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Hydrological Challenges and Solutions in the Nashik Region: A Multi Tracer and Geochemistry Approach to Groundwater Management

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Abstract : The degradation of groundwater resources, attributed to factors such as excessive abstraction and contamination, has emerged as a global concern. This study delves into the stable isotopes of water) in a hard-rock aquifer situated in the Upper Godavari watershed, an agriculturally rich region in India underlain by Basalt. The higher groundwater draft (> 90%) poses significant risks; comprehending groundwater sources, flow patterns, and their environmental impacts is pivotal for researchers and water managers. The region has faced five droughts in the past 20 years; four are categorized as medium. The recharge rates are variable and show a very minimum contribution to groundwater. The rainfall pattern shows vast variability, with the region receiving seasonal monsoon rainfall for just four months and the rest of the year experiencing minimal rainfall. This research closely monitored monsoon precipitation inputs and examined spatial and temporal fluctuations in δ18O and δ2H in both groundwater and precipitation. By discerning individual recharge events during monsoons, it became possible to identify periods when evaporation led to groundwater quality deterioration, characterized by elevated salinity and stable isotope values in the return flow. The locally derived meteoric water line (LMWL) ($\delta 2H = 6.72 * \delta 18O + 1.53$, $r^2 = 0.6$) provided valuable insights into the groundwater system. The leftward shift of the Nashik LMWL in relation to the GMWL and LMWL indicated groundwater evaporation (-33 ‰), supported by spatial variations in electrical conductivity (EC) data. Groundwater in the eastern and northern watershed areas exhibited higher salinity > 3000uS/cm, expanding > 40% of the area compared to the western and southern regions due to geological disparities (alluvium vs basalt). The findings emphasize meteoric precipitation as the primary groundwater source in the watershed. However, spatial variations in isotope values and chemical constituents indicate other contributing factors, including evaporation, groundwater source type, and natural or anthropogenic (specifically agricultural and industrial) contaminants. Therefore, the study recommends focused hydro geochemistry and isotope analysis in areas with strong agricultural and industrial influence for the development of holistic groundwater management plans for protecting the groundwater aquifers' quantity and quality.

Keywords : groundwater quality, stable isotopes, salinity, groundwater management, hard-rock aquifer
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