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Quantification of Uncertainties in Projections of Hydro-meteorological Extremes

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The impact of climate change on hydrological extremes has been widely studied particularly after the publication of the IPCC AR4 report in 2007. The methodology applied to derive hydrological extremes under climate change adopted by most scientists consists of running a cascade of models, starting from assumed emission scenarios applied to a global circulation model (GCM) and ending at hydrological model simulations. Therefore, the projected hydro-meteorological extremes are highly uncertain due to uncertainties inherent in all the links of the modelling chain.

In addition, due to the complexity of hydrologic models that use a large number of parameters to characterize hydrologic processes, many challenges arise with respect to quantification of uncertainty. This issue needs to be properly quantified to understand possible confidence ranges in extremes in the future. This paper aims to quantify the uncertainty in the hydrological projection of future extremes in streamflow and precipitation indices in mountainous and lowland catchments in Poland, using a multi-model approach based on climate projections obtained from the ENSMEBLE and EUROCORDEX projects, multiple realizations of catchment scale downscaled rainfalls, two hydrological models (HBV and GR4J) and a number of hydrological model parameters. The time-span of projections covers the 21st century. The potential sources of hydrological projection uncertainties are quantified through a Monte Carlo based simulation approach. We compare the weights based on different goodness-of-fit criteria in their ability to constrain the uncertainty of the extremes. The results of the comparison show a considerable dependence of uncertainty ranges on the type of extremes (low or high flows) and on the criterion used. The predicted distribution of future streamflows considering all sources of uncertainty (climate model, bias correction and hydrological model) is used to derive marginal distributions of uncertainty related to each uncertainty source separately.

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