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Evaluation of Groundwater Potential of Sufi Chay Basin Using Frequency Ratio Models and GIS

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Abstract

1- Introduction

Groundwater is defined as water in the saturated zone (Fitts, 2002) that fills all the pore space of soils and geologic formations below the water table (Freeze and Cherry, 1979). The term groundwater potential refers to the amount of groundwater available and the hydrologic factors in the area (Jha et al., 2010). Also the term may also refer to the possibility of groundwater in an area using hydrogeological factors. Many researchers, such as Nober (2007), Manep(2011),Falah (2019), Ghorbani Nejad et al., (2018), Lee (2015), Nohani et al. (2018), Tahmasebipour (2018) have worked on the frequency ratio model, and their results have shown that the model was suitable for determining the potential of groundwater. In this study, this method has been used to identify groundwater potential in the Sufi Chay basin to determine groundwater potential areas.

2- Methodology

The study area is located approximately between 45° 57′ 27″ and 46° 57′27″E and 34° 44′ 42″ and 37° 14′ 47″ N with an area of about 1095 km^2.

In order to apply the probabilistic-based frequency ratio model, a spatial database that considers groundwater factors was designed and

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constructed. The spatial database constructed for the study area is shown in Table 1. Eight groundwater-related factors such as elevation, slope, curvature, drainage density, lineament density, geology, soil, and land use were considered in calculating the probability factor.

Table (1) Data layers of the study area

Classification	Sub classification	GIS data type	Scale
Groundwater	Tube well Point	Tube well Point	1:25000
Base map	Topography	Polygon Polyline - Point	1:25000
	Soil	GRID	m 20*20
	Land use	GRID	m 20*20
	Geology	Polygon	1:100000
	Lineament	Polyline	1:100000

After overlaying maps based on GWPI equation (1), frequency ratio model (Manep, 2014) and groundwater potential map have been prepared (eq.1).

$$\mathrm{GWPI} = \mathrm{Wr1} + \mathrm{Wr2} + \cdots + \mathrm{Wrn} \qquad (1)$$

Where GWPI is Groundwater Potential Index;

Wr is the rating of each factors type or range.

Finally ROC curve method using Medcalc software was used to evaluate the performance of model.

3- Results and discussion

The results of the effective hydrogeological factors in the Sufi Chay basin have been calculated based on the frequency ratio. According to the results, land use have been played an important role in groundwater recharge. Most of the wells have been located in agricultural lands with frequency ratio of 3.59 and orchards of 1.9. This issue shows that most of the wells in the agricultural section were exploited. The geological factor has a great influence on the initial water permeability. The more porous and permeable the layers are, the faster the permeability is. In the region the highest frequency ratio is in playa and terraces. Also the fault layer have been indicated the amount of cracks and fractures in the area. In the Sufi Chay basin, there are more wells in areas with less faults.

Most of the groundwater was located in slopes 0 to 1˚ in the area and the presence of loamy soils due to its medium texture have increased the permeability. So these soils are a suitable place to exploiting wells in the area. Most of the wells have been located at height between 1265 and 1350 m a.s.l. with a frequency of 3.67. The drainage density is at a moderate level and therefore the amount of water permeation is appropriate. Curvature index, flat areas have the highest frequency ratio of 1.23.

4- Conclusion

The management of groundwater resources is a major issue for identifying areas with high potentials for groundwater. In this study, we tried to identify areas with the potentials for groundwater in Sufi Chay basin by using frequency ratio model. Conditioning factors used in this study include: elevation, slope, drainage density, landuse, lithology, soil, faults and topography. In the frequency ratio model, the wells with a discharge rate of above 11 liter per second were extracted in the region; then, 70 percent of wells (6981 pcs) for training and 30% of the wells for validation (2992 pcs) were randomly selected. Based on the frequency ratio, necessary analyses were conducted in classes and maps were overlapped. Finally, the groundwater resources map for model were produced. The ROC curve method was used to evaluate the performance of the model. Based on this, the percentage of the area achieved in the frequency ratio model are as follows 63% of the areas were low; 18% average; 12% high, and 7% very high.

Using the model, a final map of the potential of groundwater resources have been calculated. The map was classified including: low, medium, high and very high. In the map, the low potential areas in the northern and central parts of the basin with rigid topography, high slope and resistant rocks, and in south and southwestern part of the basin with flat topography, low slope and alluvial sediments, areas with high potential have been identified. The model validation results showed that this model has been provided acceptable performance.

Keywords: Frequency Ratio, Groundwater potential, Hydrogeological factors, Sufi Chay basin, GIS

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