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Potential Mapping Groundwater Resources by Using an Integrated Approach AHP and Fuzzy Topsis (Case Study: Silakhor Plain)

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1-Introduction

Groundwater is recognized as one of the most important and reliable sources of water supply all around the world. However, population growth and reducing the volume of surface water reserves have led to the overexploitation of groundwater and groundwater resource depletion over the world. Therefore, exploration and exploitation of groundwater resources require a thorough understanding of geology, hydrogeology, and geomorphology in any area. With the advancement of remote sensing science and the use of satellite imagery in various fields, costs have been reduced and the time required to explore various sources including groundwater has been reduced. Nowadays, using fuzzy decision-making methods, it is no longer necessary to use only the financial equivalent of social and environmental criteria in choosing the best alternatives, but also to use different quantitative and qualitative criteria in prioritizing and selecting the best options and criteria in water resources management. In this study, eleven thematic layers, including lithology, precipitation, vegetation cover, density and distance from the fault, elevation, slope, temperature, land use and density, and distance from drainages to potential detection sources of groundwater used Silakhor plain.

2-Methodology

Groundwater resources potential in Silakhor plain, using fuzzy TOPSIS method and hierarchical analysis process, is performed in the ArcGIS software environment. In this method, the weighting of the criteria and thematic layers is extracted by pairwise comparisons of the Analytical Hierarchy Process (AHP) method, and the decision matrix is formed using triangular fuzzy numbers for expert judgments. The alternatives are prioritized using the fuzzy TOPSIS method. Then, all maps should be divided into five categories based on the importance of the relative weight of the sub-criteria, using the reclassify tool. It then converts the maps with raster to polygon tools into vector maps and integrates with the dissolve tool. To apply distance of positive and negative

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ideals, fields are created as positive and negative ideals, and with the feature to raster tool, ideal positive and negative maps are created. Finally, all layers can be combined using the similarity index relationship and the potential groundwater resource map of Silakhor plain can be created.

3- Results and Discussion

The results showed that areas with high to medium potential are located more in the central and southwestern regions of the plain and places with low and very low potential are in the surrounding areas and east of the plain. A comparison of the results of this map with the thematic layers shows that the zones have more potential to correspond to quaternary alluvial and carbonate hard rock zones. Also, these areas are well adapted to areas with thick vegetation cover, trees, and forests. The results of this map show that the highest groundwater potential is located in low slope and low altitude areas, at a low distance from the drainages and faults and the high density of the drainages, but density fault and temperature have a limited effect on prone areas of groundwater in the plain.

4- Conclusions

In this study, eleven layers of potential factors including lithology, precipitation, vegetation cover, density and distance from the fault, elevation, slope, temperature, land use, and density and distance from drainages, after applying ideal positive and negative fuzzy distances in a GIS environment, were combined. Groundwater potential map of five classes including high potential, good, medium, low, and very low potential with an area of 330 km2 (13.1%), 586 km2 (23.3%), 574 km2 (22.8%), respectively. It is 581 km2 (23.1%) and 445 km2 (17.7%) and in other words, about 60% of the plain area has good potential. Overlap of wells location map with groundwater potential map and investigating the relationship between the number of wells and areas with different water resources potential in the GIS software environment showed that the method of potential detection using fuzzy TOPSIS is in good agreement with the position of wells. About 87% of the wells are located in areas with medium to high groundwater potential. Groundwater potential map is useful for future irrigation planning and sustainable groundwater development plans. The most important findings from the present study are finding the probable location of wells to extract groundwater based on sustainable use in the area. There are several methods to find potential groundwater areas using geographic techniques and multi-criteria decision analysis. However, cost-effective, simpler but scientific and reliable methods are needed for water engineers and managers to adopt. In this study, the integrated approach of the hierarchical analysis process and fuzzy TOPSIS in the GIS environment is more predictive and its application is very easy and affordable. The method shown in this study can be easily replicated in other parts of Iran as well as in other parts of the world.

Keywords: Analytical Hierarchy Process (AHP), Fuzzy TOPSIS, Groundwater, Potential, Silakhor plain