



## **The shadow price of fossil groundwater**

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The expansion of irrigated agriculture into areas with limited precipitation and surface water during the growing season has greatly increased the use of fossil groundwater (Wada et al., 2012). As a result, the depletion rate of fossil groundwater resources has shown an increasing rate during the last decades (Wada et al, 2010; Konikow, 2011; Wada et al., 2012; De Graaf et al. 2015; Ritchy et al., 2015). Although water pricing has been used extensively to stimulate efficient application of water to create maximum value (e.g. Medellín-Azuara et al., 2012; Rinaudo et al., 2012; Dinar et al., 2015), it does not preclude the use of non-renewable water resources. Here, we use a global hydrological model and historical crop production and price data to assess the shadow price of non-renewable or fossil groundwater applied to major crops in countries that use large quantities of fossil groundwater. Our results show that shadow prices for many crops are very low, indicating economically inefficient or even wasteful use of fossil groundwater resources. Using India as an example, we show that small changes in the crop mix could lead to large reductions in fossil groundwater use or alternatively, create additional financial means to invest in water saving technologies. Our study thus provides a hydro-economic basis to further the sustainable use of finite groundwater resources.