
Khalid H. Abbas Al-Aarajy¹*, Maitham A. Sultan², Zainab H. Mohammed Hassan¹

¹ Remote Sensing and GIS Department, College of Science, University of Baghdad, Baghdad, Iraq
² Ministry of Science and Technology- Environment, Water and Renewable Energy, Iraq
* khalid.h@sc.uobaghdad.edu.iq

Abstract

Freshwater found underground in the tiny spaces (pores) of soil and rocks is known as groundwater. Groundwater is a valuable resource that considerably contributes to the yearly supplies. To preserve water quality and oversee groundwater systems, evaluation of the potential zone of groundwater recharge is crucial. Using remote sensing and Geographic Information System (GIS) tools, groundwater potential zones are identified. This study proposes to use satellite imagery and the software program (ArcGIS) to find a groundwater potential zone in Babylon City, Iraq. A groundwater map has been created using various data, namely slope, drainage density, lineament density, land use/land cover, geology type, soil type, and rainfall map. All these data are collected using a weighted overlay tool. Five categories were created based on the groundwater results: very poor, poor, moderate, good, and exceptional. The 'good' class covers about 32% of the study area. The current study shows that excellent groundwater class exists in Al-Hindiyah Dam, Al-Muhaweel, Al-Midhatiyah, Al-Kifil, and Al-Mashru’a. The excellent groundwater class in Al-Shommali covers approximately 198.0054 km². Certain areas like Al-Musaib Center, Al-Hilla Center, Al-Hashimiyah, and Abi Garaq don’t have much groundwater. The moderate and excellent classes cover around 19% of the study area. The main conclusion is that Remote Sensing and GIS have gained recognition as a practical approach to mapping groundwater potential zones due to their ability to integrate diverse spatial data.

Keywords: Groundwater; Remote sensing; Geographic Information System (GIS); Water quality; Potential zones

1. Introduction

The management of groundwater resources must rely on the application of contemporary methods and scientific ideas, such as a multi-criteria approach based on GIS to pinpoint regions with groundwater potential (Al-Manmi et al., 2016). Groundwater, one of the most significant natural resources, supports human health, economic progress, and ecological diversity. It is now an extremely crucial and dependable source of water produced in all climate zones. For both urban and rural areas of both advanced and developing nations, due to its many inherent qualities; constant temperature, wide-spread, and sustainable availability, great natural quality, limited weakness, low development price, drought reliability (Preeja et al., 2011). From a hydrogeological investigation aspect, locating potential sites can be defined as the possibility of groundwater occurring in an area. Appropriate assessment of groundwater potential can help as useful guidelines for the decision maker in recognizing suitable groundwater policies within an area and appropriate management of the aquifer system in a sustainable

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method. Potential maps are also utilized in the process of choosing appropriate well locations, which aids in the efficient planning of groundwater (Karim, 2019). Freshwater supplies are under extreme pressure worldwide due to water scarcity, particularly in emerging nations. Since groundwater can be accessible more simply and affordably, it is widely employed for various applications. Because of excessive groundwater extraction, the level of groundwater is decreasing.

Increasing water demand follows population growth, economic development, and changing consumption patterns; although many countries are already experiencing water scarcity conditions. Many more countries will face a reduced availability of surface water resources by 2050. More than 30% of the world's largest groundwater systems are now in distress. The largest groundwater basins are being rapidly depleted in many places. According to Ferguson et al. (2018), the world's supply of fresh water may be much more limited than what is thought because unlimited groundwater was assumed. Challenges more severe than global are expected at regional and local scales (Boretti and Rosa, 2019).

The rate at which groundwater is being exploited prevents the water table from making up its losses. When compared to the pace of extraction, the recharge procedure is insufficient. As a result, during the pre-monsoon season, shallow aquifers are drying up. Significant areas of the country are experiencing conditions similar to drought (Biswajit et al., 2018). By considering these elements, groundwater potential can be targeted in several ways. Geological, geophysical, and remote sensing techniques are applicable and have been studied by numerous scientists. The approaches' levels of efficiency differ; some are more precise, efficient, cost-effective, and timesaving than the traditional approaches, which take a lot of time and money. Furthermore, it is possible to evaluate and store vast volumes of geospatial data and designate groundwater potential using various techniques; thanks to the integration of GIS and remote sensing investigations (Hemayatullah et al., 2020). GIS and Remote Sensing have become useful tools for accessing, monitoring, and protecting groundwater resources due to the advantages of spatial, spectral, and temporal availability and the ability to manipulate data covering large and unreachable areas quickly. It has also been found that, in addition to helping identify potential groundwater exploration areas, remote sensing contributes to estimates of the total groundwater resources in an area (Erhan et al., 2004).

