Groundwater potentiality through Analytic Hierarchy Process (AHP) using remote sensing and Geographic Information System (GIS)

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Abstract

Nowadays the use of remote sensing and Geographic Information System (GIS) is one of the most powerful cost effective tools to identify and discover the available groundwater resources. In this paper, Lithological Units, Lineaments, Slope, Topography, Drainage density, Vegetation and Isohyets lines have been achieved by stations and through remote sensing and GIS techniques. All layers of different classes were initialized through hierarchical analysis to potential areas of groundwater and after modeling in GIS Environment, Mahdishahr zone was classified according to the potential groundwater basins. The results show that in the 7 reviewed criteria by the expertise and Analytical Hierarchy Process, geological criterion and lineaments with the relative importance of 0.33 and 0.22, respectively, have greatest importance and priority for potentiality of groundwater in the region. Also in the studied area, Quaternary Alluvium consisted of old and new terrace and river sediments have the highest relative importance and desirability and terrace resources and the elevated old and low height new Foothill Alluvial fans are considered as good potential areas of groundwater. Shemshak Sandstone formations and Barut with a high density lineaments and Tizkouh formation with the thick layers of limestone and Barut are also good areas for groundwater.

Keywords: *AHP, GIS, Groundwater, Remote Sensing.*

Introduction

Water in the voids of the Earth is called groundwater (Bagyaraj *et al*., 2013). Unlike surface water, groundwater is almost available everywhere, and although renewable, is not stable (Krishnamurthy *et al*., 2000). The availability of groundwater depends on the type and physical properties of rocks, such as porosity, permeability, transmissibility, and storage capacity (Sharma & Kujur, 2012). Conventional methods to potentiality of groundwater is based largely on studies and field surveys (Ganapuram *et al*., 2009). However, conventional exploration methods such as terrestrial surveys and geophysical methods do not always account for the diverse factors that control the occurrence and movement of groundwater (Oh *et al*., 2011). With the advent of remote sensing and GIS techniques, mapping of the potentiality within each geologic unit has become easier (Singh and Prakash, 2003; Ganapuram *et al*., 2009). Incorporation of remote sensing and GIS has become one of the tools for the discovery of groundwater resources that helps us in assessing, monitoring and protection of groundwater resources (Magesh *et al*., 2012; Dar *et al*., 2011). Although there are many challenges in the exploration of the underground water resources in hard rock, much research has been reported in this field all around the world. For example, Roy (2014) has studied the arid region of South Australia for groundwater discovery. Oh *et al*. (2011), in Pohang_Korea, using using remote sensing and GIS, concluded that the soil texture has the most and the land height has the least effect in potential sources of groundwater in this region. Using remote sensing and GIS and MIF techniques, Magesh *et al*. (2012), divided the Theni region, which is located in Tamil Nadu India, into four parts of very good, good, poor, and very poor, according to the potentiality of the groundwater resources and concluded that the soil type and the slope have an important role, moreover, the lineaments density and drainage density in the region have increased this trend. Using IRS-LISSIII images, Dar *et al*. (2010) divided the Mamundiyar zone, which is located in the Tamil Nadu-India, into four parts of good, medium, medium to poor, and poor according to the potentiality of the groundwater resources and concluded that remote sensing and GIS are powerful tools for studying the groundwater resources and designing a good exploration plan.

Chenini and Mammou (2010) were able to identify suitable areas for artificial recharge of groundwater in Maknassy basin, which is located in the southern central of Tunisia, using combination of the GIS techniques and groundwater modelling.

Their results show that the value of artificial recharge in this area was 24% of the total annual rainfall, in 2004 and 2005. Using remote sensing data and GIS, Ganapuram *et al*. (2009), classified groundwater availability in the region into 5 classes in terms of very good, good, medium, poor, and zero, on the basis of the Hydrogeomorphology conditions in the Musi basin center in the State of Andrhra Pradesh, India. Kumar *et al*. (2013), according to the remote sensing methods and using Fuzzy Algebra, concluded that more than 40% of the in Khoh River Watershed, Pauri-Garhwal District, Uttarakhand, India, are very good, based on the water potential. To explore groundwater, Khodaei and Nassery (2013) concluded, by studying semi-arid areas of southwest of Orumyeh in Northwestern Iran, that the remote sensing data is a very useful tool to explore the groundwater and the use of GIS for finding target areas of the groundwater is very effective.

Because in the study of the groundwater potentiality there are some criteria and sub-criteria involved in climate hydrology, soil, and geology, it is always done with the difficulties and complexities associated. Therefore, the combination of Analytic Hierarchy Process (AHP) as one of the most comprehensive designed models in multi-criteria decision making (Ataee, 2010; GhodsiPoor, 2009) with modeling in GIS can help in assessing groundwater potentiality of different areas. Therefore, this study intends to identify and determine the best irrigated areas in Semnan Mahdishahr area using the existing parameters of hierarchical and modeled in GIS and prepare raster layer and weighted and combination of layers, identify the best potential areas of water and mapping the underground. The hope is that the resulting map of the survey results can be helpful for managers and decision-makers in the management of water resources of the study area.

Materials and Methods

Mahdishahr area is located in South of the Alborz Mountains, 15 km North of the city of Semnan. The area is located in longitude 53° 00' 35" to 53° 52' 01" and latitude 35° 36' 13" to 36° 10' 46". Its area, and minimum and maximum height is 1954 Square Kilometers, 1153, and 3724 meters above sea level, respectively. Figure 1 shows the location of the area.

