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Understanding the impact of climate variability on water and food security for US

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To ensure food and water security, it is crucial to understand the impact of climate on our capabilities to meet water demand for all sectors, and in particular for its most consumptive one, agriculture. A great challenge is the scale at which this needs to be tackled. Indeed, while all water demands need to be met locally, large river and groundwater systems, food distribution networks and political decisions span the scale of states or nations.

In this paper, we propose to quantify the risks associated to climate variability with our current water demand. This assessment is performed by exploring the response of an integrated water model developed for the continental United States at a county scale. The model comprises a surface water network with river nodes and reservoirs, a crude representation of groundwater, water demands at the county-scale and a statistical crop model. The integrated model then allocates water across the sectors by solving an optimization function, where the choice of water sources is driven both by relative cost and water availability in function of the climate considered.

To understand the impact of climate variability, reconstruction of past precipitation, temperature and run-off for the last 60 years are used as input for the integrated model. We analyse the spatial and temporal variation in water stress in response to the climate forcing to highlight regions at risk. This analysis is extended by considering 500 years of streamflow reconstructed from paleoclimate data. The proposed approach results in a quantification of the risks associated with our present water consumption and might serve as a tool for the identification of integrated solution for water across large spatial scales.