Groundwater vulnerability in Babylon Governorate was assessed and the results showed that it is an extremely low-to-low grade (Qais et al., 2016). Studying groundwater quality in arid and semi-arid regions is essential and significant because it is used as a foremost alternative source for various purposes; human and animal consumption, economics, agriculture, and irrigation, (Fatah et al., 2022). Groundwater is one of the most important natural resources stored in geological formations. The current developments such as population growth and urbanization affect groundwater in most countries (Ramzi and Al-Gburi, 2022). The current study aims to predict and verify the presence of groundwater in Babylon City, based on many parameters that have a direct impact on the accumulation of this water in the ground, based on the spatial analysis tools in the Arc Map program.

2. Study Area

The study area is within the Governorate of Babylon, which has a population of about 2,065,042 people. It lies between longitudes 44°50' E and 45°00' E and latitudes 35°55' N and 36°00' N, with a total cover area of 5469.45 km² (Fig.1). The city's climate fluctuates daily and seasonally, and it is situated in an arid region. The district is mostly affected by an annual wind that blows at an average annual speed of 7.2 km/h and originates from the northwest. Summertime temperatures are above 50 °C, accompanied by dry heat waves and minimal precipitation. The district receives less than 100 millimeters of rain per year on average, and its relative humidity is 46%. Moderate wintertime temperatures rise above 0 °C (Chabuk et al., 2020).
3. Geological Description

Topographically, Babylon Governorate is characterized by a gentle gradient of about 22 cm/km, where the ground descended from the northern and northwestern sides towards the eastern and southeastern parts (Al-Jubouri, 2002). Yacoub (2011) summarized the stratigraphy of the Mesopotamian region, the sequence of deposits can be summarized from: Pliocene-Early Pleistocene Rock Units: These are represented by the Bai Hassan, Dibdibba formations. The Bai Hassan Formation is found in the studied area, whereas the other formations are located in other locations in the Mesopotamia Plain. Then, Pleistocene Sediments. These are sediments of the Mesopotamia Fluvial Basin, alluvial fan sediments, and river terraces. The study area contains fluvial sediments and some river terraces.

In addition, there are Pleistocene-Holocene Sequences: These are the Sheet Run-off sediments, slope sediments, and gypcrete. This type of sediment is not observed in the study area. In addition to the Holocene Sequence: This is the existing sedimentary environment. This type of sediment covers the majority of Mesopotamia Plain. They represent the upper part (about 15 - 20 m) of the Quaternary sediments of the Mesopotamia Plain. The Holocene sequence contains different types of sediments like fluvial, deltaic, lacustrine, and estuarine/marine units. However, the types that cover the study area are mostly floodplains of the Euphrates and Tigris rivers, and some Aeolian sediment exists in the north and south of the studied area.

According to Jassim and Goff, 2006, the research area is located within the Mesopotamian plain on the unstable shelf, and the sediments of the recent Quaternary Period cover it. These sediments consist of the Euphrates River flood sediments and their streams (Al-Turaihi, 2022). The sediments that fill the depressions that resulted from the floods consist of thin layers of fine sand, clay, and alluvial clay (Al-Mashhadani, 2022). The location of the selected area is situated in the center of Iraq, in the Mesopotamia Zone Aquifer (Al-Madhлом et al., 2020; Al-Jiburi and Al-Basrawi, 2011). In an extensive level plain (Fig.2), the study area ranges in heights from 200 m (a.s.l.) in the Mesopotamia Zone in the north to 1 m (a.s.l.) in the Arabian Gulf (Al-Madhлом et al., 2020). The majority of the Mesopotamia Plain is
covered by Quaternary sediments, which are degraded by the fluvial system. The Holocene Sequence, which has a thickness of roughly 15-20 meters and is primarily made up of silty clay, loamy sand, and sandy loam soil, covers the majority of the sedimentary plain (Tyagi et al., 2013).

