# Groundwater Potential Assessment Using Geographic Information System (GIS) Methods in the Province of Batman, Turkey

Veysel Suleyman Yavuz (Corresponding author)
Department of Civil Engineering, Batman University
E-mail: veysel.yavuz84@gmail.com

Recep Celik
Department of Civil Engineering, Dicle University
E-mail: recep.celik@dicle.edu.tr

Nizamettin Hamidi
Department of Civil Engineering, Dicle University
E-mail: nhamidi@dicle.edu.tr

**Abstract**

Batman is a fast-growing province which the drinking and irrigation water requirements obtained from the groundwater resources. Assessment of the groundwater potential is a very important. In this study it has been used general information regarding the general geological, meteorological, natural resources, and natural water resources concerning to the province of Batman to find out the groundwater potential zones. The logs of the water wells located within the boundaries of the city center and its districts concerning to the public institutions and individuals were also examined. Static water level, dynamic water level and well yield values were classified and the thematic maps were brung out by modeling the data which was obtained from the water wells using the Arc Info GIS program Geostatistical Analyst tool extension. The groundwater level at the referred city centre and its districts together with the purpose of being able to control in the future, a database includes the thematic maps were created. As a result of these thematic maps hydrogeological assessment was evaluated. As a matter of fact that creating the risk maps and modeling the groundwater potential of Batman have an insurance feature to be optimally used water resources. Thus, it is expected that this study will assist for the next studies. It is thought that taking the groundwater potential of the industrial zones as well as the new residential areas into consideration will be more helpful for the researchers to perform further detailed studies.

**Keywords:** Batman, groundwater, static water level, dynamic water level, well yield, GIS (Geographical Information Systems)

## 1. Introduction

Population growth, industrial development, social, economic and cultural changes depending on natural resources, particularly affect the quality of surface and groundwater in a negative way. Natural resources must be protected against contamination in countries with fast developing and limited economic and technical facilities such as Turkey. In particular the protection of groundwater which makes up less water percentage of the world, it is possible with national and international studies. Equal groundwater depth, equal pH, equal EC, equal hardness and equal sulfate maps were created using GIS in the province of Adana, Turkey (Cobanoglu et al., 2006). Çelik (2007) identified the potential of the groundwater using GIS and he created static water level, dynamic water level and pump efficiency map of the Diyarbakir Plain in Diyarbakır, Turkey. Pirna (2012) studied Sweden's Gotland Island and conducted by the map on groundwater benefiting using GIS. Ojo et al. (2015) assessed the groundwater potential of the city of Akure in the southwest of Nigeria with GIS using the geomorphic, geologic and geoelectric information of the study area. They obtained the thematic maps as very low, low, medium and high and divided the region of the groundwater potential. Otherwise, Subramani et al. (2005) studied Chittenden basin which placed in India for assessment of the groundwater for drinking and irrigation and as a result of their study they saw that groundwater isn't suitable for drinking and irrigation in some areas.

This study was carried out in Turkey's Southeast Anatolia Region of the Tigris River Basin located in the province of Batman. Batman is a fast growing province and receive the needs of the drinking and irrigation water from the groundwater resources. Therefore, the potential of the groundwater is more importance. Taking into account of the geological, meteorological, natural resources and natural water sources have been studied to determine the potential of the groundwater. The data of the wells obtained from both government agencies and personal contact was used and the thematic maps was created using ArcGIS 10.2 software. Thus, it was tried to determine the assessment of the groundwater potential of the central of Batman and its districts with the created thematic maps below.

## 2. Material and Method

### 2.1. Study Area

Batman is located in the Southeast of Turkey's Tigris Basin. The city center, Beşiri, Gercüş, Hasankeyf, Kozluk and Sason are its districts. As we can see from figure 1, it is stated 41 degrees 10 minutes and 41 degrees 40 minutes in the east longitude, 38 degrees 40 minutes and 37 degrees 50 minutes in the north latitude. Altitude is 550 m. It is covered Diyarbakir from west, Bitlis and Siirt from east, Muş from north and Mardin from south.

