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Impacts of human interventions on the dynamics of the water cycle and its extremes at the European scale – a study based on the ISIMIP2 model runs

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The water cycle is heavily affected by human activities, like irrigation, groundwater pumping and the construction of reservoirs. The aim of the study is to evaluate the sensitivity in the water cycle to these human impacts in Europe, with a special focus on changes in the flow regime, high flows and low flows. The study contributes to the IAHS initiative Panta Rhei addressing changes in hydrology and society, in particular the working group Drought in the Anthropocene. We use historical data (1901-2001) to analyse the impact of human activities on runoff and discharge. The time series were simulated with the global hydrological model PCR-GLOBWB (Sutanudjaja et al., 2017) at a spatial resolution of 0.5°. The model was used under natural conditions (no human impact), transient human impact (human impacts introduced on an annual basis) and current human impact (whole period simulated with the human impacts per 2010). Human impacts include reservoirs, irrigation, water abstraction for industry, livestock and domestic. Four different meteorological forcing data sets (GSWP3, PGMFD v2, WFD and WFD+WFDEI) were used in the simulation to assess the results' sensitivity to the choice of forcing data set. The natural simulations were used as a baseline, and deviations from the baseline investigated for the two human impact scenarios (transient and current). Deviations as compared to the baseline were quantified by looking at the differences between the percentiles values (logarithmic scale) of the impact flow duration curve (FDC) and the baseline FDC. Further, the integral over the absolute deviations was computed for the full range, the low flow end (lowest 20 percent) and the high flow end (highest 20 percent) of the FDC. Results showed that for runoff, changes in the FDC of the current human impacts simulations were more evident in the low flow end compared to the high flow end of the FDC. Largest FDC changes were found in southern Europe (35° to 45°N). Here runoff showed an increase in the low flow range for the current human impact simulations, whereas discharge showed a decrease. This deviation in the results for runoff and discharge is due to the abstraction of surface water and introduction of reservoirs in the case of discharge. Percentile values of runoff were found to be highly sensitive to the choice of forcing data set. The uncertainty in the meteorological forcing had a larger impact on the runoff simulations than the different human influence scenarios. Further investigation will focus on time evolution of regional (e.g. climate zones within Europe) differences in the influence of human impacts on the low flow end, high flow end, as well as the gradient of the FDC.