Growing water stress in China from the past to the future: A spatially explicit assessment

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Severe water stress in China has been widely reported but its time-evolution and spatial patterns are rarely assessed. In this study, we illustrate the spatial and temporal characteristics of water stress in China for the historical (1971-2010) and the future (2021-2050) periods using multimodel simulations. Three water stress indices (WSIs), i.e. the ratios of water withdrawal to locally generated runoff (WSIR), to natural streamflow (WSIQ), and to natural streamflow minus upstream consumptive water withdrawal (WSIC), are used for the assessment. At the basin level, WSIR estimates generally match the reported data and indicate severe water stress in most northern basins during the historical period. At grid cell level, the WSIs show distinct spatial patterns wherein WSIR (WSIQ) overestimate (underestimate) water stress compared to WSIC. Based on the WSIC estimates, 365 million people (one-third of the total population) was under severe water stress every year during the historical period, while WSIR and WSIQ suggest 600 and 335 million people, respectively. It indicates that different estimations of water availability can affect water stress assessment greatly. The future projections of WSIC suggest that ∼500 million people (one-third of the total) will be affected by severe water stress every year. Future severe water stress will expand to nearly 40% of the total areas of China because of stiffened competitive water uses, especially in the southern basins with abundant water availability and historically little water stress. This study emphasizes the necessity of considering explicit upstream and downstream relations with respect to both water availability and water use in water stress assessment and calls more attention to the increasing water stress in China in the coming decades.