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Climate change impact on hydrological extremes along rivers in Belgium

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Climate change impact on hydrological extremes (floods and droughts / low flows) has been investigated for rivers in the Flanders region of Belgium. Results of 24 simulations with 10 Regional Climate Models (RCMs) for Europe, delivered by the PRUDENCE project for the European Commission and processed by the Royal Meteorological Institute of Belgium (P. Baguis, E. Roulin), were statistically analyzed for both the control period 1960-1990 and the scenario period 2070-2100. Perturbation factors were derived for rainfall and potential evapotranspiration (ETo) as a function of the recurrence interval or the level of the extreme rainfall or ETo condition. Also the dependency of the rainfall and ETo perturbations on the time scale (ranging from 10 minutes to the seasonal scale) were investigated. It was found that during summer period the climate change perturbation in rainfall extremes is around 20% higher in comparison with seasonal volumes.

Through statistical hypothesis testing, investigation was made of the consistency of the RCM based climate change scenarios with historical rainfall and ETo observations at the main station of the Royal Meteorological Institute of Belgium. Based on the 10 minutes rainfall series since 1898, historical trends and cycles were analyzed at the different time scales, and used on the basis of the consistency check. The difference between the point scale of the historical rain gauge observations and the spatial grid scale of the RCMs was accounted for by the use of areal correction factors. By comparison with the historical trends and cycles, some RCM simulations were statistically rejected. Based on the accepted RCM simulations, mean, high and low climate change scenarios were derived, as well as a perturbation method developed in order to modify the amplitude / duration / frequency statistics in the rainfall and ETo input series of hydrological models.

The scenarios were simulated for selected river catchments in Flanders - Belgium, making use of combined hydrological and hydrodynamic river models. It was concluded that the hydrological impact of climate change strongly depends on the topographical and land use characteristics of the catchment. In general, it was found that low flows significantly decrease in all studied catchments. Hourly low flow extremes might decrease up to 50%. The increase in river peak flow extremes is less strong, and limited to around 15%. Results indicate that low flow or drought problems will increase and might become more severe in comparison with flood risk problems induced by extreme precipitation. This is opposed to current conditions in the humid Belgian climate. Uncertainties in the results are, however, still very high. Depending on the ratio between the increase in rainfall versus the increase in ETo, and the ratio between the increase in winter rainfall versus the decrease in summer rainfall, the hydrological impact results might turn over from a positive trend into a negative trend.