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Using decadal predictions and IPCC-RCP scenarios for hydrological modelling: Assessing short to long-term climate change impacts for a small river catchment in central Germany

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Under the framework of the EU-Horizon 2020 project BINGO (Bringing INnovation to onGOing water management), climate change impacts on the water cycle in the Wupper catchment area are being studied. For this purpose, the Soil and Water Assessment Tool (SWAT) has been set up, calibrated and validated. The model integrates detailed spatially and temporarily distributed soil, land-surface and meteorological information and can therefore closely link the impact of changes in climate variables to future changes in the numerous hydrological system variables.
In this study, short-term (decadal) as well as long-term (centennial) impacts of climate change scenarios are examined, for the Wupper sub-catchment "Große Dhünn". This sub-catchment generates the inflow to a large reservoir, which is used as drinking water source for about 0.5 million people and as flood protection system for downstream areas. Changes of principal water balance components due to climate change, are therefore of high importance in this region.
Climate change information are derived from medium-term decadal predictions, based on the MiKlip framework, for the time span 2015-2024, as well as from long-term IPCC-RCP scenarios, for the years 2006-2100. The study assesses potential future hydrological changes in the "Große Dhünn" catchment, based on both data sets and compares the projected changes for the overlapping time period (2015-2024).
Decadal predictions as well as IPCC-RCP scenarios indicate that in the near future, winter months will experience reduced reservoir inflow, while summer inflow will slightly increase. The main reason for the decreasing winter discharge rates lays in decreasing precipitation during the respective winter months. In addition, temperature and concurrently also ET rates will increase during winter, which will intensify the decrease in discharge rates. Increasing summer temperatures and ET rates are compensated by increasing summer precipitation rates, and are resulting in a slight increase in summer discharge rates.
For long-term predictions however, RCP scenarios indicate that under both RCP scenarios a significant reduction of inflow to the reservoir is expected in all seasons. Furthermore low flows will shift from early to late summer, making a careful management and saving of water resources until later in the hydrological year necessary.
A comparison of simulated runoff based on decadal predictions and IPCC-RCP runoff scenarios reveals the interesting fact, that decadal predictions might underestimate the variability of future runoff responses to climate change. While RCP scenarios show a similar variability in runoff compared to historical data, decadal predictions indicate a significant reduction in future runoff variability. This is especially important to consider for future reservoir management, considering the range of potential extreme high and low flows in the near-future.