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Impact of socio-economic trends and climate variability on the occurrence and severity of blue water shortage and stress events at the global scale

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Changes in available fresh water resources (i.e. water in rivers, lakes, and reservoirs), together with changes in water use, force our society to adapt continuously to drought and water scarcity conditions. The inadequate amount of fresh water is recognized as one of the most important global risks for the near future. Whilst several studies assess the role of long term climate change and socio-economic trends on global blue water availability and scarcity events, the impact of climate variability is less well understood. Taking into account inter-annual climate variability, however, is important as it may offset other factors of change (e.g. socio-economic development, long term climate change) at the regional scale, impacting the efficiency of adaptation strategies. The tailoring of adaptation strategies to specific regions requires also more insights in the specific character of water scarcity events, being solely demand (sector-specific)- or population-driven, or driven by both. Only few studies, however, have executed such assessment and a global analysis distinguishing water use sector- and climate variability-specific water scarcity events is lacking.

In this contribution, we evaluate the impact of socio-economic trends and inter-annual climate variability on the occurrence and severity of blue water scarcity events. This is done at the global scale over the time period 1960-2000, while distinguishing two main types of scarcity: apparent, demand-driven, water stress and real, population-driven, water shortage. Subsequently, demand-driven water stress was broken down into water stress being solely irrigation-, economy-, or population-driven, or driven by all the causes. The results indicate that both socio-economic trends and climate variability impact the frequency and severity of water shortage and stress events. The results differ significantly regionally, both in sign (+/-) and in relative contribution. Furthermore, the results show a spatial differentiation between regions affected mainly by apparent water stress and regions affected primarily by real water shortage. Regional transitions within the character of water scarcity events over time, whether induced by socio-economic trends and/or climate variability, show us the need for tailored adaptation strategies from region to region.

We carried out the analysis by (1) using daily discharge and run-off time-series (0.5º x 0.5º) of three WATCH forced global hydrological models (WaterGAP, PCR-GLOBWB, and STREAM) to estimate monthly blue water availability per Food Producing Unit (FPU); (2) estimating monthly and yearly blue water stress and shortage by combining blue water availability data with time-series of blue water demand and population counts under transient, socio-economic fixed (1960) and climatology fixed (long term mean) conditions; (3) evaluating the occurrence and severity of blue water shortage and stress events under the different socio-economic and climatologic conditions per FPU and FPU-region; (4) distinguishing real water shortage from apparent water scarcity and evaluating their occurrence and severity over time per FPU and FPU-region with respect to the different socio-economic and climatologic conditions applied; and (5) comparing (2), (3), and (4) in order to illuminate the impact of climate variability and socio-economic trends on the occurrence and severity of blue water shortage and stress.