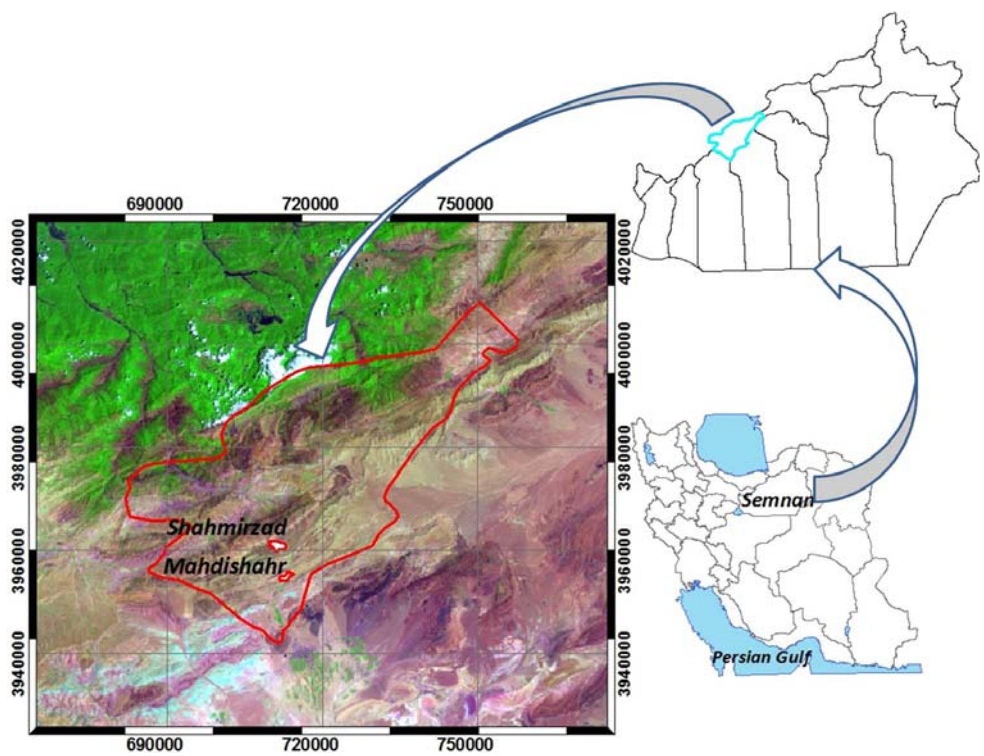


Figure1. Location of the watershed Mahdishahr

Research Methodology

The first part of this study is data collection including topographic map 1: 50000, numeral elevation data (SRTM) with 90 m resolution, Landsat ETM + Satellite data with 8 bands on the pass number 163, row 35 recorded on 30/08/2002, map geological Survey 1: 250000, and pluviometry statistics of the 9 weather stations in the region. Remote sensing and GIS techniques for obtaining Topographic maps, Lineament, Vegetation, Slope, Drainage density, Rainfall, and Lithology were used to achieve the desired goal. All layers are provided as raster and for each of its impact factors a weight was assigned based on AHP method. In Arc Hydro Tools, DEM region was analyzed and finally drainage density map of the area was prepared by Strahler method.

In AHP method, first of all, a questionnaire must be filled by qualified personnel. Then, the decision-maker for each pair of involved factors must decide to do a comparison. This analogous is descriptive in the first step, and the next step is as a quantity on a scale of one to nine in accordance with Table 1 (Saaty, 2000) and, finally, from this comparison, a binary matrix will be achieved. Through binary comparison in AHP method and via judges that are verbally, numerically or graphically done, weights or priorities for the criteria involved in decisions are obtained that are relative numbers (Kheirkhah Zarkesh, 2005). In Figure 2, a diagram of the investigation methods and processes is given.

Each of the main criteria was orally evaluated by at least 12 relative experts, as experts familiar with the area, and weight of each was calculated.

Table 1: Determination of the criteria, related to each other, by expertise

Numerical value	Preferences
9	Quite preferred or quite important or quite favorable
7	Very strong preference or importance or desirability
5	Strong preference or importance or desirability
3	A little better or a little more important or a little better
1	Preference or importance or the same desirability
2, 4, 6, 8	Preferences between these intervals

After extracting all the required criteria and preparing expert forms (questionnaires), expert opinions must be evaluated and inconsistency rate obtained. Control of the judgments inconsistency rate was done based on mathematical relationships and using Expert Choice Software. After entering the criteria in the application, their inconsistency rate calculated to determine the right binary comparison matrices. If the inconsistency rate is less than 0.1, we can conclude that a desired level of compatibility exists in binary comparisons and, otherwise, this rate represents the inconsistent judgment (Ataee, 2010; GhodsiPoor, 2009; Ishizaka and Labib, 2009; Malczewski, 2006; Oswald, 2004; Saaty, 2002).

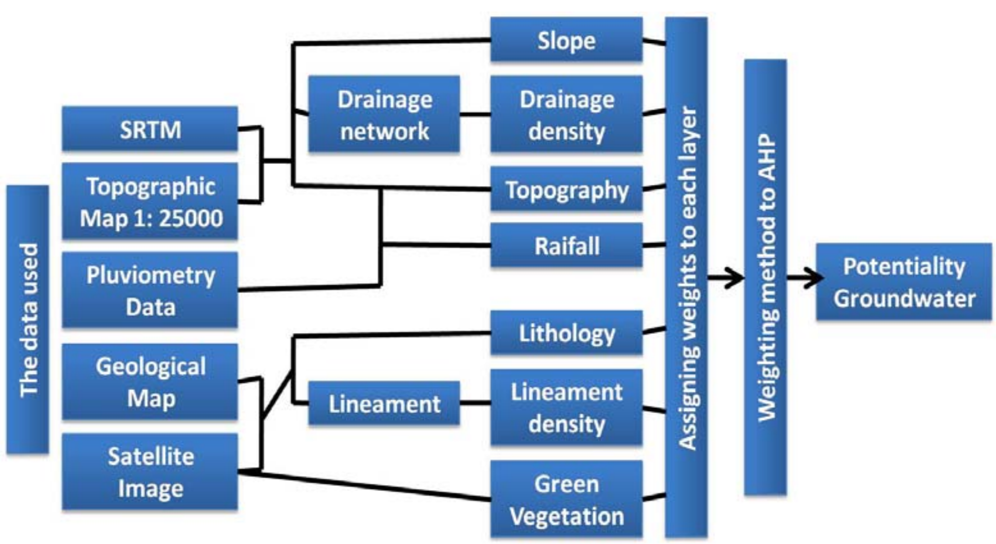


Figure 2. Diagram of the method and stages of investigation

Figure 3 illustrates decision tree of the main criteria for groundwater potentiality. Then, the achieved maps in Spatial Analyst, with overall investments, were weighted overlap and, finally, the groundwater potentiality map of the zone was provided for 4 classes of good, good to middle, middle, and poor.

