Identifying Major Factors Controlling Groundwater Quality in Semiarid Area Using Advanced Statistical Techniques

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Abstract There are many factors controlling groundwater pollution and vulnerability. However, the factors’ weights are still not reasonably investigated. In order to assess groundwater quality and the controlling factors in semiarid region, 178 groundwater samples were collected and analyzed for salinity and nitrate content. New statistical techniques of prediction profiler and hierarchical cluster combined with geographic information systems (GIS) were used to assess the groundwater quality based on three categorical controlling factors; landuse/land cover (LULC), soil texture, and aquifer type. It is hypothesized these factors are controlling groundwater quality with various weights. Groundwater salinity across the study area varied from 327.0 to 9110.0 mg/L, while nitrate ranged from 0.2 mg/L to 339.6 mg/L. Both prediction profiler and cluster analyses provided excellent tools for quantifying the pollution magnitudes, weighing the controlling factors, and visualizing the pollution zones. Prediction profiler showed high capability to predict groundwater pollution (\(P<0.0001\) and 0.0038 for salinity and nitrate, respectively) where LULC was the most effective factor, followed by aquifer type and soil texture class. According to desirability function analysis, maximum salinity and nitrate pollution was predicted to be associated with irrigated agriculture lands at shallow aquifers with silty clay loam soils. Hierarchical cluster analysis combined with GIS mapping was able to group the controlling factors into six vulnerability zones. The generated groundwater spatial pollution map allowed for potential pollution sources identification (e.g. fertilizer use, treated waste water, overdrafting). This paper also offers detailed mapping for decision makers to allow further ecosystem restoration and rehabilitation planning.

Keywords Groundwater · Nitrate · Salinity · Landuse · Soil · Geostatistical

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