Hydrologically, and because the study area is characterized by its low slope, and the presence of many shallow unconfined aquifers represented by modern Quaternary unconfined deposits, the movement of shallow groundwater flow is from the area surrounding the Babylon River towards distant areas. In the study area, this movement direction is controlled by different factors such as soil permeability, withdrawal from groundwater, recharge conditions, locations, and topographic settings, localized surface sources, precipitation, and evapotranspiration (Al-Ibrahim and Ghalib, 2018).

The groundwater piezometric level of the plain is based on the assumption of the hydraulic continuity within the entire Quaternary aquifer system. This means that all the aquifers in the plain are in a hydraulic continuity, which depends on the degree of lithification (Al-Jiburi and Al-Basrawi, 2011). The geological map of Babylon City is depicted in Fig. 2.

**Fig. 2.** Geological map of Babylon City (Sissakian and Fouad., 2015)

### 4. Methodology

ArcGIS 10.8 software was used to analyze the satellite imagery data of Landsat 8, where the data was taken in November 2021 with a spatial resolution of 30 m. In addition, a Digital Elevation Model (DEM) was used from ALOS Satellite with a high spatial resolution of 12.5 m. Surface and subsurface geology, along with climate, play a major role in determining the availability of groundwater regions as a supply of water. Therefore, many factors were adopted in this research; such as annual rainfall map, geological characterizations, soil type data, DEM, drainage density, lineament density, slope map, and Land use – Land cover (LULC).
5. Results and Discussion

5.1. Land Use - Land Cover (LULC)

The earth’s surface is covered with natural and cultural features; these features are classified into categories which are called land use and land cover (Bety, 2013). Land use describes a certain ground area, such as whether it is used for agriculture, mining, or buildings. The types of activities in an area are called the land use patterns of that area. The land cover classification, in the same way, classes a type of ground according to how living organisms and actions such as deforestation and urbanization have altered its surface. (Fig. 3) depicts the LULC map created using Arcmap10.8 and supervised classification from Landsat 8 satellite data. Also, it is important to mention that there is no one ideal classification of land use and land cover, and it is unlikely that one could ever be developed, (Bety, 2013; Khalid, 2023).

![Fig. 3. LULC of Babylon Governorate in 2021](image)

5.2. Soil Type

The properties of the soil significantly influence the infiltration of water. The soil's ability to absorb is dependent on its composite. Soil texture directly affects the permeability and porosity of a medium. Due to its porosity and permeability, fine-grained soil has a lower infiltration capacity than coarse-grained soil (Deepak, 2019). There are four soil types in Babylon City (clay, clay loam, loam, and loamy sand), as shown in Table 1, and Fig. 4.
Table 1. Soil permeability Classes and saturated hydraulic conductivity ranges are calculated from the main textural soil classes (Panos et al., 2014).

<table>
<thead>
<tr>
<th>Permeability class (p)</th>
<th>Texture</th>
<th>Saturated hydraulic conductivity, mm h⁻¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (fast and very fast)</td>
<td>Sand</td>
<td>&gt; 61.0</td>
</tr>
<tr>
<td>2 (moderate fast)</td>
<td>Loamy sand, sandy loam</td>
<td>20.3 - 61.0</td>
</tr>
<tr>
<td>3 (moderate)</td>
<td>Loam, silty loam</td>
<td>5.1 - 20.3</td>
</tr>
<tr>
<td>4 (moderate low)</td>
<td>Sandy clay loam, clay loam</td>
<td>2.0 - 5.1</td>
</tr>
<tr>
<td>5 (slow)</td>
<td>Silty clay loam, sand clay</td>
<td>1.0 - 2.0</td>
</tr>
<tr>
<td>6 (very slow)</td>
<td>Silty clay, clay</td>
<td>&lt; 1.0</td>
</tr>
</tbody>
</table>

5.3. Geological Map

According to the geological map for the study area, there are three types of Deposits (Aeolian Deposits, Flood Plain, and River Terraces). River terraces are usually composed of coarse sediments, such as gravel and sand, that can easily allow water to pass through them. On the other hand, floodplains and aeolian deposits are composed of finer sediment, such as silt and clay, limiting the material's permeability and reducing water flow. However, it is worth noting that the permeable water through specific sediments can depend on various factors such as the grain size distribution, sediment composition, and geological history, so it is essential to evaluate each site individually.

