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## Irrigation indirectly sustains rainfed crops in India and China through atmospheric recycling

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India and China host ~45% of the world's irrigated area, with irrigation accounting for 65–75% of the total water usage in these countries. The impact of intense irrigation on regional precipitation and even monsoonal dynamics is well acknowledged. However, the degree to which recycled irrigation water helps sustain rainfed crops, acting as an indirect source of water supply, remains unknown. This is especially important in India and China, where irrigated crops are grown in close proximity to rainfed ones. In this study, we quantify (a) the contribution of atmospherically recycled irrigation water to rainfall over rainfed regions, and (b) the importance of this contribution for satisfying the water demand of rainfed crops.

The methodology involves 20 years of global Lagrangian atmospheric model (FLEXPART) simulations tracking 10 million air parcels. These simulations were constrained by ERA5 reanalysis data and satellite-based terrestrial evaporation data from GLEAM4. Evaporation from irrigated and rainfed crops was computed using the FAO-Penman method. Air parcels that contribute to rainfall over rainfed crops were tracked backward in time for a period of 15 days. Subsequently, the contribution of evaporation from irrigated crops to rainfall over rainfed crop regions was computed.

Preliminary results show that, on average, ~15% of the rainfall over rainfed crops can be attributed to irrigation evaporation in upwind regions. The irrigation contribution to rainfall reaches as high as 50% in parts of the intensively irrigated Indo-Gangetic plain. Stark differences are observed between India and China, with irrigation contribution to rainfall over rainfed regions being substantially higher in India. Removal of this irrigation contribution would result in an average increase in evaporative stress of ~10%, with a maximum increase of 25%. With irrigation projected to expand to sustain crop production in a changing climate, it is likely to play an indirect yet significant role in supporting rainfed crops as well. Our results highlight the relevance of considering recycled irrigation as an essential source of water supply for rainfed crops.

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