Deciphering groundwater potential zones in sand stone terrain Based on GIS applications (Case study: Masjed-e- Soleiman, Iran)

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Abstract
The study area is situated about 100 km in the north east of Ahwaz in the southwest of Iran. The Aghajari sand stone formation covers about 70% of the study area and water demand of the inhabitants are mainly met by springs rising up from the same formation. The aim of this investigation is to find out the most favorable places in this formation for well divining to meet domestic purposes. The field collected data indicated that in places where the sand stone layer is thick, fractures well developed, slope is gentle and soil cover is thin; springs with higher discharge were noticed.. In the present study, the foregoing parameters including; sand stone layer, joint and fracture, soil cover, springs and slope were converted into GIS layers. Then, according to field observations rating was carried out and based on GIS map groundwater potential zones was determined.

Key words: *Deciphering potential zones, ground water, sand stone, GIS*

Introduction
Due to location of Iran in arid and semiarid climatic zone the average annual rainfall is about 240 mm and overall water resources is limiting. An important source of water supply in Iran is groundwater but as a result of low rainfall promising aquifers are also limited. On the other hand the annual water consumption in Iran exceeds 130 BCM and groundwater contribution in some circumstances passes 50% of the total annual utilization. Therefore, attention to groundwater for sustainable development is necessary (Velayati, 2009). In the last few decades a large number of people concentrated on groundwater research (Dawoud & Raouf, 2008; Subba Rao, 2006; Solomon & Quiel, 2006; Sander, 2006; Israil & et al. 2005). But published literature on sand stone and in particular Aghajari sand stone formation in Iran is limited. On the other hand Aghajari sandstone formation occupies a large part of the area and the only source of water is groundwater. Springs with variable discharge are rising from sandstone rock to meet inhabitants water needs. Though, the number of springs is prominent, but on account of low discharge people are in shortage of water.
The main aim of this investigation was to find out the most favorable location with respect to groundwater potential in sandstones rocks of the area. Field data indicated that different parameters are controlling groundwater occurrence. Fracture and joint density, sandstone and marl thickness, soil cover and slope are significant influencing factors. In the present investigation, in order to determine promising groundwater zones each foregoing factors was taken into consideration as a GIS layer. Field evidences have been used to evaluate each GIS layer and to allocate their weight.

Study area

The study area which occupies 680 km^2 is located in Khuzestan province in the southwest of Iran (Fig.1) and bounded between 31° 57′ to 32° 18′ N and 48° 56′ to 49° 22′ E. The average annual temperature and rainfall for the last 35 years are respectively 25.17°C and 445 mm. The area experiences semi-arid climate with high temperature and evaporation in summer.

Geology

The exposed rock formations in the area include Gachsaran (Lower Miocene), Mishan (Middle Miocene), Aghajari (Upper Miocene), Lahbari member (Upper Miocene - Lower Pliocene) and Bakhtiari (Upper Pliocene). The youngest and oldest formations are respectively Bakhtiari and Gachsaran (Fig.1). The Aghajari formation which occupies most part of the area (350 km^2) consists dominantly of sand stone and marl and sand stone incorporate prevailing constitute of Lahbari member.

Structurally, the study area with NE-SE trend is counted as a part of Zagros structural folded belt. The main geological structure is Masjid-e- Soliman fold with NW-SE trending axis and in addition to this, tectonic processes have resulted development of joint and fracture systems and fault zones.

Lineament

In fact, every linear phenomenon is an indicator of surface fracture zone and in turn displaying importance of geologic origin and tectonic event. As linear pattern are index of crust fracturing, therefore, in areas where linear density is increased consistency of joints and fracture is also more. Based on this hypothesis, lineaments are taken into account as groundwater deciphering. Thus, in areas where fracture density is significant water infiltration and transportation into sand stone is being enhanced (khoobyari & et al., 2010). Accordingly, there is a good correlation between fracture zone and high groundwater potential zone in the study area and to keep distance from fracture zones results considerable reduction in permeability. The lineament map of study area is given in figure 2.

Sand stone marl thickness ratio

The present information indicates that occurrence and thickness of sand stone plays a significant role on groundwater occurrence while marl layer is a limiting factor. Therefore, the map showing ratio of sand stone thickness to marl thickness was prepared exhibiting high, moderate, moderate to low, low and very low water potential zones (Fig.3).

Slope

Slope is seriously affecting infiltration rate and steep slope is a constraint factor. In order to visualize slope impact on water occurrence a slope map was depicted in figure 4.

Soil cover

In some parts of the study area soil thickness is remarkable and in the same areas water availability is low. Thus, another governing factor influencing water bearing horizon is marl soil. The soil thickness map is given in figure 5.

Spring

The springs discharge is reflecting groundwater condition of an aquifer (Kresic & Stevanivic, 2010). In the study area spring discharge was taken into account as an index to determine aquifers potential. Therefore, based on discharge a boundary map for springs was prepared and areas locating in higher discharge zone exhibiting more promising aquifers. The springs discharge map of the study area is given in figure 6.

Overlying and groundwater potential map

Based on significant of raster layers in the area a weight was given to them and according to mathematical coincides in GIS, water potential map was prepared. According to this map five water potential zones including very high, high, moderate, low and very low was demarcated (Table 1 and figure 7).

Conclusion

The collected data in the present investigation has indicated that only a fraction of the study is promising with regard to groundwater occurrence. In the most part of the area (50%) aquifers are in moderate condition while 40% of the area suffers from shortage of water and aquifers are very poor.