In the study area, the best permeability was found in floodplains, river terraces, and Aeolian Sediment (Fig. 5).
Rainfall is the primary source of recharge for groundwater systems. Because rainfall and groundwater are intimately associated. Climate change poses a strong threat to the world; especially in Iraq, which is considered one of the arid and semi-arid regions. The climatic changes lead to an increase in the demand for groundwater, especially with low rainfall and an increase in the population (Al-Gburi et al., 2022).

The water table is the topmost level of the saturated zone where groundwater is located. When it rains, a certain amount of water seeps into the ground, passing through the unsaturated zone and eventually reaching the water table. Several elements, including soil characteristics, vegetation cover, and land use, affect how much water permeates into the soil and reaches the water table. On the other hand, groundwater recharge can be severely constrained in low-precipitation locations like deserts and arid regions, where groundwater levels may even be nonexistent (Bridget, et al., 2012). Modifications to rainfall patterns or intensity can also impact groundwater recharge. For instance, protracted droughts can result in decreased recharge and groundwater resource depletion, but intense rainfall events can bring about quick recharge and localized flooding. Human activities; like urbanization or agricultural irrigation can also change how groundwater systems are naturally recharged and impact groundwater levels. The recharging and sustainability of groundwater systems depend mainly on rainfall, and variations in rainfall patterns can significantly impact groundwater resources.

The classification of rainfall in Babylon Governorate is shown in Fig. 6 which is divided into 5 classes. Each class represents a significant amount of the annual rainfall in the area, and the values are \(\leq (0.238, 0.308, 0.378, 0.449, \text{ and } 0.519)\), with the number one in the legend denoting the value of the lowest class, which is \(\leq (0.238)\), and the highest class, which is \(\leq (0.519)\).
5.5. Analyzing Terrain Slope Using DEM

The horizontal distance of the contours explains one of the crucial terrain factors known as slope. Densely spaced contours in the vector form often indicate higher slopes, whereas sparse contours typically show intermediate slopes. In the elevation output raster, however, a slope value is present in every pixel. In this case, softer slopes are represented by smaller slope values, and steeper slopes are represented by greater slope values. Finding the greatest rate at which each cell's value changes about its neighbors in the elevation raster yields the slope. The slope values are computed in vector and raster representations in either percentages or degrees (Waikar, 2014; Fouad, 2023). The slope was estimated from the Digital Elevation Model (DEM), as shown in Fig. 7.
Where from this figure can be noted that the five slope classes range from 1 to 5. Class 1 represents the smallest slope value (0 degrees) and is shown in black color; class 5 represents the highest slope value (46 degrees) in light yellow.

5.6 Analysis of Drainage Density

Understanding the characteristics of runoff and groundwater penetration in any region is made easier by drainage density. Values of drain density using the natural break approach, the total length of drainage channels per unit area were calculated. Higher infiltration and lower runoff indicate areas with poor drainage density (Suganthi et al. 2013). There are five classes of drainage density shown in Fig. 8 class five, which is depicted in light blue, has the highest drainage density value. This means this area has the most enormous water flow and the lowest water permeability and infiltration levels. Dark blue class 1 represents the smallest drainage density value, implying the highest infiltration and water permeability, this can be shown in Fig. 8 which represents the Drainage Density in the study area.

5.7. Lineaments and Groundwater Results

Lineaments, identified by their relatively linear alignments, are structurally regulated linear or curved features observed in satellite imagery. These characteristics communicate the surface topography beneath the structures. Lineaments are where faulting and fracturing have occurred, leading to more permeability and secondary porosity. These elements are crucial from a hydro-geological perspective because they create channels via which groundwater can circulate. Because lineaments usually denote a permeable zone, the density of lineaments in a given location may indirectly reveal the groundwater potential. Groundwater potential zones benefit from high lineament density areas (Magesh et al. 2012). There are only a few curved features in Babylon Governorate, so the areas with a high value for lineament are low. For example, in Fig. (9), the yellow region represents the maximum value of
lineament density, and dark blue represents the minimum value. Estimating these values depends on a DEM after converting it to hill shades in different solar angles, such as (90°, 100°, and 200°), etc, by using the ArcMap software program.

