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Why we model spatial supply chain dynamics of water use in food systems

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Efficient use of water resources is paramount to support the global food system in feeding the human population. Water scarcity has increased and, unfortunately, is estimated to become an even more critical problem by mid-century. There is no shortage of suggested measures to mitigate it, ranging from shifting demand towards less consuming products to radically improving and rearranging food production. Marginal changes can be evaluated relatively easily by scaling current water use according to the production of the foodstuffs in question or production efficiency. But many water efficiency improvement measures do not stop at marginal changes. Larger shifts require modelling the water use in the system in its altered state, accounting for substantial changes in average water use per unit foodstuff produced.

Accuracy of the water use estimates is only one of the reasons to consider modelling the main dynamics of the system. Modelling dynamics also improves our understanding of how changes in demand, production methods and locations as well as interactions between actors propagate into water use and scarcity estimates. Food production efficiency, be it for crops or livestock, varies spatially in efficiency due to climate and soil conditions, level of industrialisation and other factors. As demand of different foodstuffs changes due to shifts in diet and reductions in losses, competitive advantages of food-producing regions shift, potentially leading to reallocation of production to new areas. Reducing the share of livestock products in human diet may hamper the effective use of secondary or substandard outputs of food production as feed. Acceptance and thus applicability of resource-saving measures depends on their impact on everyday life, economy and, how effective and reliable they are perceived by stakeholders.

Even if data is insufficient to accurately predict future water scarcity, modelling food system dynamics can lead to useful understanding of real phenomena. For example, we use spatial optimisation of crop production to show that scaling down the global demand of animal-based foodstuffs would potentially allow an even greater reduction in consumptive water use than is estimated by assuming current food production water efficiencies. On the other hand, completely abandoning livestock production may reverse some of these savings due to some of the feed resources not being fit for human use. Drawing attention to these dynamics would help us make best use of the measures towards more efficient water use, enabling more people to be fed with less dramatic effects on the environment.