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Spatial Modelling of Water Quality Parameters Based on Geological Formations

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1-Introduction

Iran is one of the arid and semi-arid regions of the world with an average annual rainfall of 240 mm. The country is such arid that the average annual rainfall is less than 130 mm (Jafari and Tavili, 2013:149) in 65% of its regions; therefore, it has been facing a water shortage for a long time. Thus, due to the limitation of surface and groundwater resources in the country, particularly arid and semi-arid regions, it is necessary to identify the factors affecting the quality of water resources for protection to reduce the vulnerability of these resources. Among the various factors that cause water quality degradation, the type and material of rocks or geology are crucial in changing groundwater quality (Jehbez, 1994: 1). Accordingly, in this research, the efficiency of the GWR model was measured to determine the sources of water pollution by selecting the Izdakhvat basin as a sample of inland Zagros basin that has good but saline water resources; these areas received the most impact from a particular formation.

2-Methodology

Izadkhaast catchment, code 2647, is one of the closed basins of the Mond River catchment located in Fars province. The area of this basin is 1371.3 square kilometers the height and plain of which is respectively, 879.6 and 491.7 square kilometers of the total area of the basin. The maximum and minimum height in the basin are, respectively, 2182 and 1029 meters.

In this study, the geographical weight regression (GWR) model has been used to investigate the relationship between geological formations, water quality parameters, and spatial modeling. This method is based on processing the hydrological information (water quality data) and geology using the GIS technique. The required parameters were considered as model inputs; moreover, geological map 1:100000 sheets of ZarrinDasht,

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Jahrom, and Bezenjan Geological Survey was used to extract geological data as well as the obtained data of observation wells, Fars Regional Water Joint Stock Organization. As the water quality data is related to 14 observation wells in 2010 (due to the more complete data), which is among 16 quality parameter data, after examining the relationship between the parameters together, those who had the highest correlation and significant relationship with the EC parameter, were selected for statistical analysis. They were also selected to quantify the geological formations. For each well, Polygon Thyssen was drawn. The area of the formations in each of the polygons was extracted and added as an independent variable to the descriptive table of the desired file shape, and then they were analyzed for modeling in ARC GIS environments in the following steps:

1- First, to enter the best model for execution in the GWR method, independent variables related to trial and error in the OLS method were analyzed so that the best model with a significant relationship between variables, i.e., P value less than 0.05, R^2 more and lower AICc coefficient was selected.

2- After selecting the best model, the Moran index was used to evaluate the spatial autocorrelation of the OLS model residues. This index measures the degree of clustering or dispersion of standard residues. The residues were used to test the reliability of the model in predicting local conditions by experimenting with spatial correlation.

3- Finally, the variables selected from the OLS model were entered into the GWR model to achieve higher precision in spatial relationship analysis. The GWR recorded local changes by weighing more close observations than farther ones (Pratt and Chang, 2012:52).

GWR outputs include local residuals as well as the results of R^2 or the coefficient of determination, where R^2 is the standard for determining the performance of multivariate regression models.

3-Results and Discussion

According to the results of the OLS model, the sign of beta coefficients for Aghajari Formation (MPLa), alluvial deposits Qc, and QScg were negative. They indicated their inverse relationship with qualitative parameters. However, most of the qualitative parameters were directly and remarkably related to seasonal lakes, salt dome (Pc CHD), Champe member (Mchm), and mole member (Mmo) in the area, which indicated surface erosion and leaching of salt and gypsum from the surface by surface currents and their transfer to the low points of the basin, i.e., seasonal lakes. These formations

have also shown themselves as Mahour and Badland hills due to their instability against further erosion.

After selecting the best models, all the standard residues of the selected OLS models were examined to ensure the normal distribution of the data and to evaluate the spatial autocorrelation using the Moran index. All residuals in the selected OLS models were within the standard range, indicating a normal data distribution.

Finally, to better understand the correlation between geological formations and water quality parameters in different parts of the basin, the variables selected from the OLS model were entered into the GWR model. The results of this model have been presented as spatial model maps for each parameter based on the results of coefficients of determination (R2).

According to the maps, the highest correlation was related to the potassium parameter, and the lowest value was related to the chlorine parameter, while the other parameters also showed a very high correlation with independent variables. In most qualitative parameters such as sodium, potassium, chlorine, and electrical conductivity, the highest correlation was related to the west of the basin, which indicated the high impact of the salt diaper in the west of the basin on water resources and wells that are close to the points of lower quality than wells in higher and farther points. Low resistance and erosion of evaporative sediments were also contributed to this issue, as water sources in contact with evaporative sediments may contain large amounts of potassium, sodium, chlorine, and sulfate in an insoluble form.

4-Conclusions

The results of this study revealed that this model with high spatial variability determined the impact of different formations on water resources in various places and critical areas with the most negative effects. This significant model was a simple and enriched method for managing and planning in basins that do not have enough data.

The results of this model also showed that evaporative sediments in the basin, including the salt dome in the west of the basin, were the most important formations of water quality degradation. Also, the significant relationship between water quality parameters and low points of the basin or seasonal lakes indicated the leaching and transport of these sediments to these points by running water. These formations have shown the faces of mounds and hills in the region due to their weakness.

Keywords: Water Quality, Geology, GWR, Izadkhast basin

5-References

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