model is considerably larger than due to choice of bias correction method. Only for climate models that perform exceptionally poor for simulation of historic climate, the choice of bias correction method becomes similarly important for future runoff simulations. Systematic differences – albeit smaller than between climate models – are found between two groups of bias correction methods. The climate change signals differ between these two groups after application of the bias correction. A detailed analysis of climate model error properties reveals for most climate models a problematic cross-correlation between projected trends in future climate and errors in historic climate variability. Thereby, the climate change signals in future mean annual temperature and precipitation are modified in frequency-based bias correction methods, such as the popular quantile mapping method. As there is no way of quantifying the error in future climate change signals, this raises the important question if we should put more "trust" in the climate change signals of (a) bias corrected climate model data or (b) raw, un-corrected climate model data.

Reference:

Kling H, Fuchs M, Paulin M. 2012. Runoff conditions in the upper Danube basin under an ensemble of climate change scenarios. Journal of Hydrology 424-425: 264-277