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Assessment of Groundwater Vulnerability to Pollution Using DRASTIC Model and Fuzzy Logic Case Study: Tabriz Plain

Maryam Bayati Khatibi [*1], Faeze Rostami [2], Khalil Valizadeh Kamran [3]

1-Professor of Geomorphology, Department planning and environmental science, University of Tabriz, Tabriz, Iran
2-M.Sc. Gis and RS Student, Department planning and environmental science, University of Tabriz,Tabriz, Iran
3-Assosiate professor of Gis and RS, Department planning and environmental science, University of Tabriz, Tabriz, Iran

1-Introduction

Groundwater aquifers are considered one of the most important freshwater sources globally. Urbanization, industrialization, improper use of fertilizers and pesticides in agriculture, illegal sewage disposal, and population growth are the most important problematic factors for groundwater. Protecting groundwater quality, especially in growing urban areas, is an important issue because, on the one hand, it is the main source of water for drinking and industrial activities, and on the other hand, the cost of reducing groundwater pollutants is high. It takes much time. Therefore, using the most appropriate hydrogeological systems and models is necessary to protect groundwater quality. Groundwater aquifer vulnerability assessment can be used as a preventive action to protect the aquifer against contamination. Tabriz plain is one of the large plains in the northwest of the country, which has been feeding large aquifers for a long time with its large aquifers, and its vast fields have fed many gardens of this aquifer throughout history. From groundwater and pollution of aquifers, it is necessary to study the vulnerable areas of this plain. Since the extent of this vulnerability depends on climatic conditions, soil characteristics, topography, hydrogeological conditions, and countless other factors, these factors have been resorted to in the study of aquifer vulnerability. And water table (D), net nutrition (R), aquifer environment (A), soil type (S), topography (T), the effect of the unsaturated zone (I), and hydraulic conductivity of the aquifer (C), all of which in the studies Is taken into consideration

2-Methodology

In this research, the Darstik method has been used to investigate the vulnerability of the aquifers of Tabriz plain. In this method, a ranking of seven parameters has been used to prepare the vulnerability map. To use the Drastik method, various information sources,

* Corresponding Author, **E-mail**:m_bayati@tabrizu.ac.ir

including Meteorological statistics, information on drilling logs of piezometric wells, pumping tests results, region DEM, geological and soil maps prepared by the regional water companies, and the Geological Survey have been used. The layers are first referenced to prepare the maps, and all the information is converted to an acceptable format for ARC GIS software. In this study, the water table depth is considered, and the water table information is taken from the data of piezometric wells in the Tabriz plain aquifer from the regional water organization. The average aquifer water level from 95 wells for four months since 1997 (May, July, November, March) has been obtained. The generalized unknown and the map obtained from this method are classified according to the Aller ranking of the table. The DRASTIC index is based on seven input data and consists of three parts: weight, range, and rank. Each of these components is given a weight of 1 to 5 based on their importance in vulnerability, which is the most important. The weight parameter is given as five and the minimum weight as 1. Also, each of the seven parameters of this method is divided into important and effective intervals in the contamination potential. Finally, rank is used to evaluate the relative value of these intervals. Ratings range from 1 to 10. The result of using this method is to obtain a numerical index (D¡) which is obtained from the sum of the product of weight (w) and rank (R) of all seven parameters. After ranking all the parameters used according to the table In Arc Map software, the final vulnerability can be obtained using equation (1) below the map.

DRASTIC index = Dr*Dw + Rr*Rw + Ar*Aw + Sr*Sw + Tr*Tw + Ir*Iw + Cr*Cw

Finally, to investigate the groundwater quality of Tabriz plain, ten parameters K, Na, Mg, ca, so4, CL, Hco3, TDS, Ec, TH from wells located in the plain collected by the Regional Water Organization used. There are various methods for analyzing the accuracy of the results. In this study, the one-parameter sensitivity analysis method has been used. The result shows the statistical results obtained from the one-parameter sensitivity analysis on the depth and effect parameter of the water table. An unsaturated area is the most effective indicator in assessing the potential of vulnerability. Then net feeding, aquifer environment, and topography also had the greatest impact on the model.