5.8. Integrating Geographic Data in ArcMap for Groundwater Assessment

Seven layers were created for the study area using ArcMap software to determine the availability of groundwater as a water source by depending on some studied geological factors that are including (Sediment type, Soil type, Slope, LU/LC, Rainfall, Drainage density, and Lineaments density), were extracted by gathering all of these factors using the weight overlay tool. A specific weight was assigned to each factor, as shown in Table 2. The data set obtained in this research included data sets that indicate the presence of groundwater, to find potential groundwater areas in the study area.

![Lineament density of Babylon Governorate](image)

**Fig. 9.** Lineament density of Babylon Governorate

**Table 2.** Classification of the groundwater factors with their weights

<table>
<thead>
<tr>
<th>Factors</th>
<th>Individual class</th>
<th>Score of each class</th>
<th>Parameter weight</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sediment type</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aeolian Sediment</td>
<td>3</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>River terraces</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flood plain</td>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loam</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clayey Loam</td>
<td>4</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td><strong>Soil type</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clay</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loamy Sand</td>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 - 1.2</td>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2 – 2.9</td>
<td>8</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td><strong>Slope (in degree)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.9 – 4.5</td>
<td>5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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5.9. Mapping Groundwater Potential Zones

Integrating different thematic maps, which included (Deposit type, soil type, rainfall, LULC, slope, drainage density, and lineament density), created the groundwater zones for the study area. These zones were delineated for the research area by collecting the interpreted layers using weighted multiple influencing factors and assigning separate potential zones. The results from this study indicated that the Babylon Governorate has five classes for the groundwater potential zones: very poor, poor, moderated, good, and excellent (Table 3).

As shown in Fig. 10, the fifth class in white color represents an excellent groundwater zone of about 19% of the total groundwater potential zone. It is concentrated in Al-Hindiyah Dam, Al-Muhaweel, Al-Midhatiyah, Al-Kifil, Al-Mashru’a, and Al-Shommali, which contain excellent groundwater with a high concentration of about 1029.36 km², as shown in Table 4 above region contain excellent groundwater due to the widespread of agriculture and high plantation, as well as the distribution of loam soil types and floodplains. These parameters are contributors to the formation of groundwater. The fourth class (good) is the largest zone in the study area; compared to other classes and covers about 32% of the governorate; it is found in abundance in each Jarf Al-Sakhlar, Al-Shomali, Al-Qasim, Al-Muhaweel, Al-Midhatiyah, Al-Kifil, Al-Imam and Al-Mashru’a, which contain ‘good’ groundwater class covering 316.50 km². The third class is moderate and covers about 19% of the study area, it is located in Al-Muhaweel, Al-Iskandariyah, Al-Imam, and found with a large amount in Al-Mashru’a region with a cover of about 307.80 km². Poor class, which covers about 3% of the study area. It is
located in Al-Mashru’a, Al-Iskandriyah, and Al-Qasim, which has the greatest area of this class. The first class is located in regions with high water flow (drainage density), dense building distribution, and other factors, which represent the very poor groundwater zone; as shown with a dark blue color in Fig. 10, it is located in Al-Talieuh, Al-Qasim, Al-Muhaweel, Al-Midhatiyah, Al-Mashru’a, Al-Kifil (Table 4).

![Groundwater Potential Zones of Babylon Governorate](image)

**Table 3.** Properties of classes.

<table>
<thead>
<tr>
<th>Number</th>
<th>Name</th>
<th>Color</th>
<th>Area (km²)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Very poor</td>
<td>Dark blue</td>
<td>1488.215</td>
<td>27</td>
</tr>
<tr>
<td>2</td>
<td>Poor</td>
<td>Blue</td>
<td>143.9595</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>Moderated</td>
<td>Bluish leaden</td>
<td>1058.488</td>
<td>19</td>
</tr>
<tr>
<td>4</td>
<td>Good</td>
<td>Light blue</td>
<td>1725.04</td>
<td>32</td>
</tr>
<tr>
<td>5</td>
<td>Excellent</td>
<td>White</td>
<td>1029.36</td>
<td>19</td>
</tr>
</tbody>
</table>