Results

• In this study, seven factors of Lithology, Lineaments, Slope, Topography, Drainage density, Vegetation and Isohyet in Potentiality of Mahdishahr areas groundwater evaluated using Analytic Hierarchy Process and Geographic Information System, as results show below.

Geology

The higher the rock porosity, the higher storage and permeability of the groundwater, thus groundwater performance will increase further (Abdalla, 2012). Due to the influence of lithology condition on the hydrogeological system, the geological map can be partitioned into three main groups of hard carbonate formations, hard Non-carbonate formations, and alluvial deposits. In terms of geology, this area is consisted of a part of the Southern slopes wrinkles of the Alborz with the same geological formation in which effects of four geological periods can be found Figure 4 shows lithological units of the area. Major geological formations are shown in Table 2. Table 3 shows a measure of geology and the relative importance of them and Figure 3 shows maps of the geology zone and their relative importance, and Figure 5 shows geological units map of the area which is resulted from weight.

Green Vegetation

Green Vegetation in the dry season and arid and Semi-arid areas is a good indicator for shallow groundwater (Khodaei and Nassery, 2013). Using available images and varied vegetation indices such as NDVI, vegetation maps were obtained in the dry season. Vegetation in the central area are mainly farms and orchards which are located on the alluvial valleys. Table 4 shows vegetation criteria, classes, and their relative importance and Figure 6 shows vegetation zone map which is resulted from weight.

Drainage Density

Drainage density has some influence on runoff distribution and groundwater recharge (Abdalla, 2012). The drainage density in the area indicates a low-infiltration rate whereas the low density areas are favorable with a high- infiltration rate (Saha *et al.*, 2010; Vasanthavigar *et al.*, 2011).

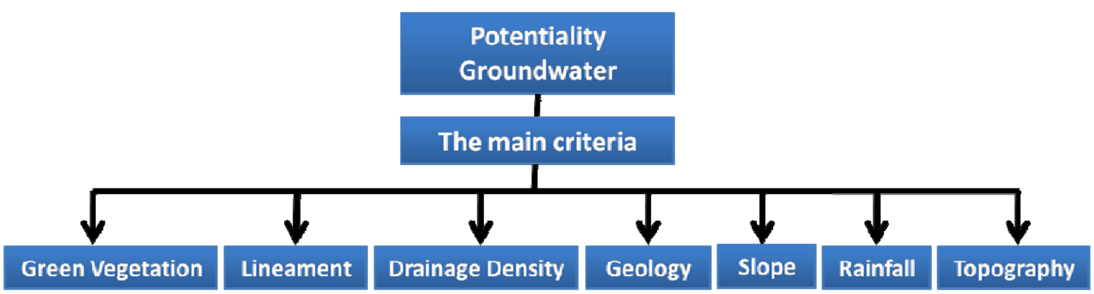


Figure 3. Decision Tree of the main criteria to groundwater potentiality

Table 2. Geological formations of the watershed Mahdishahr

Formation	Material	Age
Barut	Shale, Sandstone, Dolomite	Near Cambrian
Ruteh	Lime, Dolomite	Permian
Elika	Dolomite, Lime	Triassic
Shemshak	Sandstone, Shale , Lime	Near Jurassic
Lar	Lime, Dolomite	Far Jurassic
Tizkouh	Thick layer and massive Lime	Cretaceous
Ziarat	Limestone and Marly limestone	Eocene
Karaj	Shale, Andesitic Volcanic rock and Lime layers	Eocene
Quaternary Alluvium	Old and new terraces and fluvial sediments	Quaternary

Table 3. Geological criteria: Classes and their relative importance

Classes	Quaternary Alluvium	Formation Tizkouh	Formation Lar	Formation Barut	Formation Shemshak	Formation Ruteh	Formation Elika	Formation Ziarat	Formation Karaj	Geometric Mean	Relative Importance
Quaternary alluvium	1	2	3	4	5	6	7	8	9	4.1472	0.3043
Formation Tizkouh	1.2	1	2	3	4	5	6	7	8	3.00	0.2201
Formation Lar	1.3	1.2	1	2	3	4	5	6	7	2.1131	0.1550
Formation Barut	1.4	1.3	1.2	1	2	3	4	5	6	1.4592	0.1071
Formation Shemshak	1.5	1.4	1.3	1.2	1	2	3	4	5	1	0.0734
Formation Ruteh	1.6	1.5	1.4	1.3	1.2	1	2	3	4	0.8195	0.0601
Formation Elika	1.7	1.6	1.5	1.4	1.3	1.2	1	2	3	0.4732	0.0347
Formation Ziarat	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1	2	0.3756	0.0276
Formation Karaj	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1	0.2411	0.0177

Table 4. Vegetation criteria: Classes and their relative importance

Classes	Vegetated	Non Vegetated	Geometric Mean	Relative Importance
Vegetated	1	2	1.4142	0.6667
Non Vegetated	1.2	1	0.7071	0.3333