3-Results and Discussion

The result shows the statistical results obtained from the one-parameter sensitivity analysis on the depth and effect parameter of the water table. The unsaturated area is the most effective indicator in assessing the potential of vulnerability, and then net feeding, aquifer environment, and topography also had the greatest impact on the model. In this study, the fuzzy method was used to investigate the vulnerability of the Tabriz plain aquifer more accurately. Considering that each of the seven parameters used has different

scales, before overlapping the layers, a raster map of each was prepared, and then in fuzzy functions, these maps were also scaled and given to each pixel. Values were given between zero and one. The result shows that the lowest vulnerability potential belongs to the southeastern areas of the plain (Sahand Mountains); the northwestern, southwestern areas, and parts of the center of the plain (located in Tabriz) have the highest vulnerability potential. According to the drawing map, about half of the plain (47%) has a high capacity for groundwater vulnerability. In this research, quality maps have been drawn using the GQI index. The information of these maps shows that the concentration of parameters is higher in the northwestern and southwestern parts than in other parts of the aquifer. The components Tds, Th, Ec, have the highest weight and have been identified as the most important factor in reducing the quality of drinking water.

4-Conclusions

Groundwater near large cities is very vulnerable. The large population of these cities, while in dire need of these aquifers, their pollution limits the possibility of using high-quality water. Tabriz plain, including the plain In this study, to evaluate the pollution potential of the Tabriz plain aquifer, the DRASTIC and fuzzy methods were used in the GIS software environment, taking into account parameters such as depth to the water table net feeding. Aquifer environment, soil environment, topography, unsaturation zone, and hydraulic conductivity were evaluated. The results of evaluations and analyzes showed that 5.78, 14.91, 32.02, 27.63, 19.43, and 0.20% of the aquifer, according to the vulnerability classification table, have the potential of vulnerability without risk of contamination, very low, low to medium, medium to high, respectively.

Furthermore, 59% of Tabriz plain was in low and low to medium classes, the most potential related to the northwestern to southwestern regions. The most important reasons are the low water level in these areas, and it is also high in hydraulic conductivity and unsaturated environment. In addition to the Darst method, the fuzzy method was also used. The results of the method showed that the lowest amount of pollution potential is related to the southeastern regions of the plain (Sahand Mountains), and the highest values are allocated to the northwest and southwest as well as parts of the center of the plain (Tabriz) According to the modeling, 47% of the total area of the plain is highly vulnerable, which is very consistent with the result of the DRASTIC method. But because the DRASTIC method ignores the boundaries, for this reason, in the fuzzy model, zoning is done more accurately

Keywords: DRASTIC model, Fuzzy logic, GQI water quality index, WHO global standard, Sensitivity analysis, Tabriz plain.

5-References

Khodaei, K., Shahsavari, A.A., Etebari, B. (2006). Evaluation of aquifer vulnerability of JOVEIN PLAIN using DRASTIC and gods methods, *IRANIAN JOURNAL OF GEOLOGY SPRING* 2006, 2(4): 37-87.

Khorshiddoust, A.M., Valizadeh Kamran, Kh., Ghasemi Bghtash A. (2018). Analysis of the temporal-spatial distribution of dangerous contaminants in Tabriz with emphasis on PM10, *Journal: PHYSICAL GEOGRAPHY RESEARCH QUARTERLY*, winter 2018, 49(4): 585 To 602.

Nakhostin Rouhi, M., Rezaei Moghaddam, M., Rahimpour, T. (2017). Groundwater vulnerability zonation using DRASTIC and SI models in GIS (Case Study: Ajabshir Plain), *Iranian Journal of ECO HYDROLOGY*, 4(2): 587-599.