### 2.2. Geological and Hydrogeological Characteristics

General geological structure of the province of Batman is Selmo formation, Silvan-Germik formation and Midyat Formation. Gercüş, Hasankeyf, Sason and Kozluk are widely seen around Midyat Formation. The city centre and Beşiri it can be seen Selmo Formation predominate. The province's groundwater aquifer is conglomerate. Batman River alluvions provides the needs of drinking water in these regions. Groundwater depth in this area is around 9-10 m. Lahti Formation which consist of conglomerate and sandstone are efficient units by means of the groundwater region that distributed in the southeast of the province. The water level in Lahti Formation is between 25-30 m (Batman Provincial Environmental Status Report, 2013).

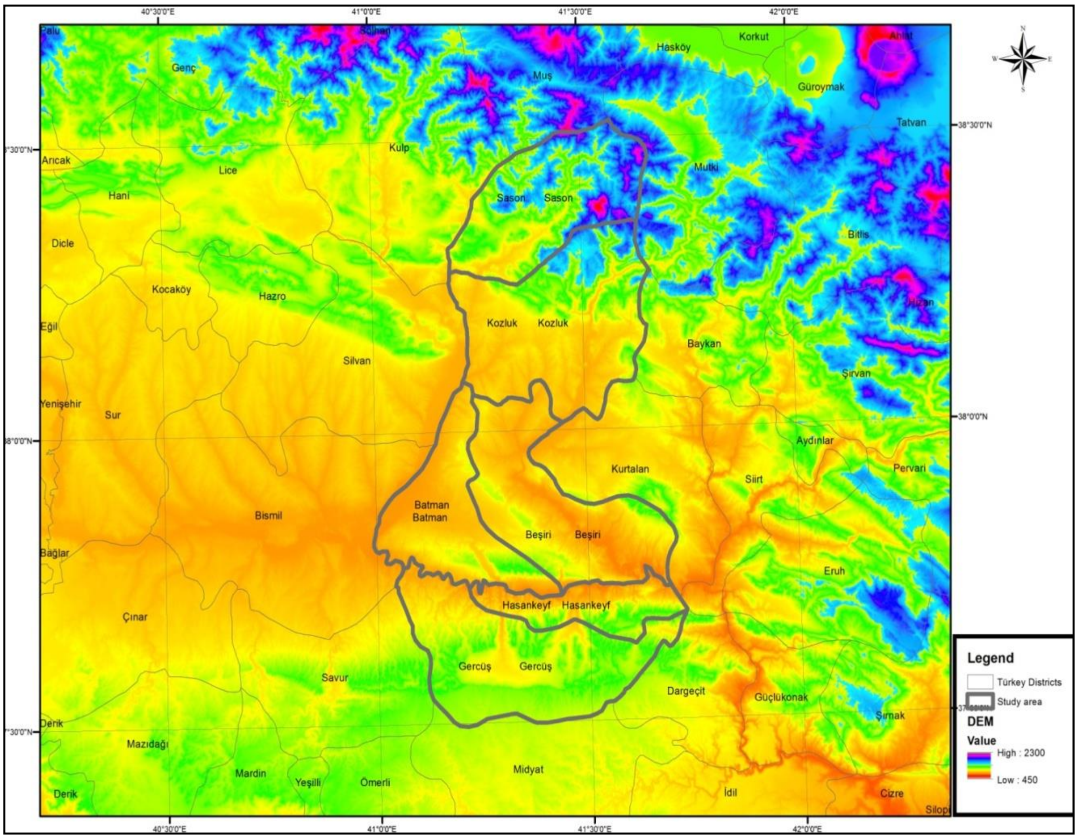


Figure 1. Study Area

 

