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Progressing the state of knowledge on the human influence on hydrological droughts through case studies

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Human activities can have a large influence on changes in the hydrological system and hydrological extremes, more than climate variability and climate change in some cases. However, there are currently only a limited number of studies which aim to quantify the human impact on hydrological droughts. Here we present a synthesis study of existing and new results that aims to summarize and quantify the anthropogenic impact on hydrological drought from case studies and observations. By combining a large number of case studies, we allow conclusions to be drawn about the effects of different human activities. This work suggests ways forward to increase our understanding on how human activities are influencing drought characteristics; invaluable information for water resource management and adaptation.

During this project, the impact of different human activities (e.g. water abstraction, reservoir building, urbanisation, etc) on drought frequency, duration and deficit has been calculated in a consistent manner, allowing for an improved understanding to how they have impacted droughts. This consistent methodology is a necessary element for this comparative hydrology exercise, yet we use one which is flexible and applicable to different case study set ups and data availability. The methodology used here depends on available observation data, with three possible approaches: i) paired catchment approach; ii) upstream-downstream comparison; iii) observation modelling framework.

The synthesised results of the existing and new case studies cover a number of human activities, hydroclimatic and socio-economic contexts. In particular, we remove the climate dependency in the results by using case studies from multiple climatic regions, including UK, Italy, US, Australia, Mexico and Chile. For groundwater abstraction, it is clear across all the relevant case studies that abstraction activities worsen drought events. This is especially prominent in the deficit volumes, with nearly all results showing at least a 50% increase in deficit compared to the natural situation due to the human activity. However, for the reservoir case studies we find mixed results with some catchments showing drought alleviation and others demonstrating an aggravation of drought. These results show us that the impact of reservoirs on droughts downstream is dependent on reservoir management and purpose. From the urbanised case studies we find urbanisation to be a more difficult human activity to quantify and analyse. Mixed results indicate possible conflicting processes occurring due to urbanisation, and the need for further case studies and discussions.

This is the first step towards quantifying the human influence on drought on the global scale using catchment scale observation-based studies, which will provide important information for global scale modellers, water managers and drought policy makers.