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Tailored scenarios for streamflow climate change impacts based on the perturbation of precipitation and evapotranspiration

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It is advisable to account for a wide range of uncertainty by including the maximum possible number of climate models and scenarios for future impacts. As this is not always feasible, impact assessments are inevitably performed with a limited set of scenarios. The development of tailored scenarios is a challenge that needs more attention as the number of available climate change simulations grows. Whether these scenarios are representative enough for climate change impacts is a question that needs addressing. This study presents a methodology of constructing tailored scenarios for assessing runoff flows including extreme conditions (peak flows) from an ensemble of future climate change signals of precipitation and potential evapotranspiration (ETo) derived from the climate model simulations. The aim of the tailoring process is to formulate scenarios that can optimally represent the uncertainty spectrum of climate scenarios. These tailored scenarios have the advantage of being few in number as well as having a clear description of the seasonal variation of the climate signals, hence allowing easy interpretation of the implications of future changes.

The tailoring process requires an analysis of the hydrological impacts from the likely future change signals from all available climate model simulations in a simplified (computationally less expensive) impact model. Historical precipitation and ETo time series are perturbed with the climate change signals based on a quantile perturbation technique that accounts for the changes in extremes. For precipitation, the change in wetday frequency is taken into account using a markov-chain approach. Resulting hydrological impacts from the perturbed time series are then subdivided into high, mean and low hydrological impacts using a quantile change analysis. From this classification, the corresponding precipitation and ETo change factors are back-tracked on a seasonal basis to determine precipitation–ETo covariation. The established precipitation–ETo covariations are used to inform the scenario construction process. Additionally, the back-tracking of extreme flows from driving scenarios allows for a diagnosis of the physical responses to climate change scenarios. The method is demonstrated through the application of scenarios from 10 Regional Climate Models,21 Global Climate Models and selected catchments in central Belgium.

Reference

Ntegeka, V., Baguis, P., Roulin, E., & Willems, P. (2014). Developing tailored climate change scenarios for hydrological impact assessments. Journal of Hydrology, 508, 307-321.