### 2.3. Meteorological Characteristics

Batman has a continental climate with cool and rainy winters and hot and dry summers. The average number of rainy days are 86, the annual average rainfall of 472 kg/m$^2$ realized (Batman Provincial Environmental Status Report, 2013). According to the data of the Ministry of Forestry and Water Affairs, Turkish State Meteorological Service (2016), the average temperature between the years 1950 to 2015 as can be seen from Table 1 and Table 2, the highest values in July and August, and the lowest values are in December and January. Average sunshine duration is 12.2 hours in July, with the average number of rainy days took place in March and April. However, the average monthly total rainfall of 74.7 kg/m$^2$ is for the month of March.

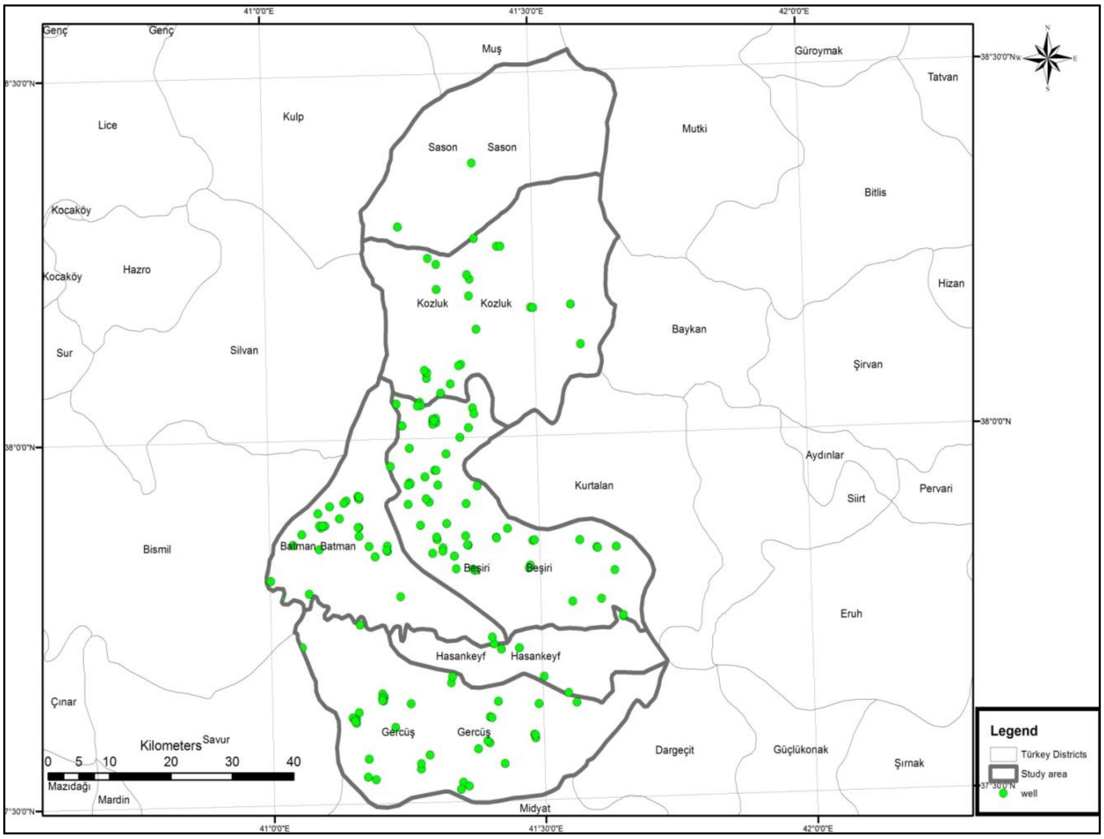


Figure 2. Well Location

Table 1. Average values that occur over many years belong to Batman (1950 - 2015) (MGM, 2016)

