

# Groundwater Resource Assessment using Geophysical Investigation and Hydrological Modelling in Vindhyan-Ganga Sedimentary Formations

\*Manik Goel<sup>1</sup>, Pankaj Kumar Gupta<sup>2</sup>, Brijesh K yadav<sup>1</sup>

1. Indian Institute of Technology Roorkee, Roorkee, India, 2. University of Waterloo, Waterloo, ON, Canada

Owing to the accessibility and quality of groundwater, it is a crucial component of water resources for the living being. Despite the immense effort in the field of groundwater management, there is an annual depletion of 19.2 Gigatons in northern India itself. In this study, stress on the existing groundwater resources for meeting the groundwater demand is assessed along with its complete quality assessment over the Indo-Gangetic plain in the Vindhyan-Ganga Sedimentary formations. An extensive field study is carried performing 12 Vertical Electrical Soundings (VES) for geophysical investigation and two aquifer tests for characterization of the hydraulic properties of the study area. The survey locations are identified based on the topography and underlain geology of the area. The aquifer systems in the area are classified based on the input from the aquifer test and geophysical investigation surveys conducted. The stages of groundwater development is calculated from the annual groundwater use and recharge computed by analyzing the 10-year groundwater table fluctuation data along with other critical meteorological parameters for the area. The total rechargeable area is calculated by considering the landscape slope determined by the Digital Elevation Model (DEM) prepared from Landsat 8 OLI data. In addition to the in-situ measurements of various physical quality parameters, 10 groundwater samples are analyzed using AAS (Atomic Absorption Spectroscopy) for heavy metals and other major ions. Correlation between different water quality parameters is established using Principal Component Analysis (PCA). Findings of VES are used to simulate the contaminant plume transport through the vadose zone using a hydrological model. The classical advection-dispersion equation, coupled with the Richards' equation, is numerically simulated at different locations for assessing the intrinsic vulnerability of the region. The study concludes that total annual groundwater extraction is 13.89 MCM, with the annual groundwater recharge of 51.96 MCM. The majority of sites are having a concentration of Cd, Pb, As, and Fe more than their recommended WHO limits. Several patches of high vulnerable zones are found out in the south-eastern and western parts of the study area. The findings of this study will assist in decision related to the planning of industrial locations and developing groundwater remediation strategies that would ultimately lead to the improvement in living standards of the people and enhanced health safety of the community by collective efforts of local administration.

Keywords: Groundwater estimation, Vindhyan-Ganga Sedimentary Formations, Vertical Electrical Sounding, Atomic Absorption Spectroscopy, Hydrological Modelling