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Table 1 Water potential zones and percentage area

Zone	Conditions	Area (Km^2)	Percentage
1	Very high	8.5	1.85
2	High	58.5	12.7
3	Moderate	217	47.2
4	Low	151	32.8
5	Very low	25	5.45

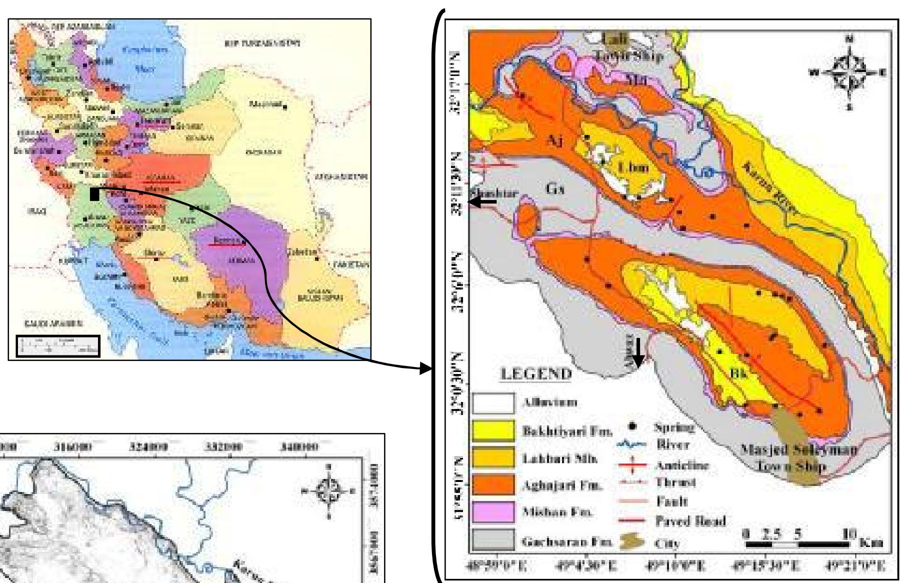

Fig. 1 Location and geological map of the

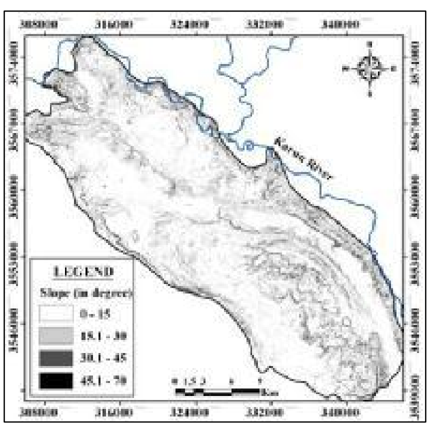

Fig. 4 Slope map of the study area

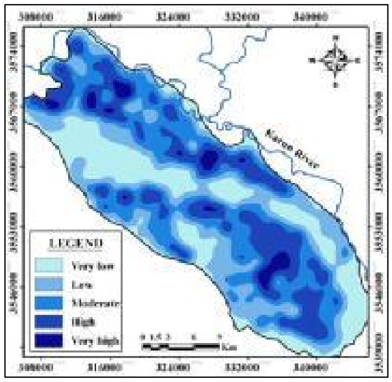

Fig. 2 Lineament density map of

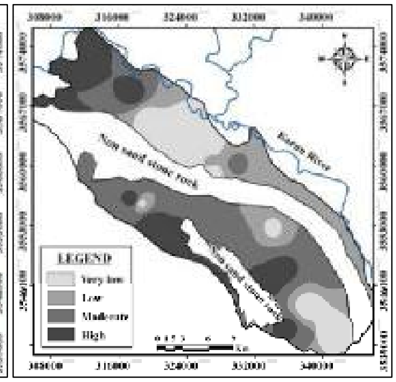

Fig. 3 Sand stone marl thickness

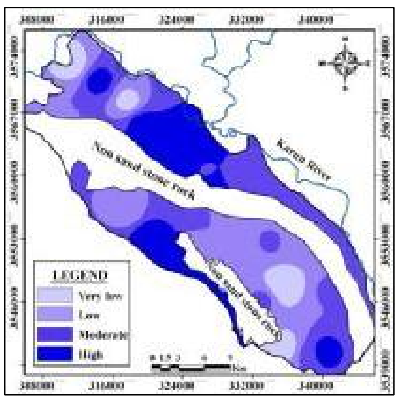

Fig. 5 Soil cover map of the area

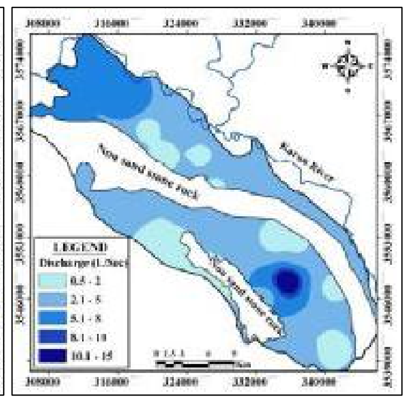

Fig. 6 Springs discharge map of

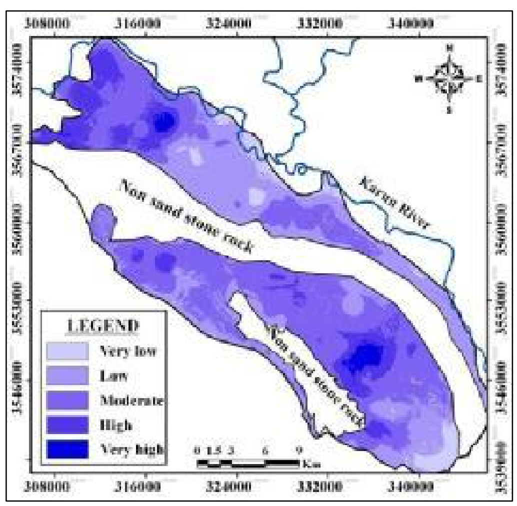

Fig. 7 Groundwater potential