

EGU24-1816, updated on 19 May 2024

<https://doi.org/10.5194/egusphere-egu24-1816>

EGU General Assembly 2024

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Do tragedies of the commons contribute to the premature depletion of transboundary aquifers?

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Many of the 500+ internationally shared aquifers are rapidly depleting but poorly regulated with less than 10 international treaties focusing on shared groundwater. The common-pool nature of groundwater has long been identified as an important complicating factor. Pumping by any user increases pumping costs for all users by decreasing groundwater levels throughout the aquifer. This creates a tragedy of the commons, where all users have incentives to over-pump, thus prematurely depleting the resource. While this mechanism is well documented in domestic aquifers, large geographic distances between demand centers and heterogeneous economic and hydrogeologic conditions on either side of the border affects incentives to over-pump in transboundary aquifers. Whether -- and where -- common-pool incentives might lead to the premature depletion of transboundary aquifers remain poorly understood.

We fill these gaps by combining remote sensing and large scale hydrologic and agricultural modeling datasets in a global analysis of known transboundary aquifers. We first evaluate the proportion of global irrigation water demand that is sourced from transboundary aquifers, and the proportion of these withdrawals associated with unsustainable pumping. We then identify regions, where unsustainable irrigation arises close enough to a political border to affect transboundary groundwater levels and pumping costs. Finally, we leverage recent theoretical results to identify the subset of these regions where heterogeneous economic conditions on either side of the border creates substantial incentives to over-pump. Results provide key insights on the role played by common-pool overdraft incentives on the premature depletion of transboundary aquifers and identify hotspots where international groundwater regulation is most urgently needed.