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Assessing the Impacts of Land use and Geology on Groundwater Quality Using Multivariate Statistical Models and Geostatistical Analyses Case Study: Part of the Hable-Rood River Basin

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1- Introduction

Underground water is one of the most important water resources that plays an important role in providing water for agricultural and drinking activities in arid and semi-arid regions (Usamah and Ahmad, 2018, Wu et al., 2019, Kumar et al., 2019). Awareness of the quality of water resources is one of the most important requirements in managing, planning, and developing, protecting, and controlling water resources. Using multivariate statistical techniques helps researchers identify the most important factors affecting the quality of water systems and is a valuable tool for water resources management (Pasandidehfard et al., 2019). On the other hand, geostatistical methods are also capable of zoning water quality at the watershed level and can play an important role in completing the assessment of water quality (Ahmadi et al., 2019). The aim of this study is to evaluate the quality of groundwater used for drinking and farming in Hable-Rood Basin, analyze and interpret the quality of these resources using ArcGIS, and perform statistical tests to determine the role of land use and geology formations in water quality.

2-Methodology

To do this research, 132 water sources including wells, springs, and Qanats were used during the statistical period of 2008-2018. The watershed can be divided into fifteen main categories in terms of geology. Hable-Rood watershed has 11 main land uses, which has the largest area of the watershed for pasture and the smallest area of the dams. The main components were analyzed (factor analysis) to understand the most important parameters affecting the water quality. This method weighs the components and expresses a special value for each of them (Finkler et al., 2016). Factor analysis has three stages of producing a correlation matrix from all variables (Pearson correlation method), extracting the main factors, and interpreting the results. Duncan's test was also used to check the significance level of parameters among land uses and the type of formations.

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Geostatistical methods were used for zoning water quality for drinking and farming purposes in the GIS. The spatial relationship of a random variable in the geostatistics was determined by the semivariogram (software GS +). The root mean square error (RMSE) method was used to assess the geostatistical methods and select the best method. It should be noted that the Schoeller diagram and Wilcox diagram were used for the drinking water zoning and agricultural water quality zoning, respectively.

3-Results and Discussion

The results showed that the Cl, EC, TDS, Na, Ca, TH, and SO4 vary significantly in different land uses. The highest average was related to industrial areas within the watershed due to the release of industrial materials and the spread and diffusion of groundwater pollution. Also, the parameters of Cl, EC, TDS, TH, and SO4 differed significantly in varied formations. The trend of water quality changes shows the water quality impact of land use, and water quality has decreased sharply in the industrial area, low-yielding land, saline lands, agriculture, and residential areas. The EC parameter showed the highest correlation with TDS at 5% significance level, which is due to a high correlation with the effect of increasing EC on TDS. The pH parameter did not correlate with the other parameters. The factor analysis on the basis of water quality characteristics showed that 88.16% of the water quality variations among land uses were controlled by a single factor (TDS with a weight of 0.99). The factor analysis on the basis of water quality characteristics showed that 91.59% of water quality changes in the formations were determined by two factors (the first and the second factors with weight loads of 0.95 and 0.95 belonged to the TDS and EC parameters, respectively), and the variance percentages of each of factors 1 and 2 were 77.29 and 14.3%, respectively.

4- Conclusion

In this research, the effects of geology and land use on groundwater quality were evaluated using multivariate statistical methods and geostatistical methods in ArcGIS. It was determined that some of the groundwater quality parameters were affected by land use and some of the other parameters were under the influence of the geology in the watershed. In general, however, it can be stated that in the first priority, the land use factor and human activities, and in the second priority, the geological factor affecting groundwater quality have the most significant effects. In the formation part of the geology, the dissolution of calcareous and dolomite formations, the chemical processes of salt dissolution, and evaporative formations are the main factors controlling

groundwater chemistry in the region. Based on the results, multivariate statistical techniques and geostatistical methods have the ability to recognize factors affecting groundwater quality and the zoning of water quality for different uses and are, therefore, suggested for similar research.

Keywords: Water Quality, Geology, Factor Analysis, Land Use, Hable-Rood Basin, Semnan Province.

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