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Analyzing and Classifying Groundwater Quality in the Western Tehran Using Multi-Criteria Decision Models

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Summary

In arid and semi-arid environments, water resource management, particularly groundwater management, is critical. Numerous natural and human factors have resulted in severe circumstances, pollution, and diminishing groundwater levels throughout the country, especially in Tehran province, in recent decades. Prior to the 1970s, studies on water quality were mostly concerned with its surface aspects; however, with the expansion of sciences like water chemistry, geology, and others, the study on groundwater quality has progressed further in the twenty-first century. Univariate or multivariate statistical approaches are one of the strategies used to examine spatial and temporal changes in groundwater quality and quantity. The significance of water resources in Iran is heightened by its location in the desert belt, particularly in dry and interior areas. Consequently, as one of the marginal parts of the inland basin, the present research used multivariate statistical analysis to analyze and classify geomorphic landforms and their influence on groundwater quality in the west of Tehran province. For this objective, statistical techniques were used to generate temporal and geographic fluctuation statistics for 13 water quality measures for around 50 drinking and non-drinking water wells during 9 years. The concentrations of chloride, sulfate, bicarbonate, electrical conductivity, total soluble solids, sodium, and fluorine in high and low irrigation periods were significantly correlated to the morphometric properties of basins and alluvial fans in the region, according to the findings.

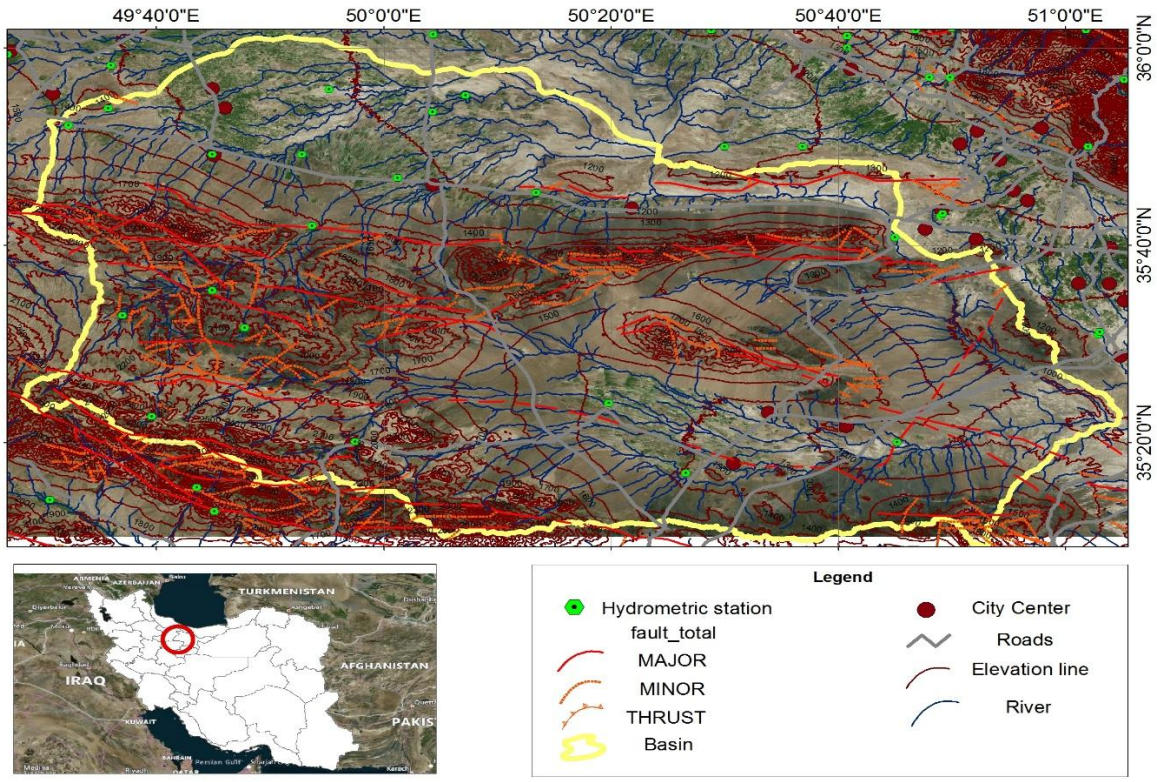

Figure number 1: Map of the study area west of Tehran, Iran

Theory / Method / Workflow

The research region extends from 40 kilometers west of Tehran province to 80 kilometers east of Qazvin city. Parts of the provinces of Tehran, Markazi, Qazvin, and Alborz make up this area. Data on 13 quality parameters from 50 drinking water wells were chosen for the present study, and drinking water wells in western Tehran province were categorized into three quality classes based on hierarchical cluster analysis. In addition, factor analysis based on the principal component analysis approach was utilized to determine the most essential water quality characteristics in each homogenous zone. To evaluate the suitability or merit of the data, the KMO adequacy and Bartlett sphericity tests were applied before the factor analysis. The number of elements or key components of groundwater quality was initially established after analyzing the data's adequacy and sphericity. The primary component in each qualitative cluster of data with several eigenvalues was selected for this purpose. In addition, a graph was constructed to properly recognize the number of major components based on the relationship between factors and their values, with the number of main components being calculated after breaking the graph's axis. The findings of cluster analysis, factor analysis, and one-way analysis of variance were shown using SPSS software, and the research region was zoned after doing the statistical analysis using the interpolation method and Arc Gis software. The soil structure was also analyzed after recording the location of each well using GPS, as well as the land-use status and geology, and all data were compared with the morphometric properties of landforms derived from satellite images.

Results, Observations, Conclusions

Drinking water wells in the western Tehran province can be categorized into three quality groups, according to cluster analysis done on groundwater quality data in this region. As a result, the significance of the data was measured for each cluster, and the qualitative value of each cluster was calculated accordingly. Consequently, it was discovered that travelling from the first to the third cluster greatly increases the concentration of all qualitative measures apart from pH, which is directly related to each alluvial fan's morphometric properties. The findings revealed that water quality in the third cluster (central regions) is less satisfactory and that in each qualitative cluster, three geomorphic factors as the most essential factors of water quality change with a total variance of 92, 83, and 88 in the homogeneous clusters 2, 1 and 3 rationalize the changes in water quality. The parameters determining variations in water quality are generally related to lithological, anthropogenic features, alluvial fan area, cone volume, drainage network density, and so on, as shown by factor analysis.

Novel/Additive Information

In this research, several fixed models have been presented as a solution to determine the most suitable place in terms of groundwater quality in areas with dry climate and low water. Based on this, by geomorphic factors, 10 places with suitable water quality for exploiting wells for different uses (drinking, industry, agriculture) in the western region of Tehran have been presented.

Acknowledgements

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