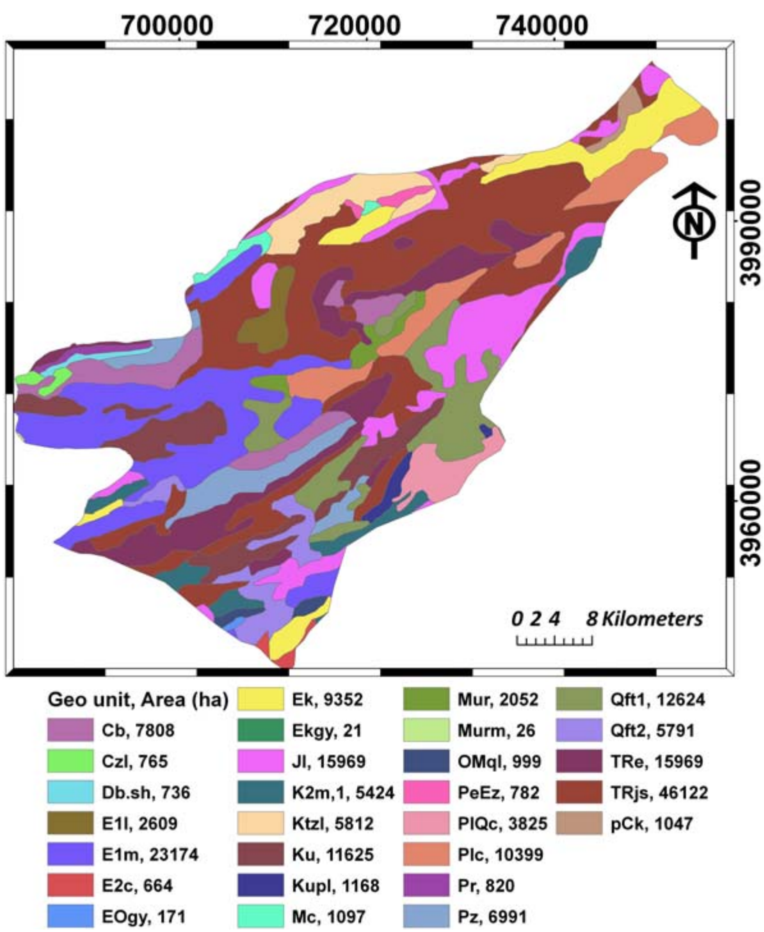


Figure 4. Lithological units map of the watershed Mahdishahr

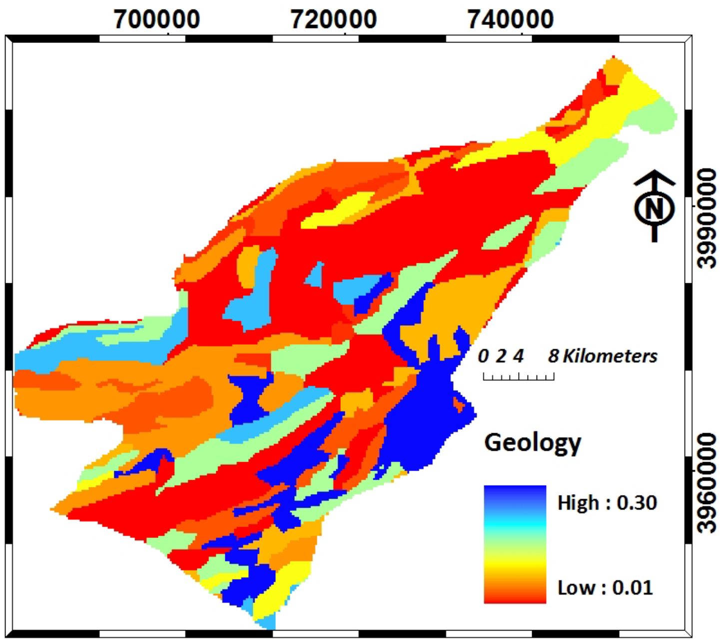
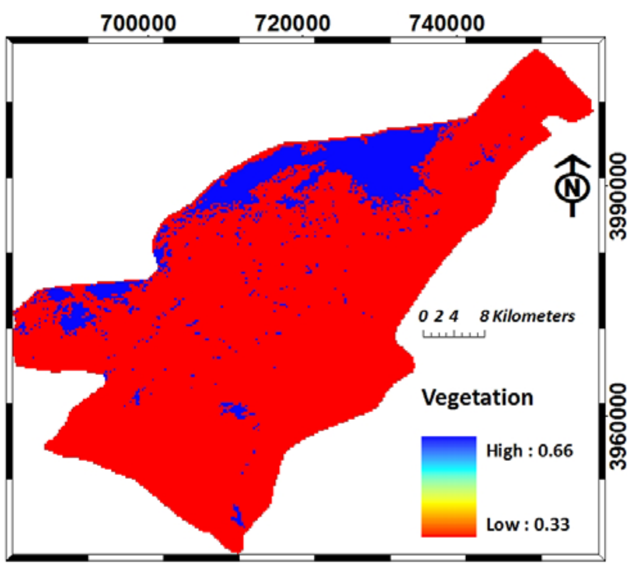


Figure 5. Geological map for weighting of the watershed Mahdishahr



Figur 6. The map resulted from vegetation weighting of the watershed Mahdishahr

Hence, the lesser the drainage density, the higher is the probability of recharge or potential groundwater zone (Bagyaraj *et al*, 2013). Drainage density of the region is generally Dendrite and, after preparation by Strahler method, it was classified based on the amount of waterways concentration into 5 classes.

Table 5 shows the drainage density criterion, classes, and their relative importance and Figure 7 shows the drainage density map of the zone which is resulted from weight. Obviously, high drainage density shows low penetration rate and low drainage density shows high penetration rate.

Rainfall

Rainfall distribution along with the gradient depends directly on runoff penetration, therefore, it is possible to increase the potential for groundwater (Magesh *et al*., 2012). For preparation of the zone Isohyet map, first of all, using rainfall 29 year data from 9 rain gauge stations in the region which include Shahmirzad, Mahdishahr, Eig, Abdolabad, Talebabad, Molladeh, Hafdar, Ahovan, and Lasjerd col, the rainfall gradient relationship with elevation was obtained (Fig. 8). Then, using gradient relationship and DEM, Isohyet map was prepared. The mean annual rainfall of Mahdishahr is 250 mm per year, but, due to the mountainous region, rainfall is higher than elsewhere in the region. According to the rainfall map of the region, Maximum precipitation of 650 mm is seen. So the region in relation with rainfall from 250 mm to 650 mm was classified into 3 classes. It is obvious that in areas with more rainfall, possibility of the groundwater existence is greater. Table 6 shows rainfall criterion, classes, and their relative importance and Figure 9 shows the zone Isohyet map which is resulted from weighting.

