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Global physical water scarcity trajectories for the 20th century

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Food security and the overall wellbeing of human kind are threatened by overexploitation of our freshwater resources. Water scarcity is not only a threat to people, but also to many of the planet's key ecosystems. Due to increasing population pressure, changing water consumption behaviour, and climate change, the threat is projected to become even worse in the future. Water can be physically scarce in two ways: population-driven water shortage occurs in areas where a large population has to depend on a limited resources (indicated by m3/capita/yr), while demand-driven water stress is related to the excessive use of otherwise sufficient water resources (indicated by demand/supply ratio). Although many studies have increased our understanding of current water scarcity and how this may increase in the future, the understanding of trajectories with the past development of the water scarcity is less well understood. To date, studies of past water resources have focused on either water shortage or water stress.

We aim to calculate global water scarcity, both water stress and water shortage, for the period 1900-2005. We can thus provide, for the first time, continuous regional trends and local analyses of trajectories of water scarcity for the entire 20th century. By including both dimensions of water scarcity, we can increase the understanding of reasons behind the scarcity. We found that in year 1900 13% of the population (i.e. 0.22 billion people) was living in areas that suffer some kind of water scarcity (<1700 m3/capita/yr or ratio >0.2), while in year 2005 this percentage has increased to 57% (3.80 billion). Especially the population suffering from both high water stress (ratio >0.4) and high water shortage (<1000 m3/capita/yr) has risen considerably, from 2% (29 million people) in 1900, up to 19% (1.2 billion people) in 2005. Geographically these concern mainly northern African regions, the Middle East, Pakistan and parts of India and Northern China. The region of sub-Saharan Africa mainly suffers from water shortage.

We used WaterGAP model to simulate the water use and available water resources. WaterGAP was forced with WATCH data. For the past population, we used HYDE dataset. The water scarcity results are plotted in Falkenmark's water scarcity matrix, which combines water stress and water shortage, to illustrate trajectories of how water scarcity develops for different regions. Insights into these trajectories can help to understand possible measures to alleviate water scarcity for different regions and support macro-scale analysis and planning to tackle with the future challenges in terms of water scarcity.