ABSTRACT

Considering the growing water scarcity and ever-increasing demand for groundwater in India, the present study was conceived to carry out comprehensive and integrated investigation of groundwater in Tiruchirappalli district of Tamil Nadu, South India. This study focuses on the trend analysis of rainfall, groundwater-level and groundwater-quality time series, geospatial modeling for groundwater potential estimation, in-depth groundwater-quality evaluation including geostatistical modeling, assessment of aquifer vulnerability and risk to contamination, and the optimization of groundwater-quality monitoring network.

The long-term trend analysis of rainfall and groundwater level revealed an increasing trend in the northern part of the study area at the rate of 0.7–5 mm/year and 0.007–0.2 m/year, respectively. On the other hand, the rainfall and groundwater level have a decreasing trend (3–11 mm/year and 0.01–0.7 m/year, respectively) in the southern part of the study area. Almost all the groundwater-quality parameters (except Calcium) have an increasing trend in some part or other, with Calcium showing a decreasing trend (0.7–4 mg/L per year) in most parts of the study area. The 'Innovative Trend Test' was found more sensitive and robust than the conventional Mann-Kendall and Linear Regression tests for analyzing trend. For identifying groundwater prospect zones, the performance of the Analytic Hierarchy Process (AHP) technique was found much superior (prediction accuracy = 87%) compared to the Catastrophe and Entropy techniques. Based on the groundwater potential map yielded by the AHP technique, 'Very good' and 'Good' groundwater prospect zones cover about 35% of the study area, while the 'Moderate' zone covers about 31%, and the 'Poor' and 'Very poor' zones together occupies 34% of the study area. The results of geostatistical modeling revealed that the 'Simple' kriging along with 'Spherical' Semi-variogram model is the best for mapping the spatial distribution of groundwater quality over the study area. The groundwater quality of the unconfined aquifer is relatively 'Low' in the eastern and southern portions of the study area. The AHP method of groundwater-quality index (GWQI) was found more accurate than the commonly used method of GWQI. Moreover, the modified DRASTIC-P model (called "DRASTIC-P-LDLU") model has the highest accuracy in predicting aquifer vulnerability. The assessment of risk to groundwater contamination revealed that 'Intermediate' (45% of the area), 'Major' (37%), 'Catastrophic' (10%) and 'Minor' (8%) risk zones in the study area. The network of 66 observation wells is adequate and cost-effective for the efficient monitoring of groundwater quality in the study area. Finally, it is concluded that the scientific framework for the integrated assessment of groundwater quantity and quality demonstrated in this study can be replicated to other parts of Indian subcontinent as well as to other regions of the world.

Keywords: *Groundwater prospect, Geochemical characterization, Geostatistical modeling, Aquifer vulnerability, Risk assessment, Monitoring network optimization, Groundwater quality, Trend analysis, Hard-rock aquifer systems.*