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The future virtual-water trade network under possible scenarios of food production and consumption

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Growing population and changing diets are projected to double food demand by 2050. Indeed, consumption patterns will increase the agricultural demand for crops both for food and feed, with direct implications on green and blue water resources. Provided the increasing interdependence among water systems (i.e. through the virtual water trade network), projecting the future trade network is a major challenge in the context of water and food security. Recent studies tried to project the trade networks of agricultural products, considering several scenarios, and adopting different methodologies. However, serious limitations inflate the uncertainty of these projections. Limitations include lack of a proper validation of the approach adopted to project the network, the assumption of a constant network topology over time, the lack of a country food-balance preservation, and the paucity of considered food products.
In this study, we overcome these limitations by projecting the future trade networks of twelve products (including meat), looking at a year 2050 and at year 2080 as the prediction horizons. We base export and import projections on consumption and production scenarios: when production exceeds consumption, the country is considered a net exporter, otherwise a net importer. Hence, we first construct possible patterns of food consumption and production, based on available scenarios on population patterns, diet composition, yield changes and agricultural area variations. Then we obtain total imports and exports for each product. Considering every net exporter linked with all the net importers and each net importer linked with all the net exporters, we model the network topology in 2050-2080 for each product. Finally, we adopt the biproportionate adjustment model (i.e. the RAS algorithm) to distribute the country import and export along each link, preserving at the same time the country balance. Bilateral trade flows are finally aggregated at the regional scale in order to provide a meaningful and robust picture. For instance, the global trade of wheat may see a consistent intensification in the future, especially along certain links: wheat trade may double in 2050 with a substantial intensification of the trade between East Europe and Central Asia with the MENA region and South Asia. By 2050, East Asia nearly stop wheat exports while strongly increase the imports to satisfy the demand of a growing population; however, by 2080 East Asia may be able to export again part of its production, especially toward Oceania and New Zealand.