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New insights for the hydrology of the Rhine based on the new generation climate models

Laurène Bouaziz (1), Frederiek Sperna Weiland (1), Jules Beersma (2), and Hendrik Buiteveld (3)

(1) Deltares, ZWS-HYD, Delft, the Netherlands (laurene.bouaziz@deltares.nl), (2) Royal Netherlands Meteorological Institute (KNMI), the Netherlands, (3) Rijkswaterstaat Water, Transport and Environment, the Netherlands

Decision makers base their choices of adaptation strategies on climate change projections and their associated hydrological consequences. New insights of climate change gained under the new generation of climate models belonging to the IPCC 5th assessment report may influence (the planning of) adaption measures and/or future expectations. In this study, hydrological impacts of climate change as projected under the new generation of climate models for the Rhine were assessed. Hereto we downscaled 31 General Circulation Models (GCMs), which were developed as part of the Coupled Model Intercomparison Project Phase 5 (CMIP5), using an advanced Delta Change Method for the Rhine basin. Changes in mean monthly, maximum and minimum flows at Lobith were derived with the semi-distributed hydrological model HBV of the Rhine. The projected changes were compared to changes that were previously obtained in the trans-boundary project Rheinblick using eight CMIP3 GCMs and Regional Climate Models (RCMs) for emission scenario A1B.

All eight selected CMIP3 models (scenario A1B) predicted for 2071-2100 a decrease in mean monthly flows between June and October. Similar decreases were found for some of the 31 CMIP5 models for Representative Concentration Pathways (RCPs) 4.5, 6.0 and 8.5. However, under each RCP, there were also models that projected an increase in mean flows between June and October and on average the decrease was smaller than for the eight CMIP3 models. For 2071-2100, also the mean annual minimum 7-days discharge decreased less in the CMIP5 model simulations than was projected in CMIP3.

When assessing the response of mean monthly flows of the CMIP5 simulation with the CSIRO-Mk3-6-0 and HadGEM2-ES models with respect to initial conditions and RCPs, it was found that natural variability plays a dominant role in the near future (2021-2050), while changes in mean monthly flows are dominated by the radiative forcing in the far future (2071-2100). According to RCP 8.5 model simulations, the change in mean monthly flow from May to November may be half the change in mean monthly flow projected by RCP 4.5. From January to March, RCP 8.5 simulations projected higher changes in mean monthly flows than RCP 4.5 simulations.

These new insights based on the CMIP5 simulations imply that for the Rhine, the mean and low flow extremes might not decrease as much in summer as was expected under CMIP3. Stresses on water availability during summer are therefore also less than expected from CMIP3.