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A Drier world in the future? Assessing water deficit frequency and spatial extent using the ISI-MIP multi-model experiments.

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Water security is one of the most pressing issues facing society, given a rapidly increasing world population and changing climate. It is anticipated that the future space-time distribution of extreme hydrological events will be altered. Projection of changes in the hydrological cycle, particularly drought occurence, is critical for understanding future patterns of water availability and making decisions to ensure water security. To address this research gap, this study aims to assess the frequency and worldwide extent of water deficits using future simulations from a multimodel ensemble.

Daily total runoff time series from the Inter-Sectoral Impact Model Intercomparison Project (ISI-MIP) experiment are used to calculate a daily deficiency index worldwide over two periods: 1976-2006 (control runs) and 2070-2100 (future runs). The experiment consists of 6 hydrological models (excluding water management effects) forced by 3 different global circulation models (GCMs) for the four different worlds described by Representative Concentration Pathways (RCPs). Days with water deficit are are defined when total runoff is below a daily-varying threshold of the 10th percentile of runoff (Q10) for the control runs.

The results highlight hot-spots where substantial water deficits are projected by most models: Mexico, North-East Latin America, West Africa, Southern Europe/Northern Africa, South Western Australia. Water deficits are sensitive to RCPs with the highest emission concentrations (RCP 8.5) to which the greatest increase in frequency and spatial extent is associated. While future distributions of global extent of water deficits are statistically different from the control runs for all climate-hydrological model combinations, runs under RCP 2.6 are associated with lowest increase in water deficit, suggesting that lowering emissions may mitigate the impact of climate change on water resources with major implications for provision of future water security.