Table 5. Drainage density criteria: Classes and their relative importance

Classes	0.5	0.5-0.9	0.9-1.4	1.4-1.8	1.8-2.6	Geometric Mean	Relative Importance
0.5	1	3	8	8	9	4.4413	0.5262
0.5-0.9	1.3	1	7	7	8	2.6499	0.3140
0.9-1.4	1.8	1.7	1	1	2	0.5135	0.0608
1.4-1.8	1.8	1.7	1	1	2	0.5135	0.0608
1.8-2.6	1.9	1.8	1.2	1.2	1	0.3222	0.0382

Table 6. Rain criterion: Classes and their relative importance

Classes	Less than 250 mm	250 – 450 mm	450 – 650 mm	Geometric Mean	Relative Importance
450 – 650 mm	7	5	1	3.2711	0.7147
250 – 450 mm	5	1	1.5	1	0.2185
Less than 250 mm	1	1.5	1.7	0.3057	0.0668

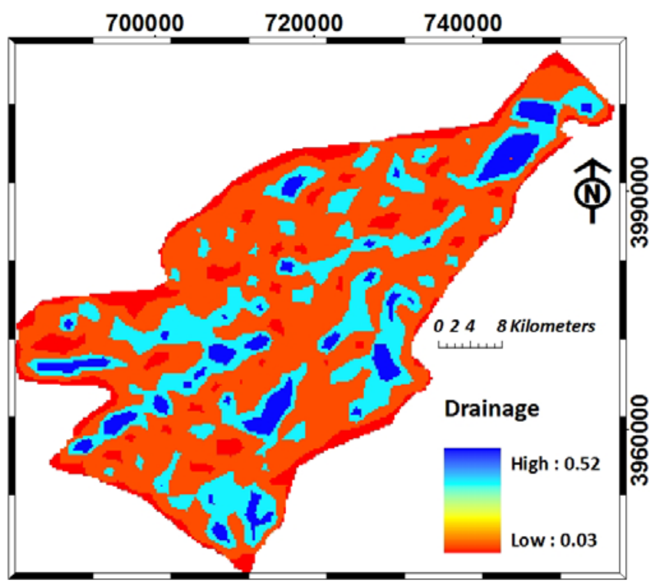


Figure 7. The map resulted from drainage density weighting of the watershed Mahdishahr

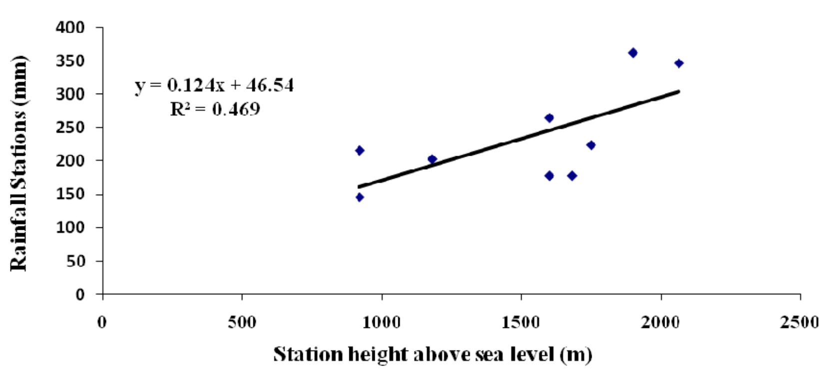


Figure 8. Precipitation gradient relative to elevation

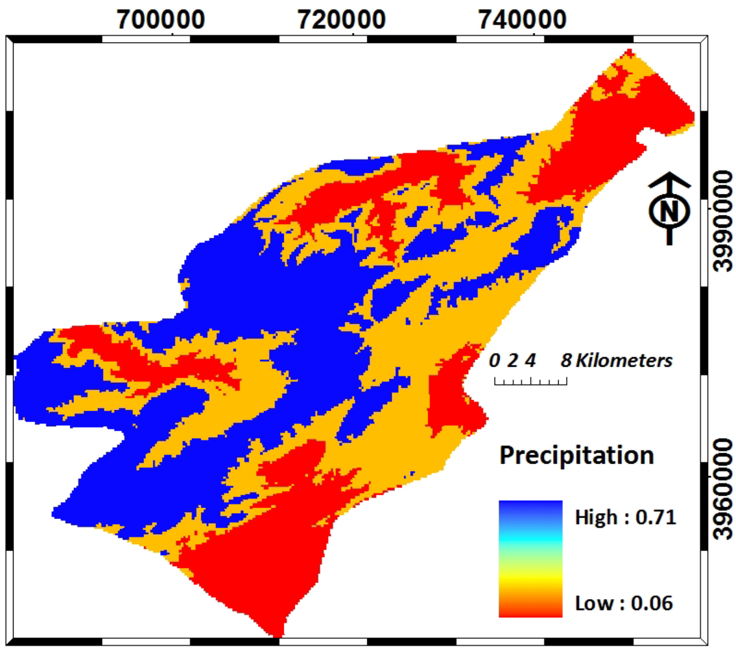


Figure 9. Weighted rainfall map of the watershed Mahdishahr

Lineament

Lineaments are linear or curvilinear structures on the earth surface that are indicative of weaker zones of bed rocks and are considered as secondary aquifer in hard rock regions and are visible in remote sensing images (Sharma & Kujur, 2012). Density of Lineaments may indirectly indicate the groundwater potentiality for a region and the fact that this area is permeable (Magesh *et al*, 2012). Remote sensing techniques are useful tools in identifying geological structures such as lineaments (Chaabouni *et al*., 2012). For the lineaments extraction oriented filters for edge revelation like Sobel, Robert, and Laplacian were used. But, according to the findings of (Madi & Zhao, 2013), use of the Sobel filter in image processing for lineaments extraction is more suitable, so in the most of cases this filter was used. Finally, the lineaments map was derived and then the density map was prepared. Lineaments density of the area was categorized into 5 classes. Table 7 shows the lineament density criterion, classes, and their relative importance and figure 10 shows the lineament density map of the zone which is resulted from weight.

