

Inverse modelling approach in a spatial environment to study the dynamics of groundwater flow in the main aquifer of the Doon Valley, India

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Abstract Study of the dynamics of groundwater flow where the maximum water demands are met from groundwater supplies is a challenging task for water resource planners. Dehradun city, India, is almost entirely dependent on groundwater resources for its domestic and irrigation needs. Irrigation water is being tapped from the downstream baseflows of the main aquifer. High rates of pumping in the main aquifer some times create shortages in the downstream baseflows. In this study special emphasis has been given to demonstrating the inverse groundwater modelling technique in a spatial environment to study the dynamics of groundwater flow in the areas where sufficient field data are not available. Spatio-temporal variabilities of groundwater recharge flux, aquifer parameters, and groundwater flow dynamics in the main aquifer of the Doon Valley in India have been studied based on integration of various data sets and methods within the numerical groundwater model. The data sets and methods include satellite remote sensing solution of the mass water balance, GIS modelling, baseflow measurements, depth to groundwater table, lithological information, pumping data, and river flow simulation. Groundwater recharge has been estimated using a distributed hydrological model and fed into the groundwater model as an input. Average recharge rate in the study area varies from 1.86 to 6.77 mm/day during the monsoon period. Spatial variabilities of hydraulic conductivities have been assessed using an inverse modelling technique. The water budget of the aquifer system for the two stress periods (wet and dry) were computed in the calibration process. Model results are validated with the field observations. Computed and observed depth to groundwater table are found to have very good correlation. The calibrated model can be used to study the dynamics of groundwater flow in the region. As the drinking water and irrigation requirements in the study area are met from the groundwater resources, the optimum pumping rates can be decided by restricting the pumping to the productive aquifer with a minimum drawdown of the water table and minimal influence on the downstream irrigation canals.

Key words groundwater modelling; satellite remote sensing; geographic information system; groundwater recharge; groundwater budget