Human impact on hydrological drought in the 20th and 21st century

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Human actions impact current drought conditions and, in combination with climate change, will very likely impact future hydrological drought characteristics across the world. Here, I quantify the impact of human water use, groundwater pumping, reservoir regulation and climate change on historical and future low flows
on a global scale. I use the global hydrological and water resources model PCR-GLOBWB to simulate daily discharge for the period 1950–2100.
First, I will show a historical analysis for the period 1950-2015, where we focus on the recent drought in the state of California and the alterations in drought characteristics that have occurred due to human water management. Next, I use 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 to project human impact on drought for 2000-2100. A natural or pristine scenario was used to calculate the impact of the climate on hydrological drought and was compared to a scenario with human influences.
The results show that drought is severely affected by human actions, mainly by groundwater pumping and reservoir operations, respectively worsening and alleviating drought severity. For the case study in the state of California, we see the severe impact of human actions on drought in the increase in drought duration compared to the pristine conditions. The impact is most evident in groundwater and discharge, because most of the human impact is caused by groundwater pumping and surface water abstraction.
For the 21st century, we see 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 RCPs 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 groundwater pumping and reservoirs is non-trivial and can vary substantially per region and per season. Considering their large impact on changing drought conditions, human influences should be included in projections of future drought characteristics.

Keywords: Human impact, Drought, Climate change, Groundwater, Reservoirs, PCR-GLOBWB