Global Economic Limits of Groundwater used for Irrigation

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Under pressure of population growth and increasing food demand, irrigated agriculture has expanded into semi-arid areas with limited surface water resources. As a consequence, irrigation has become increasingly dependent on groundwater, which has resulted in high rates of aquifer depletion in many aquifers around the globe. As groundwater decline leads to increasing costs of groundwater pumping, an important question is at which groundwater depth pumping costs will exceed revenues from crop production. Here, we assess globally the maximum economic depth of groundwater extraction for the irrigated areas overlying productive aquifers under current crop cover and current climate. To this end we combine globally available data on crop cover, crop yield and crop prices with crop water requirements and groundwater level estimates from a global hydrological and groundwater model. The estimating maximum economic depths are consistent with well depths obtained from a rich well dataset over the U.S. Our results show that the maximum economic depth greatly varies between regions with times to reach this depth varying greatly as well. We estimate the global volume of economically extractable groundwater, which is only a small fraction of the estimated fresh groundwater resources underlying irrigated areas, but nevertheless represents a significant economic value. Although globally the time to complete economic depletion is large, the remaining value of economically recoverable groundwater shows a sharp decline over the coming decades. Our results provide a global time horizon for transformation to a more sustainable use of groundwater resources.

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