Simulating soil moisture dynamics in the overexploited Indo Gangetic alluvium area in Central Punjab, India

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In arid and semiarid areas, accurate estimation of groundwater recharge is essential for sustainable management of water resources. In the Indo-Gangetic alluvial plains of Punjab region, India, groundwater is the main source of irrigation. Insufficient rainfall associated with intensive cultivation in the alluvial plains of this region has resulted in the degradation of groundwater regime both in quality and quantity. In view of moderate to low rainfall in the region, return flow from applied irrigation is likely to be a major source of groundwater recharge. In this study, we estimated the contribution of irrigation return flow on groundwater recharge in paddy fields by modeling water flow in the vadose zone using the HYDRUS-1D software and compared the results with the estimated recharge on a rainfed site by the injection of tritium.

Three representative sites in the alluvial plain were selected, one rainfed site and two fields under rice cultivation. For each site, soil moisture was monitored in situ by vertical neutron probe surveys. The hydraulic properties of the soils at the site were determined using in situ experiments and laboratory measurements. Tritium was injected at selected sites and groundwater recharge was estimated from the depth profile of tritium.

At each site, the 1-dimensional flow model was calibrated using climate, soil hydraulic property, and groundwater levels data, and was validated using the measured soil moisture content. Good agreement was achieved between the HYDRUS-1D simulations and field measurements of moisture content for both rainfed and paddy cultivated sites. Based on the calculated results, unsaturated moisture influx was estimated.

Keywords: Irrigation return flow, Soil moisture dynamics, Modeling

