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Climate change impacts on hydrological extremes (floods, low flows) along catchments in the Scheldt river basin

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The potential climate change impacts on hydrological extremes (floods and low flows) have been investigated for rivers in highly urbanized catchments in the Scheldt river basin in Belgium. Results of 31 simulations with 11 Regional Climate Models (RCMs) from the EU PRUDENCE project were statistically analyzed for both the control period 1961-1990 and the scenario period 2071-2100. The more recent ENSEMBLES RCMs were not included because a cursory analysis showed somewhat higher biases for rainfall which was consistent with other detailed findings. The PRUDENCE RCM simulations were transformed into tailored climate change scenarios for rainfall and potential evapotranspiration to facilitate the hydrological impact study. The hydrological impacts were investigated by means of combined hydrological-hydraulic models; both lumped conceptual models, and spatially distributed and detailed physically-based models were considered. The performance of these models in predicting extreme high and low flow statistics has been validated through hydrological time series techniques and statistical extreme value analysis.

Given that the hydrological model uncertainty is less than the climate model uncertainty, it was found necessary to apply an ensemble of climate models. The accuracy of the RCM simulations in describing rainfall extremes was assessed for the control period using frequency analysis techniques. The range of projected changes in the daily extremes and the range of projected changes in the number of wet days for rainfall were statistically downscaled (to the hourly time scale) using a quantile perturbation method. The quantile perturbation method is a variant of the quantile mapping technique commonly applied in climate modeling for bias removal. The method essentially extracts the quantile perturbations from the high resolution RCMs and then applies the perturbations to observed series. The use of quantile perturbations is particularly relevant for reflecting the change in the extreme value statistics as projected by the climate models. For instance, it has been widely established that while the future summers will get drier, the summer extreme rainfalls will in fact increase; the quantile approach effectively implements such differences in perturbations.

The climate change impacts in the Scheldt river basin generally tend towards wetter winters and drier summers. The runoff peaks (flood risk) systematically increase and decrease depending on the scenario showing high uncertainty and can reach increases up to +35%. Low flows decrease severely in all cases. The findings show that the intensity of the impacts is only slightly dependent on the location. The differences in the local physico-morphological characteristics, historical climatological data and other hydrological features seem to weakly influence the differences seen in the hydrological responses due to climate change scenarios.