Slope

The slope is an important factor to identify potential areas for groundwater. The higher is the slope, the more is the rate of runoff and erosions and the less the permeability. (Magesh *et al*., 2012). Surface runoff usually in areas with gentle slope usually has more time to penetrate, so it helps to recharge groundwater (Abdalla, 2012). According to the SRTM data and other height data of the area, in Spatial Analysis Tools, ArcHidro 9.3, slope map was prepared in 5 classes. Areas with a slope of 0 to 7% due to the relatively high penetration rate and reduction of runoff are in a very good category and areas with a slope of 63% and more due to increased runoff and a very low penetration rate are in extremely bad category. Table 8 shows slope criterion, classes, and their relative importance and Figure 11 shows slope map of the area which is resulted from weight.

Topography

Flow direction of the surface runoff and groundwater occurrence is determined by topography (Abdalla, 2012). Available moisture and and runoff is controlled by Topographic features conditions of the area (Bouaziz *et al*., 2011). Analyzing the SRTM data, topographic conditions of the area were determined. The region has a semi-arid climate with almost mountainous conditions. The zone Minimum height is 1150 meters and the Maximum height is 3724 meters above sea level. Large height difference between the Minimum and Maximum height of the region has caused a lot of hillsides with high slopes that they lead the direction of water flow towards the lower altitude areas. Table 9 shows the topographic criterion, classes, and their relative importance and Figure 12 shows the topographic map of the area which is resulted from weighting.

Table 7. Criterion of the lineaments density: Classes and their relative importance

Classes	(0-0.4) km/km2	(0.4-0.8) km/km2	(0.8-1.2) km/km2	(1.2-1.6) km/km2	(1.6-2.22) km/km2	Geometric Mean	Relative Importance
(1.6-2.22) km/km2	9	7	5	3	1	3.9363	0.5101
(1.2-1.6) km/km2	7	5	3	1	1.3	2.0360	0.2638
(0.8-1.2) km/km2	5	3	1	1.3	1.5	1	0.1296
(0.4-0.8) km/km2	3	1	1.3	1.5	1.7	0.4911	0.0636
(0-0.4) km/km2	1	1.3	1.5	1.7	1.9	0.2540	0.0329

Table 8. Slope criterion: Classes and their relative importance

Classes	0-7 %	7-21 %	21-42 %	42-63%	>63%	Geometric Mean	Relative Importance
0-7 %	1	5	7	8	9	4.7894	0.5469
7-21 %	1.5	1	6	7	8	2.320	0.2649
21-42 %	1.7	1.6	1	6	7	1	0.1142
42-63%	1.8	1.7	1.6	1	6	0.4471	0.0511
>63%	1.9	1.8	1.7	1.6	1	0.2013	0.0230

Table 9. Topographic criterion: Classes and their relative importance

Classes	< 1800 m	1800-2800 m	2800-3800 m	Geometric Mean	Relative Importance
< 1800 m	1	5	9	3.5569	0.7352
1800-2800 m	1.5	1	5	1	0.2067
2800-3800 m	1.9	1.5	1	0.2811	0.0581

