Achieving Sustainable Irrigation Water Withdrawals: Global Impacts on Food Production and Land Use

Objective

Evaluate consequences of restricting unrenewable irrigation withdrawals for land use, terrestrial carbon and food security

Approach

Developed a grid-resolving partial equilibrium economic model SIMPLE-G and coupled it with Water Balance Model to assess the extent of unsustainable irrigation at the sub-basin level in 2050.

Simulated the outcomes of eliminating unsustainable irrigation under two adaptation scenarios: inter-basin water transfers and international market integration.

Impact

Our research shows that the pursuit of the UN sustainable development goals should not be done in isolation due to the potential tradeoffs across land, water, food and energy resources

This multi-scale modeling approach reveals heterogeneous local responses to system stresses, and can support more effective decision making.

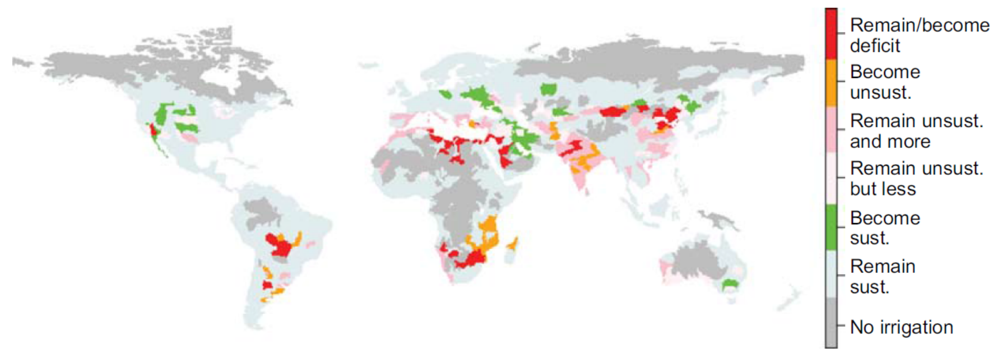

Figure 1. Irrigation vulnerability index at the sub-basin level, 2050 baseline relative to 2006 baseline. The 2050 baseline assumes the RCP 8.5 forcing scenario, no sustainability requirement, no adaptation, and no incremental TFP growth in irrigated sector. Given that fossil groundwater withdrawal is not included in total water supply, water available for irrigation can be negative in some sub-basins. That means irrigation water in these sub-basins comes from nonrenewable groundwater mining. These basins are defined as 'deficit'. 'Sustainable' and 'unsustainable' refer to vulnerability indices that are below and above 0.2, respectively.

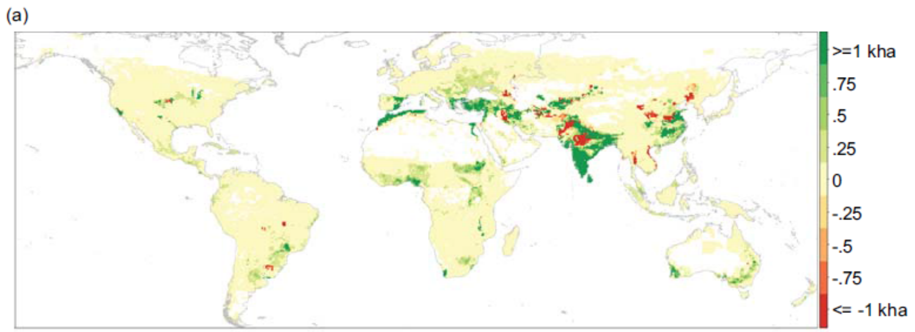

Figure 4. Net cropland area change at the 30 arc-min grid-cell level (unit: thousand hectares). Sub-figures show the changes when equal total factor productivity (TFP) growth is interacted with (*a*) business-as-usual (BAU), (*b*) inter-basin hydrological transfers (IBT), and (*c*) integrated market (INT), as well as the changes when faster TFP growth interacted with (*d*) BAU, (*e*) IBT, and (*f*) INT. Global net cropland changes are 12.73, 11.52, 14.32, 1.43, −1.24, and 3.88 million hectares, respectively. See figure S7 for separate maps of irrigated and rainfed cropland area change.

Liu, J., Hertel, T.W., Lammers, R., Prusevich, A., Baldos, U., Grogan, D. and Frolking, S., 2017. "Achieving Sustainable Irrigation Water Withdrawals: Global Impacts on Food Production and Land Use." *Environmental Research Letters*, https://doi.org/10.1088/1748-9326/aa88db

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