Research Paper

Hydrogeomorphology, Vol. 9, No. 32, Fall 2022, pp (22-26)

Received: 2022.07.09
Accepted: 2022.03.21

Determination of Alluvial Sediment Thickness of Shahriar Plain Using the Geoelectric Sounding Method and Kriging Interpolation in the GIS Environment

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1-Introduction

Geophysical methods are best for identifying subsurface structures and groundwater reservoirs. Various geophysical methods are used for this purpose. The science of geostatistics investigates variable phenomena in time and space and analyzes sampled points with different positions to produce a continuous surface. Geostatistical analysis can also be used for spatial modeling in various applications of spatial information systems. One of the advantages of these methods is fitting the surface of the model with sampling points (Alavi Panah et al., 2008). The alluvial zones of Shahriar plain, on which significant parts of residential agricultural and industrial uses are located, contain the groundwater aquifer, which provides a large share of Tehran's water needs. Knowledge of geography as a spatial science has always tried accurately understand the relationship between humans and the geographical environment. Today, the geographic information system, one of the new technical achievements, has increased the power of geographical knowledge in understanding the geographical environment (Jumehpour, 2006). This system collects and analyzes all information related to geographical location (Huxheld, 2001). This system has been created and developed for land use design and natural resource management at local and regional levels (Ebrahimzadeh et al., 2008). Geophysics, with the help of physical phenomena and with the help of experimental methods and tols, can reveal underground unknowns that are geologically hidden (Publication 115-A, Management, and Planning Organization of the country). Interpolation is a method of estimating the value of phenomena in unsampled locations using known values at neighboring points; neighboring points may be regularly or irregularly scattered in that area. Therefore, interpolation is used to convert the data from the points observed in continuous topics (Qahroudi Tali et al., 2012)

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2-Methodology

The studied area is Shahryar plain in Shahryar city of Tehran province. The current research is applied and is based on library and field analysis of geophysical data that is used through electric soundings (geoelectric) and interpolation with ordinary kriging method with exponential semivariogram. According to the investigations and previous studies, it has provided the most accurate results in this kind of research (Tabatabai and Ghazali, 2018). The data of electrical soundings and the sections taken along the profiles were received from Tehran Regional Water Organization and limited on the region map. According to the Table (1) of the specific resistance of the layers, the type of each of them was identified. In the following steps, re-interpolation was done by trial and error by removing nine sounding data from three profiles, and the obtained data were compared with the deleted data. The standard kriging interpolation method with semi-variogram was used using the RMSE error indicators and the MDE deviation of the results. An expression with the lowest error value of the results equal to 0.043 was selected using Relation (1).

$$\boldsymbol{Z(s) = \mu + \varepsilon(s)} \qquad (1)$$

where Z(s) is the desired variable, μ(s) is a deterministic process with an unknown constant coefficient, and ε(s) is a random process or autocorrelation error. The position of the data that has an error can be easily identified. This model assumes that the average coefficient of the model is stable and acceptable. This model has considerable flexibility as a simple forecasting method. Finally, this model with the lowest error value of 1.5% was selected. Then, the general distribution map of the thickness and type of alluvium in the area and the topographic maps of the underlying formations were drawn.

Table (1): Specific resistance of sediments (Jafari, 2012)

The material of the layers	(ΩM) Specific resistance in
Dry deposits of domains	100 to more than 300
Relatively coarse-grained alluvial	50 to 100
Sediments Relatively fine-grained alluvia	20 to 50
Sediments clay or marl sediments (fine-grained)	to 20

The indices of RMSE error and deviation of MDE results are also calculated using Relations (2) and (3).

$$\text{RMSE}=\sqrt[2]{\frac{\sum_{i=1}^{n}(Esi-Eot)}{n}} \qquad (2)$$

$$MDE=\frac{\sum_{i=1}^{n}(Esi-Eot)}{n} \quad (3)$$

where Esi is the estimated value of the test points with interpolation methods, and Eoi is the actual value of those points. The MDE evaluation parameter shows whether the model underestimates or overestimates the value of the desired variable and, secondly, what is its quantitative value when MDE is equal to zero. The model estimated the studied space well, and there was no deviation (Ansari and Davari, 2008). The zero value of the RMSE index also indicates the absence of error in the model estimation. The results of the analysis of different interpolation methods using the indicators of the RMSE error rate and the deviation of the MDE are given in Table (2).

Table (2): Results of the comparison of interpolation methods

R	interpolation methods	MDE	RMSE
1	Kriging_Ordinary_Exponentil	0.043	0.65
2	Kriging_Ordinary_Spherical	0.21	0.86
3	Kriging_Ordinary_Circular	2.28	0.72
4	Kriging_Ordinary_Gaussian	0.33	0.88
5	Kriging_Ordinary_ Linear	0.39	0.83
6	Kriging_Universal_Liner with Liner drift	1.11	2.01
7	Kriging_Universal_Liner with Quadratic drift	2.01	2.34
8	IDW	2.09	1.5
9	Spline_regularized	2.33	1.75
10	Spline_Tension	2.57	1.69

3-Results and Discussion

Considering that before the present research, which is taken from the dissertation, a handful of researches with the same title have been done inside and outside the country, and it has not been possible to access the full text; however, the comparison of the results with the results of some researches mentioned in the literature review section indicates the correctness of the interpolation. Furthermore, according to the method of estimating the amount of error to verify the accuracy of the data by deliberately removing the known data and comparing it with the data obtained from interpolation, as well as comparing it with the drilling log of observation wells, the results obtained indicate the accuracy of the interpolation done by the mentioned method.

4-Conclusions

The results obtained from the alluvial thickness map and the plain map of the region show that as we approach the margin of the plain, the thickness of the alluvium decreases. This decrease in thickness in the western and northwestern regions, with a height of about 100 meters above the height of the plain, has brought the thickness of alluvium to less than 10 meters. On the other hand, the closer we get to the central area of the plain, the thicker the alluvium increases. In the center of the plain, the lower layer consisting of tuff and igneous rocks bring the thickness of the alluvium to 350 meters. Another depression in the eastern margin, with an area of approximately 100 square kilometers, has increased the thickness of the alluvium from 200 to 350 meters. The water level in this depression, with an average height of 50 meters, has good water storage. In general, due to the unevenness of the bed surface and the erosion of the surface layer, the results show that the thickness of alluvial layers in this area is not evenly distributed. However, the topography of the bedrock, the fourth layer, has a good uniformity in the center of the Dashtgun area at an altitude of 600 to 750 meters. Nevertheless, at the edge of the plain, this altitude increases so that in the northeastern region, which leads to the southern slopes of Alborz, it increases rapidly to 1200 meters.

Keywords: Determination of deposit thickness, Kriging interpolation method, Geophysical methods, Geoelectric, Shahriar (Tehran Province) plain.

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