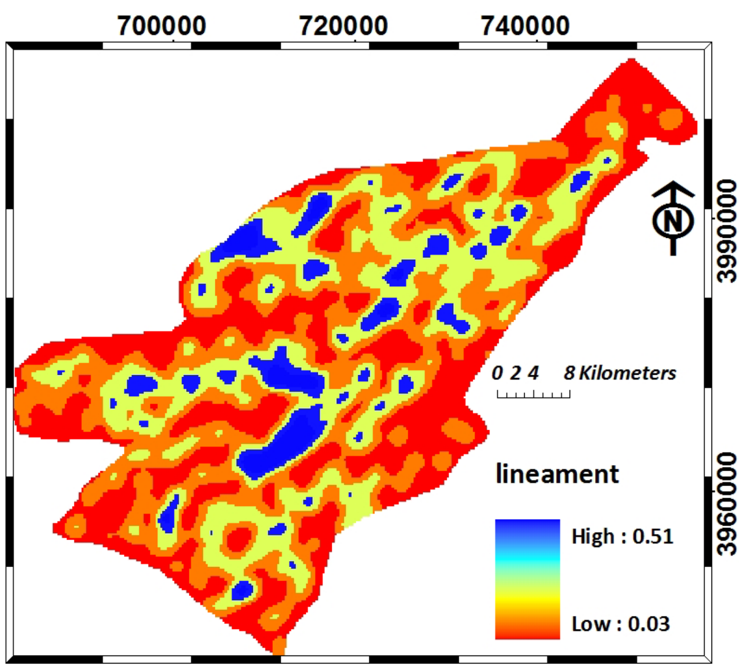


Figure 10. Map of weighted lineaments density of the watershed Mahdishahr

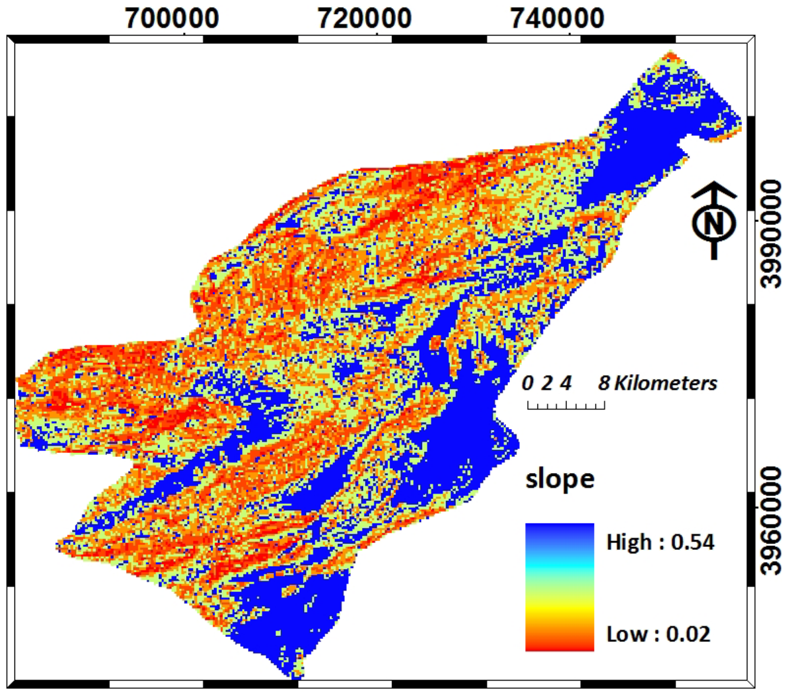


Figure 11. Map of the slope weighting of the watershed Mahdishahr

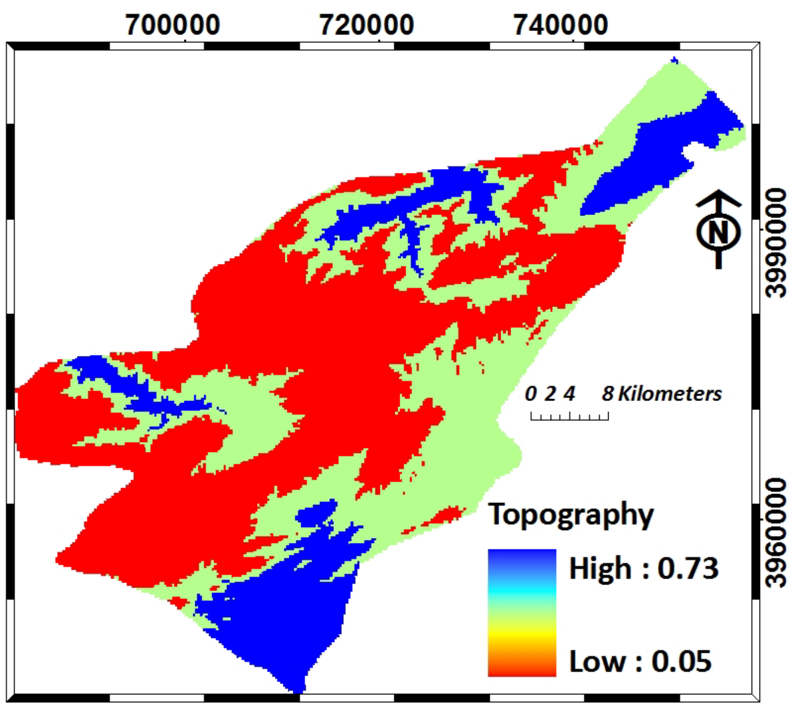


Figure 12. Weighted topography map of the watershed Mahdishahr

Identifying Potential Areas of Groundwater:

Separation of the area in terms of groundwater potentiality through the integration (integration) Map of different Lithological units, Lineaments, Slope, Topography, Drainage density, Vegetation, and Precipitation lines using remote sensing techniques and providing GIS and AHP method were weighted and was possible. Table 10 standards, classes, and the relative importance of each of the criteria for finding groundwater potentiality maps of Semnan Mahdishahr area shows the weight of the AHP method. Given the relative importance of each of the criteria, the potential issue of multiplying layers of raster maps each of the criteria (Rfi) in their relative importance (Wfi) according to equation 1, respectively. The values of this equation are divided into four groups: good, good, fair and poor categories that are shown in Figure 13.

According to Figure 13, 20% of areas had good potential underground water, 40% had moderate to good potential, and 4% had average potential. Good potential groundwater areas are mainly in the central parts of the North and West, South, Southeast and Northeast region. In central and parts of the Northwest region, mainly sandstone formations Shemshak and Barut can be seen as well as thick layers of limestone formations Tizkouh, Lar, and Ziarat. Good areas have formed a high density lineaments groundwater in these areas to increase the surface in the Southern, Southeastern and Northeastern region. Mostly mountainous reserves terraces and alluvial fans, old and new high river sediments, and alluvial plains exist in these areas that are good areas of groundwater.

$$E = \sum_{i=1}^{7} (wfi \times Rfi)$$

E = 0.33 × Geology + 0.22 × Lineaments density +0.16 × Drainage density + 0.11 × Slope + 0.08 × Rainfall + 0.06 × Topography + 0.04 × Green Vegetation

Table 10: The main criteria and their relative importance

Classes	Geology	Lineaments	Drainage density	Slope	Rainfall	Topography	Green Vegetation	Geometric Mean	Relative Importance
Geology	1	2	3	4	5	6	7	4.18	0.33
Lineaments	1.2	1	2	3	4	5	6	3.03	0.22
Drainage density	1.3	1.2	1	2	3	4	5	2.14	0.16
Slope	1.4	1.3	1.2	1	2	3	4	1.49	0.11
Rainfall	1.5	1.4	1.3	1.2	1	2	3	1.03	0.08
Topography	1.6	1.5	1.4	1.3	1.2	1	2	0.85	0.06
Green Vegetation	1.7	1.6	1.5	1.4	1.3	1.2	1	0.50	0.04

