



Geostatistical modelling of groundwater quality for irrigation: a case study of Mayiladuthurai district, Tamil Nadu

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Abstract

The present work was carried out in the district of Mayiladuthurai, Tamil Nadu, India, which forms the delta part of the river Cauvery. Groundwater quality parameters of pre-monsoon and post-monsoon seasons of nine consecutive years were analysed to evaluate the status of groundwater quality for irrigation. Water quality data were initially subjected to cation–anion balance error analysis. Cluster analysis was then performed on data sets using SPSS software from which three clusters were identified based on the level of water contamination. Principal component analysis of water quality showed that factors such as seawater intrusion, anthropogenic activity and natural geology lead to deterioration of water quality in that region. Using Schoeller diagram, major ions in the water were found to be Na^+ , HCO_3^- , Cl^- , Mg^{2+} and SO_4^{2-} . From the Piper diagram, water type was predicted to be a mixed water type indicating that freshening of aquifer is essential. Weighted overlay analysis was performed using seven selective parameters that affected irrigation water quality using QGIS; it was found that groundwater quality falls under suitable zone in 53% of agricultural area and moderately suitable zone in 47% of agricultural area. Major factor contributing to decline in water quality was salinity, followed by magnesium hazard, as inferred from sensitivity analysis performed on the different water quality parameters.

Keywords Cluster analysis · Principal component analysis · GIS · Schoeller diagram · Piper trilinear · Mayiladuthurai

Introduction

Groundwater usage has phenomenally increased during past five decades, especially in arid and semi-arid regions of southern and western India (CGIAR 2017; Rajasekhar et al. 2019). In particular, in the state of Tamil Nadu, there has been a tremendous increase in the usage of groundwater (Chinnasamy and Agoramoorthy 2015; Kuttimani et al. 2017). The Cauvery delta region depends upon groundwater to be the major source for agricultural purposes as the major river Cauvery is non-perennial (Vetrimurugan et al. 2013). Also, the groundwater in that region will be preserved only if there is continuous flow of water in the river.

Investigation of hydrochemical characteristics of groundwater, geochemical processes, and its evolution under natural water circulation process help in effective utilization and protection of this valuable resource (Kuttimani et al. 2017; Ravikumar and Somashekar 2017). Statistical techniques such as correlation, factor analysis, cluster analysis, and dendrogram are useful in understanding the different groundwater quality variables and their sources (Chen et al. 2018; Gaikwad et al. 2020). This paper focuses on statistical analysis of ground water quality, generating irrigation water quality map and identification of possible causes for the decrease in ground water quality of Mayiladuthurai District where agriculture is the major occupation.

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Study area

Mayiladuthurai district is bound by Cuddalore district in the north, Thanjavur district in the west, Thiruvavur in the south and Karaikal district in the east by Bay of Bengal. The district lies between 10° 57' 00" N and 11° 26' 00" N latitude, 79° 31' 00" E to 79° 55' 00" E longitude and has an aerial