| Months | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average temperature (°C) | 2.7 | 5.0 | 9.6 | 14.6 | 19.8 | 26.7 | 31.2 | 30.2 | 24.9 | 17.7 | 9.9 | 4.5 |
| Average Maximum Temperature (°C) | 7.6 | 10.5 | 15.8 | 21.6 | 27.7 | 34.9 | 39.4 | 39.4 | 34.4 | 26.6 | 16.9 | 9.6 |
| Average Minimum Temperature (°C) | -1.5 | 0.1 | 3.6 | 7.9 | 11.4 | 15.9 | 20.3 | 19.7 | 15.1 | 10.1 | 4.1 | 0.4 |
| Average Sunshine duration (hour) | 3.1 | 4.3 | 5.4 | 7.2 | 9.3 | 11.5 | 12.2 | 11.3 | 10.0 | 7.0 | 5.2 | 3.0 |
| Average Number of Rainy Days | 11.0 | 10.4 | 11.6 | 11.6 | 8.1 | 2.3 | 0.4 | 0.4 | 1.1 | 5.8 | 7.4 | 9.9 |
| Average Monthly Total Precipitation (kg/m$^2$) | 60.2 | 68.6 | 74.7 | 73.8 | 46.6 | 7.0 | 0.7 | 0.7 | 3.9 | 32.6 | 55.1 | 65.6 |

 

Table 2. The highest and lowest values occurred over many years belong to Batman (1950 - 2015) (MGM, 2016)

| Months | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Highest Temperature (°C) | 18.2 | 23.5 | 30.6 | 35.8 | 42.0 | 45.1 | 48.8 | 46.2 | 43.8 | 37.0 | 28.6 | 22.6 |
| Lowest Temperature (°C) | -24.0 | -22.2 | -17.0 | -9.0 | 0.9 | 5.0 | 11.8 | 11.1 | 4.4 | -3.0 | -7.8 | -23.0 |

### 2.4. Obtaining Thematic Maps

In this study, around 150 water wells which drilled for irrigation and drinking water were analysed. The coordinates of the data of water wells were observed and exploited (figure 2). Well drilling data were collected in the Microsoft Excel program and in a digital map layer in GIS program. The ESRI ArcGIS Desktop-Arc Info 10.2 software was used in this study to process and create map layers. ED_1950_UTM_ Zone_37N projection, is used in all of the maps. ESRI the geostatistics analysed extension was used for obtaining these maps was used for obtaining thematic maps.

The thematic maps in this study are the static water level map (figure 3), the dynamic water level map (figure 4) and the well yield map (figure 5). The results and recommendations of these maps can be written as follows.

## 3. Results and Suggestions

1. Areas are suitable for use as a spring and artesian wells in the southwest of the city center. Where the Zilek spring water is in the area and according to the studies it has the capacity to supply the needs of drinking water of the city.
2. Likewise, the static water level in the central part of Kozluk in the range of 1-20 m and the dynamic water level is 4-30 m range. In these areas, as well as spring water or artesian wells can be used.
3. Sason which have the large wooded area of the province and mountainous topography, in these areas the static water level is around 20-40 m and the dynamic water level is between 55-85 m.
4. The two great plains of the province of Batman; Batman Plain (city center) and Beşiri Plain (Beşiri) are areas where agriculture yield is very high. These two plain areas are not appropriate to drill for irrigation. As it can be seen from the wells yield map it can be said that it is not efficient in many of these regions.
5. The city center providing drinking water needs to be proof of the Batman River alluvium, it is extremely important in terms of water quality. This region has remained static water level is low between the dynamic water level is 85-140 m.
6. Gercüş, in areas close to the center of the static and dynamic water levels are low because of the Kırkat Pond built for irrigation purposes.
7. As a general well drilling for the city is not seen to be productive. Instead of drilling the water wells it is suggested that increasing the presence of irrigation canals.

