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Integrated Catchments Approaches For Characterization Of Groundwater Renewability With Changing Landuse In The Indo-Gangetic Plain

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Over the past few decades, rapid growth in population, urbanization and competition for economic development has brought in significant changes in water use in the Indo-Gangetic Plains. Due to zonal disparity in surface water supply, groundwater remains the only option to meet the ever-increasing demand and assessing groundwater renewability, in relation to changes in landuse, is the prime issue of concern. Integrated Catchments Approach relies on an understanding of these intricate and complex linkages among groundwater, biophysical and socio-economic environment, at sub-catchment, catchment and regional scales. Efforts have been made to develop indicators for these linkages.

Extensive reconnaissance survey, integrated with Tritium tracing of soil moisture transport, variations in the isotopes (^{2}H, ^{18}O) and hydro-chemical constituents in rainfall and groundwater, provided a detailed representation of groundwater renewability. Continental enrichment in the ^{18}O isotope signatures of rainfall from Bay of Bengal side to the northwest, associated with enriched ^{18}O in rainfall deficient years and depleted ^{18}O in heavy rainfall, have been superimposed on RS/GIS maps on landuse. These reflect groundwater recharge, with a wide range of lateral and vertical variations in the $_{18}O$ signatures of groundwater, suggesting occurrence of an inhomogeneous and stratified system. Assessed recharge varies widely (<1-60%) in space and time, with most parts receiving less than 5-10% recharge. Average recharge is 18% in Punjab, 15% in Haryana, 20% in western Uttar Pradesh. In many areas, lateral flow from surrounding areas, canal/river seepage, and localized infiltration of isotopically enriched and highly degraded surface run-off through stagnant water pools, contribute to the recharge. Fresh groundwater reserve has become more vulnerable to depletion due to recharge carrying contaminants from agricultural land and indiscriminately disposed waste dumps, and intermixing with polluted water along specific flow-pathways. Groundwater renewal takes place in pulses, depending on recharge characteristics, water table fluctuations, and soil physical properties. More research is needed on isotopic responses in groundwater, under natural and exploited conditions, to regularly update aquifer vulnerability maps, and delineate protection zones around major catchment areas. Sub-catchment specific parameters should be integrated with regional information for evolving a responsible policy for planned groundwater abstraction within these protection zones, based on new guidelines on short-term and long-term management and socio-economic objectives.

Keywords: Isotopes; Integrated Catchment; Groundwater; Landuse, Indo-Gangetic Plain.