**Table 4.** Information about groundwater classes for each region

<table>
<thead>
<tr>
<th>Regions of Babylon</th>
<th>Class name</th>
<th>Area in km²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very poor</td>
<td>80.6841</td>
</tr>
<tr>
<td></td>
<td>poor</td>
<td>11.5209</td>
</tr>
<tr>
<td>Al-Hindiyah Dam</td>
<td>Moderated</td>
<td>21.1194</td>
</tr>
<tr>
<td></td>
<td>Good</td>
<td>39.6801</td>
</tr>
<tr>
<td></td>
<td>Excellent</td>
<td>126.1827</td>
</tr>
<tr>
<td></td>
<td>Very poor</td>
<td>35.8659</td>
</tr>
<tr>
<td></td>
<td>poor</td>
<td>9.5643</td>
</tr>
<tr>
<td>Jarf Al-Sakher</td>
<td>Moderated</td>
<td>54.0477</td>
</tr>
<tr>
<td></td>
<td>Good</td>
<td>180.7056</td>
</tr>
<tr>
<td></td>
<td>Excellent</td>
<td>53.8965</td>
</tr>
<tr>
<td></td>
<td>Very poor</td>
<td>126.9027</td>
</tr>
<tr>
<td></td>
<td>poor</td>
<td>53.3965</td>
</tr>
<tr>
<td>Al-Talieuh</td>
<td>Moderated</td>
<td>51.9264</td>
</tr>
<tr>
<td></td>
<td>Good</td>
<td>63.7677</td>
</tr>
<tr>
<td></td>
<td>Excellent</td>
<td>55.9566</td>
</tr>
<tr>
<td></td>
<td>Very poor</td>
<td>82.407</td>
</tr>
<tr>
<td>Al-Shomali</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

272
poor 
Moderated 
Good 
Excellent 
Very poor 

Al-Qasim 

Moderated 
Good 
Excellent 
Very poor 

Al-Musib Center 

Moderated 
Good 
Excellent 
Very poor 

Al-Muhaheel 

Moderated 
Good 
Excellent 
Very poor 

Al-Midhatiyah 

Moderated 
Good 
Excellent 
Very poor 

Al-Mashrui'a 

Moderated 
Good 
Excellent 
Very poor 

Al-Kifil 

Moderated 
Good 
Excellent 
Very poor 

Al-Iskandariyah 

Moderated 
Good 
Excellent 
Very poor 

Al-Hilla Center 

Moderated 
Good 
Excellent 
Very poor 

Al-Hashimiyah 

Moderated 
Good 
Excellent 
Very poor 

Al-Imam 

Moderated 
Good 
Excellent 
Very poor 

Abi Garaq 

Moderated 
Good 
Excellent 

6. Conclusions

- RS & GIS has gained recognition as a practical approach for mapping groundwater potential zones; due to their ability to integrate diverse spatial data.
This study successfully identified some characteristics of groundwater and its relationship with natural and anthropogenic factors in the Babylon Governorate.

In conjunction with ArcGIS, the DEM has proved particularly useful in analyzing and identifying slope, drainage density, and lineament density from satellite data.

The resulting groundwater map was segmented into five categories based on abundance: very poor, poor, moderate, good, and excellent. The findings of this research were noteworthy, with the class “good” comprising about 32% of 1725.04 km², which is primarily located in the northeastern region of Babylon Governorate, specifically the Al-Mashru’a region, where it covers about 316.50 km².

The moderate and excellent classes have an unexpected similarity; each comprises approximately 19% of the total discovered groundwater.

The abundant presence of agricultural, loamy soil types and floodplains greatly contribute to the existence of excellent groundwater. This is evident in areas like Al-Hindiyah Dam, Al-Muhaweel, Al-Midhatiyah, Al-Kifil, Al-Mashru’a and Al-Shommal.

The poor groundwater class accounted for the smallest proportion of the total discovered groundwater classes; 3%, where most of this class is located in the Al-Kifil region due to the high water flow, numerous buildings, clay and loamy clay soil, and various other factors that affect water permeability.

This study emphasizes the significance of utilizing GIS and remote sensing techniques in groundwater zones mapping. In contrast, regions such as Al-Musayib Center, Al-Hilla Center, Al-Hashimiyah, and Abi Garaq exhibited the lowest percentages of all groundwater class zones.

References