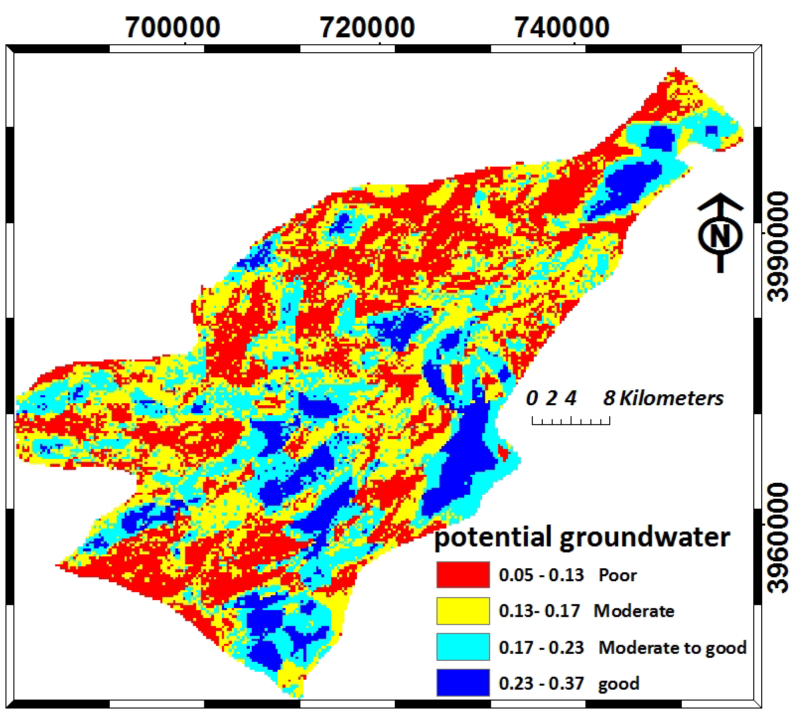


Figure 13. Map of the potentiality groundwater of the watershed Mahdishahr access with AHP method

Discussion

Exploration of groundwater in the hard rock terrains is a complex work, but advanced applications, RS and GIS, with an integrated approach, create effective and efficient methods for the study, development, and management of water resources which can overcome this complexity (Srinivasa Rao & Jugran, 2003). To explore potential areas of groundwater, RS and GIS have been used by many researchers around the world and different results are presented and it is specified that different factors are effective in determination of groundwater potential zones (Magesh *et al*., 2012). Teeuw (1995) believes that just lineaments are important in groundwater exploration and Madi and Zhao (2013) confine to Analysis of lineaments for Potentiality of aquifers. Whereas Sener *et al*., (2005), Ganapuram *et al*., (2008), Magesh *et al*., (2012), and Dar *et al*., (2011) argue that in addition to the lineaments, conflation of parameters such as drainage density, Geomorphology, Geology, Slope, Land use, Rainfall, and soil texture are important for groundwater exploration.

Research results of (Dar *et al*., 2011) the Mamundiyar basin which is located in Tamil Nadu-India showed that areas with high groundwater potentiality are mainly along the lineaments, pediments, and concave hillsides with a slope lower than 2%. In valley fills and meandering-channels and areas with medium potential groundwater mid slopes of the intra-drainage divides with low angle concave slope like buried Pediplains, Denudational Hills, and residual hills and the presence of lineaments and fractures in these regions leads to increase the yield potential. Areas with low potential are mostly moderate to steep convex hillsides such as Pediplains, Plateaus, Denudational hills mesas and buttes, escarpments. Also research results of Ganapuram *et al*. (2009) showed that the alluvial plain in filled valley, flood plain, and deeply buried Pediplain are areas with high potentiality of groundwater in the Musi basin in the center in the state of Andhra Pradesh (India). Faults and lineaments in these regions lead to an increase in the groundwater potentiality.

Results obtained are in accordance with the results of the other researchers such as Abdalla (2012) who have introduced Wadi fillings areas and the Quaternary deposits which have highly porous bedrock with high density lineaments and mild slope less than 5% as potential areas of groundwater in the eastern desert of Egypt. Also Rai *et al*., (2005), in Jharia and Raniganj coalfields, Dhanbad district, Jharkhand state consider dissected pediplain with sedimentary outcrops as good prospects for groundwater and also Similarly buried pediment and dissected buried pediment and crisscross lineaments have good prospects of groundwater. In addition, Kumar *et al*., (2013), based on the Fuzzy membership values and various Fuzzy integration rules-based approach and using GIS, have introduced combination of alluvial plains, fine drainage density, gentle slope as good area and Structural and Denudational hill, coarse drainage density, high slope areas as poor in terms of groundwater potentiality in Khoh river basin in the Pauri area of Uttrakhand, India.

Conclusion

In this paper, seven layers of Geological formations, Lineaments density, Slope, Topography, Rainfall, Vegetation and Drainage density were weighted using remote sensing and GIS techniques prepared and using the Analytic Hierarchy Process. Results showed that within 7 criteria which are examined by expertise and the Analytic Hierarchy Process, Geology and Lineaments criteria with the relative importance of 0.33 and 0.22, respectively, have the most relative importance and priority to the Potentiality of groundwater in the regions and fields with more vegetation, drainage density, rainfall and more lineaments density and also have less tilt and height, in terms of weight have greater relative importance and thus are good place for groundwater potentiality. In the studied area, Quaternary Alluvial which consists of old and new terraces and fluvial sediments has the highest relative importance and desirability and terrace deposits and elevated old Foothills Alluvial fans and also Terrace deposits and low height new foothills alluvial fans are considered as good potential areas in the Mahdishahr, Semnan for groundwater. In addition, the high density of the lineaments creates groundwater potential areas. This issue is seen in Shemshak Sandstone formations and Barut and thick layer limestone of the Tizkouh formation that are in the central region.

In conclusion of this research, with the aim of potentiality of the groundwater we can say that obtained results for each area are different (Magesh *et al*., 2012) and using Arc GIS software and the results of the techniques of remote sensing into the factors in identifying potential areas of groundwater, we can traverse the desert and speculate and with a save money and time, areas of groundwater potentiality are easily recognized.

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