Water stressed regions in GTAP

Farzad et al.[1] incorporated irrigation into the GTAP-BIO model using data for irrigated and rain-fed from various studies but did not account for the likelihood of water being a constraint for the purposes of irrigation. ARB staff consulted with researchers at the World Resources Institute (WRI) to provide assistance to identify water constrained regions in the world which could potentially limit expansion of irrigation in such regions. Researchers at WRI used reports by Gassert et al.[2,3] to develop water stress ratios for various regions and agro-ecological zones (AEZs) in the world. Using thresholds established in literature,[4,5] they marked regions/AEZs with water stress values greater than 40% (water withdrawal greater than 40% of available water on an average annual basis) to be under high water stress. For the GTAP-BIO analysis, the water stress ratios were converted to indexed values by log-transforming them, such that a stress value of 40% was given a score of three, 20% a 2, 10% a 1, and 5% a 0. The indexed values were limited to be between 0 and 5 (5% and 160%) as a way of limiting outliers.

Within each AEZ-Region unit, a weighted average of water stress scores is computed based on where irrigated agriculture is within the region. Areas with more acres of irrigated agriculture have a greater weight in determining the score of the region. A score of 3 or higher was designated to mean that irrigated agriculture, on average, is under high water stress within that region. The GTAP-BIO model is currently not capable of translating each of the individual indices to represent a gradation in irrigation constraints. Instead, all regions/AEZs with scores greater than 3 were marked with a value of “1” to represent ‘irrigation-constrained’ with the remaining regions marked with a value of “0” to represent no constraints for expansion of irrigation in such regions/AEZs. The attached Excel sheet provides the data used to calculate the water stress scores and the determination of water stressed regions.

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[1] F. Taheripour, T. Hertel, and J. Liu, The role of irrigation in determining the global land use impacts of biofuels, Energy, Sustainability, and Society, 3:4, 2013, http://www.energsustainsoc.com/content/3/1/4

[2] F. Gassert, M. Luck, M. Landis, P. Reig, and T. Shiao, Aqueduct Global Maps 2.1: Constructing Decision-Relevant Global Water Risk Indicators, Working Paper, World Resources Institute, April 2014.

[3] F. Gassert, P. Reig, T. Luo, and A. Maddocks, A weighted aggregation of spatially distinct hydrological indicators, Working Paper, World Resources Institute, December 2013.

[4] Charles J. Vörösmarty et al., “Global Water Resources: Vulnerability from Climate Change and Population Growth,” Science 289, no. 5477 (2000): 284–88

[5] United Nations Commission on Sustainable Development (UNCSD), Comprehensive Assessment of the Freshwater Resources of the World (New York, 1997), http://www.un.org/esa/documents/ecosoc/cn17/1997/ecn171997-9.htm