Research Paper

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Improving the DRASTIC Model by Programming Gene Expression in Determining Aquifer Vulnerability to Nitrate, Case Study: Kermanshah Plain Aquifer

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1-Introduction

Kermanshah plain is one of the watery plains in the west of the country and considering that the groundwater of the study area is mainly used for agriculture and urban and rural drinking, maintaining the stability of this aquifer is very important in terms of quality. Drastic method is one of the most common methods used to assess the vulnerability of groundwater. One of the advantages of Drastik model is the low cost and the amount of data. But the main weakness of this model is the application of expert opinions to the weight and ranking of the variables used in it. In this study, first, the vulnerability of the region using DRASTIC model based on seven geological water variables effective in pollution, including water table depth, net nutrition, soil environment, topography, impact of unsaturated area and hydraulic conductivity and then to improve the model Strictness and prediction of nitrate concentration in the region, gene expression planning model was used. In order to examine the correlation of the parameters in Static, the new method of scoring and ranking is used, which is different from previous researches, which seems to have not been considered in this field in the country so far.

2-Methodology

The structure of this model is based on 7 geological water variables, which include groundwater depth (D), nutrition (R), aquifer (A), soil environment (S), topography (T), impact of unsaturated zone (I) And hydraulic conductivity (C). The most important parameter has a weight of 5 and the least important has a weight of 1. The intervals of each of the correct parameters are assigned a rank between 1-10. In this study, GeneXpro Tools (v5) program was used to implement the GEP model. In order to assess the vulnerability of groundwater to nitrate pollution, 7 hydrogeological parameters were used. In fact, its parameters were the same as those used in the drastic method. The input

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parameters are (Dt), (Rt), (At), (St), (Tt), (It), (Ct) and (NO3t + 1) nitrate in the future period.

3-Results and Discussion

Parameter data including groundwater depth (D), feeding (R), aquifer (A), soil environment (S), topography (T), impact of unsaturated zone (I) and hydraulic conductivity (C) Used as input data. Nitrate was modeled as a function of drastic parameters. The results showed that the total output obtained from the simulation was nitrate concentration with observational values. The results showed that according to the root mean square error (RMSE), mean absolute error (MAE), coefficient of determination (R2) and correlation coefficient (r) and analysis of each criterion, the results show Excellent and strong is the gene expression programming model. This confirms the ability of this model as a suitable and efficient tool for simulation and estimation of nitrate vulnerable areas. Another feature of GEP is the comparison and integration with other intelligent methods and the ability to establish an implicit relationship between the input and output parameters of the model. In other words, gene expression programming is able to provide existing approximate equations and optimal tree structure, which distinguishes it from other models such as neural and artificial networks. The tree structure helps to express the initial population as a simple linear structure at each stage, and all changes are made to simple structures only, so there is no need for relatively complex structures to expand at each stage. Also, the shape of the tree structure of compound 15, which has been selected as the best and best model used in this study, is presented as an example.

4-Conclusion

The results showed that a large part of the study area is in a low vulnerability area, which due to the nature of the drastic method, it is inferred that underground resources in the study area are not in the area of severe pollution, but because the Kermanshah plain It is one of the active agricultural areas and many agricultural fertilizers are used in it, so factors such as water table depth, nutrition, hydraulic conductivity and unsaturated environment are effective indicators of vulnerability. Therefore, it is necessary to assess the vulnerability of the aquifer of this plain and determine areas with high potential for pollution. In this regard, 7 effective variables in groundwater vulnerability were prepared as 7 raster layers and the vulnerability index for the region was obtained between 45 and 115. The nitrate concentration zoning map confirms the results of the drastic model. In areas with moderate vulnerability, nitrate concentrations above 30 ppm were determined. While in areas with low vulnerability, the concentration of nitrate in groundwater was less than 30 ppm. Therefore, in general, it can be acknowledged that the results of field observations confirm the accuracy of the drastic model in determining vulnerable areas. The results also show that the GEP model used in this study, having (RMSE), (MAE),

(R2) and (r) high and good, resulted in a relatively accurate estimate of the vulnerability in the study area. . By modifying and optimizing the DRASTIC method by the Gene Expression Programming Model (GEP), more accurate results can be achieved than the classical method for assessing groundwater vulnerability. Which was obtained by modifying and optimizing the weighting index (5D, 4R, 5A, 5I, 4C).

Keywords: Drastic, Gene expression programming, Nitrate, Vulnerability, Kermanshah plain, West of Iran.