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Assessing Hydrological Impacts of Wastewater Irrigation on Groundwater: A Case Study from Hyderabad, India

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Abstract

In the lands adjacent to the Musi-River, downstream of the city of Hyderabad, India, waste-water reuse for irrigation of various crops is common. Studies have shown that poor water quality has been a driver for crop selection in this area and this study describes the methodological approach used to understand the hydrological impacts and processes on groundwater associated with wastewater irrigation of a variety of crop types.

A watershed (2.8 km^2) comprising wastewater- and groundwater-irrigated agriculture was selected based on land-use maps and observations. The watershed was delineated using DEM and GIS data. A crop model (BUDGET) was combined with field measurements, base-line data on irrigation practices, and land use patterns, to assess the overall water balance. The suitability of the method was validated with questionnaire survey results and available secondary data. 4 Piezometers were installed to assess and monitor groundwater levels and quality.

Major crops irrigated with wastewater were found to be paragrass (20 ha), paddy (8 ha) and leafy vegetables (1.8 ha). Groundwater was used for paddy (6 ha) and leafy vegetables (1.6 ha). Discharge from 17 wells or pumps was measured. Base-line data for 23 distinct fields were collected.

The annual irrigation flux was calculated to be 1.6×10^6 m^3 and comprised of 77 % wastewater, 23 % groundwater. Return-flows from irrigation were 0.44×10^6 m^3 and made up of 60 % wastewater and 40 % groundwater.

There is neither a difference in the application rate of irrigation for paddy and Paragrass (n=12, $p = 0.12$) (Mann-Whitney-U-Test) nor in irrigation practices between waste-water and groundwater users (n=10, $p = 0.10$). The accuracy of survey results and crop modelling is dependant on crop type ($p = 0.043$, n=9) and season ($p = 0.04$, n=9). Piezometric measurements support differences in return-flows as modeled.

Groundwater development is low, however, the irrigation return flows constitute an important source of ground water recharge. Findings indicate further potential for groundwater-based irrigation in wastewater irrigated areas maximmizing the area under cultivation and benefits from the available water resources. These preliminary findings are being verified by more in-depth studies that are presently underway and will finally allow the assessment different land and water use scenarios with regards to groundwater quality and quantity.

Keywords: Crop modelling, irrigation management, irrigation return-flows, waste water irrigation

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