 

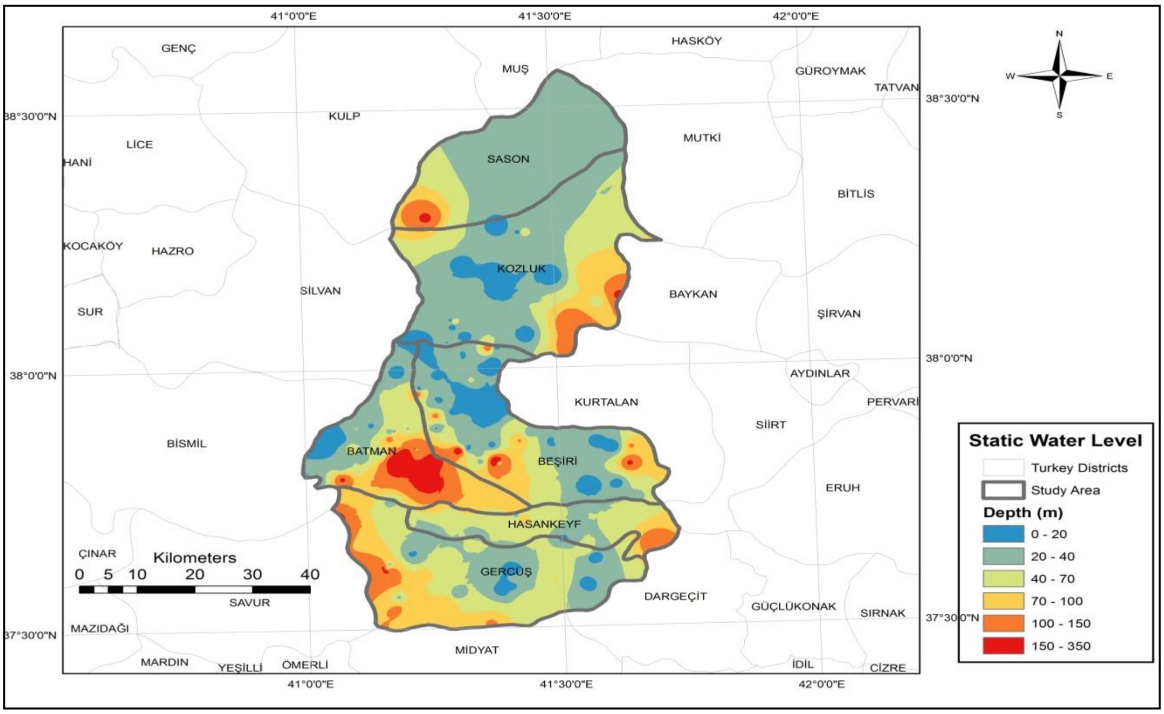


Figure 3. Static Water Level Map

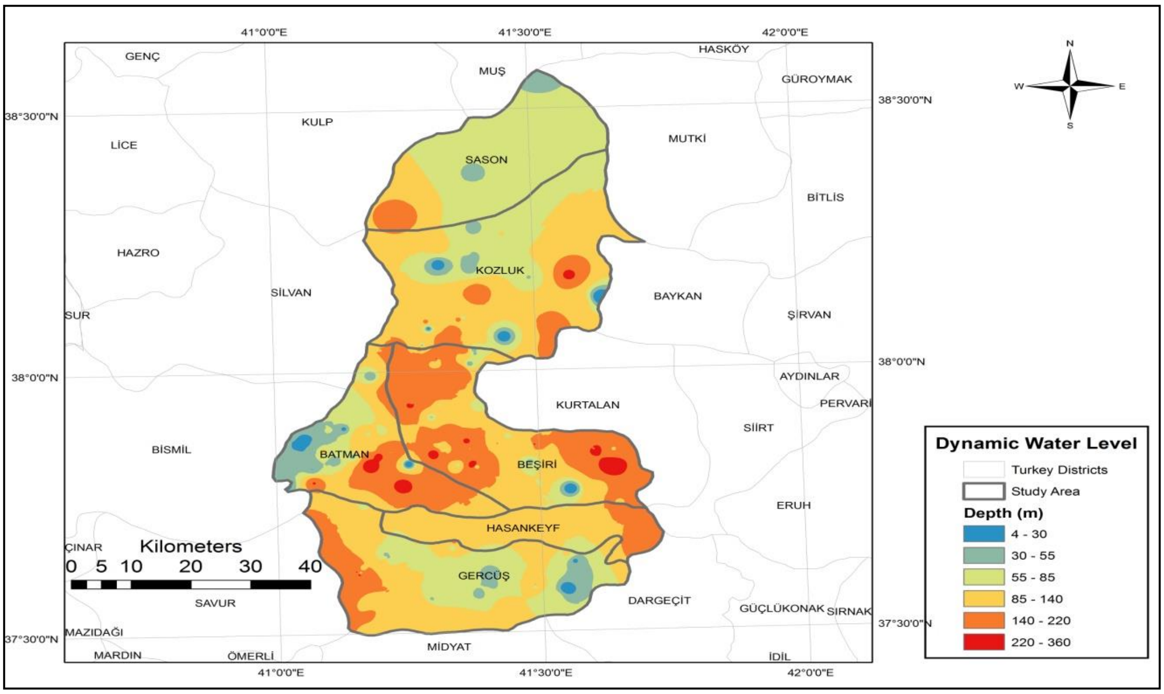


