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Human and climate impacts on the 21st century hydrological drought

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Climate change will very likely impact future hydrological drought characteristics across the world. Here, we quantify the impact of human water use including reservoir regulation and climate change on future low flows and associated hydrological drought characteristics on a global scale. The global hydrological and water resources model PCR-GLOBWB is used to simulate daily discharge globally at 0.5 degree spatial resolution for 1971–2099. The model was forced with the latest CMIP5 climate projections taken from five General Circulation Models (GCMs) and four emission scenarios (RCPs), under the framework of the Inter-Sectoral Impact Model Intercomparison Project.

A natural or pristine scenario has been used to calculate the impact of the changing climate on hydrological drought and has been compared to a scenario with human influences. In the latter scenario reservoir operations and human water use are included in the simulations of discharge for the 21st century. The impact of humans on the low flow regime and hydrological drought characteristics has been studied at a catchment scale.

Results show a significant impact of climate change and human water use in large parts of Asia, Middle East and the Mediterranean, where the relative contribution of humans on the changed drought severity can be close to 100 percent. The differences between Representative Concentration Pathways are small indicating that human water use is proportional to the changes in the climate. Reservoirs tend to reduce the impact of drought by water retention in the wet season, which in turn will lead to increased water availability in the dry season, especially for large regions in Europe and North America. The impact of climate change varies throughout the season for parts of Europe and North-America, while in other regions (e.g. North-Africa, Middle East and Mediterranean), the impact is not influenced by seasonal changes.

This study illustrates that the impact of human water use and reservoirs is nontrivial and can vary substantially per region and per season. Therefore, human influences should be included in projections of future drought characteristics, considering their large impact on the changing drought conditions.