Figure 4. Dynamic Water Level Map

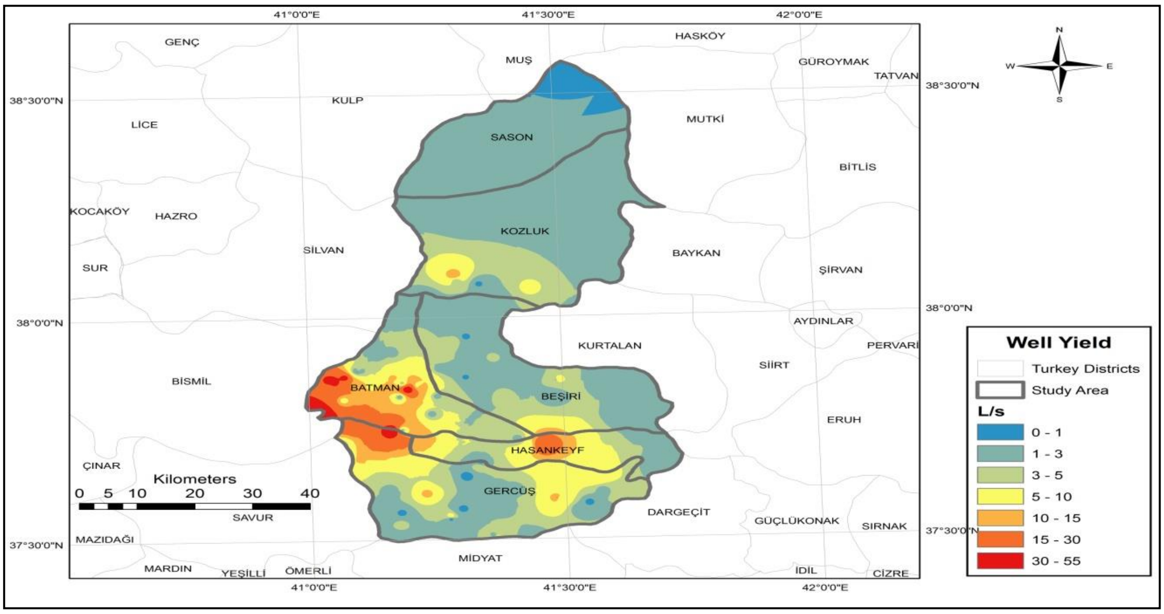


Figure 5. Well Yield Map

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