(IJPS) 2025, Vol. No. 20, Jul-Dec **e-ISSN: 2455-6270 p-ISSN: 2455-7455**

Studying the Optimal Investment of Land and Water Resources in Babil Governorate by using Geographic Information Systems

Ass. Prof. Dr. Nagham Mansour Obaid

Department of Geography, College of Education - Ibn Rushd, University of Baghdad, Iraq.

DOI:10.37648/ijps.v20i01.008

[1]*Received: 23/06/2025; Accepted: 11/07/2025; Published: 20/07/2025*

Abstract

This study analyzes the current status of land and water resource investment in Babylon Governorate, aiming to identify optimal strategies to maximize utilization using Geographic Information Systems (GIS). Poor planning and inefficient resource allocation challenge agricultural and environmental development. Using spatial and environmental data, a geospatial database was built and analyzed to produce maps showing soil distribution, water sources, and land uses. Results revealed spatial variability with high potential agricultural investment areas mainly in northern and western parts of the governorate. The study recommends adopting spatial analysis tools in strategic planning and establishing an updated geodatabase to support sustainable development decision-making.

Keywords: *Babel Governorate; Geographic Information Systems (GIS); optimal investment; water resources; land uses.*

1. Introduction

Babylon Province is characterized by the diversity of its natural resources, especially agricultural land and surface and groundwater. However, these resources face multiple challenges represented by population growth, climate change, soil degradation, and increasing food demand. In this context, the importance of employing Geographic Information Systems (GIS) technologies emerges in analyzing these resources and planning for their optimal investment to achieve sustainable development.

2. Research Problem

Despite the abundance of agricultural land and the availability of surface and groundwater, Babel Governorate suffers from a weakness in the mechanisms for scientifically and strategically investing these resources, leading to a decline in agricultural productivity and a decrease in land usage. Thus, the research problem is represented by the question: How can GIS technologies be employed to identify the most suitable locations for investing in land and water resources in the governorate?

[1]*How to cite the article:* Obaid N.M..(July 2025); Studying the Optimal Investment of Land and Water Resources in Babil Governorate by using Geographic Information Systems; *International Journal of Professional Studies*; Jul-Dec 2025, Vol 20, 121-131; DOI: http://doi.org/10.37648/ijps.v20i01.008

3. Research Objectives

- Study the natural and topographic characteristics of Babylon Governorate.

- Analyze the distribution of water resources and soil types.

- Determine the suitability of land for agriculture using Geographic Information Systems.

- Develop investment maps highlighting optimal agricultural and water use sites.

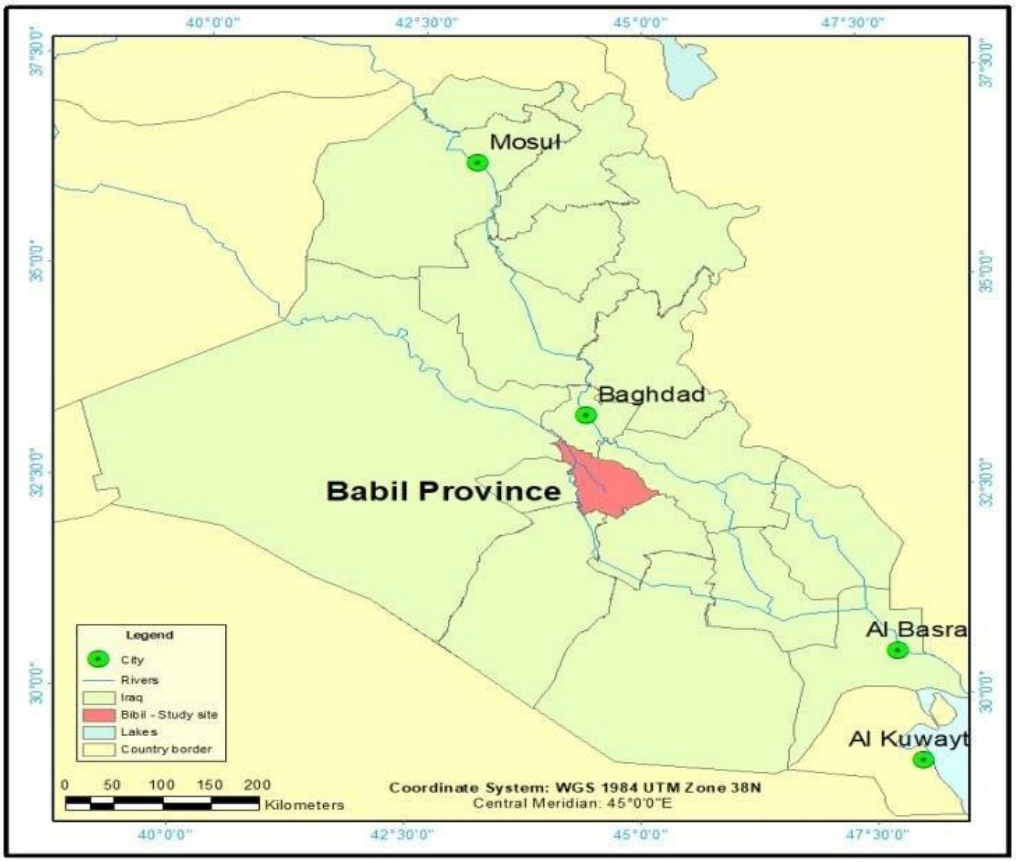
- Provide recommendations that support the optimal investment of land and water resources in the governorate .

4. Location and Area

The spatial boundaries of the research are located in Babil Governorate in central Iraq, which is characterized by diverse geomorphological and climatic features, with available water sources from the Euphrates River and a network of canals. It includes vast agricultural areas that can be efficiently utilized if precise spatial data is available. Additionally, it possesses a cultural and historical heritage that requires attention to the harmony of its urban expansion. The city is geographically situated between latitudes (32°7' - 33°8') north, and longitudes (43°57' - 45°12') east, covering an area of (61.22) km². Babil Governorate has an area of approximately 5119 km², distributed across four districts: Al-Hillah (the administrative capital), Al-Mahawil District, Al-Hashimiyah District, and Al-Musayyab District, which consist of 61 sub-districts [1]. Its geographical location is defined by the study area based on the administrative divisions and boundaries of Iraq, which delineate Babil Governorate (Map 1). The boundaries start at the extreme northwest of the governorate at the Euphrates River and move southeast until it meets the General Drainage Project, forming the northern boundary of the study area that separates it from Baghdad Governorate – this boundary continues in accordance with the General Drainage Project that forms the border with Al-Wasat Governorate.

(IJPS) 2025, Vol. No. 20, Jul-Dec e-ISSN: 2455-6270 p-ISSN: 2455-7455

Map (1) Location of the study area



Source: 1-which is located in the Republic of Iraq the General Directorate of Survey The Arab Iraq Map Scale(100000:1 1998). 2-The nanny of the satellite games that is the mall to you for Al-Sassah 5.(3,2,2).

5. Research Methodology

The research relied on the descriptive analytical method, using Geographic Information Systems (GIS) tools to create a spatial database specifically for Babil Governorate. Satellite images, topographic and geological maps, and official climate and water data were used, and they were analyzed using software like ArcGIS and QGIS.

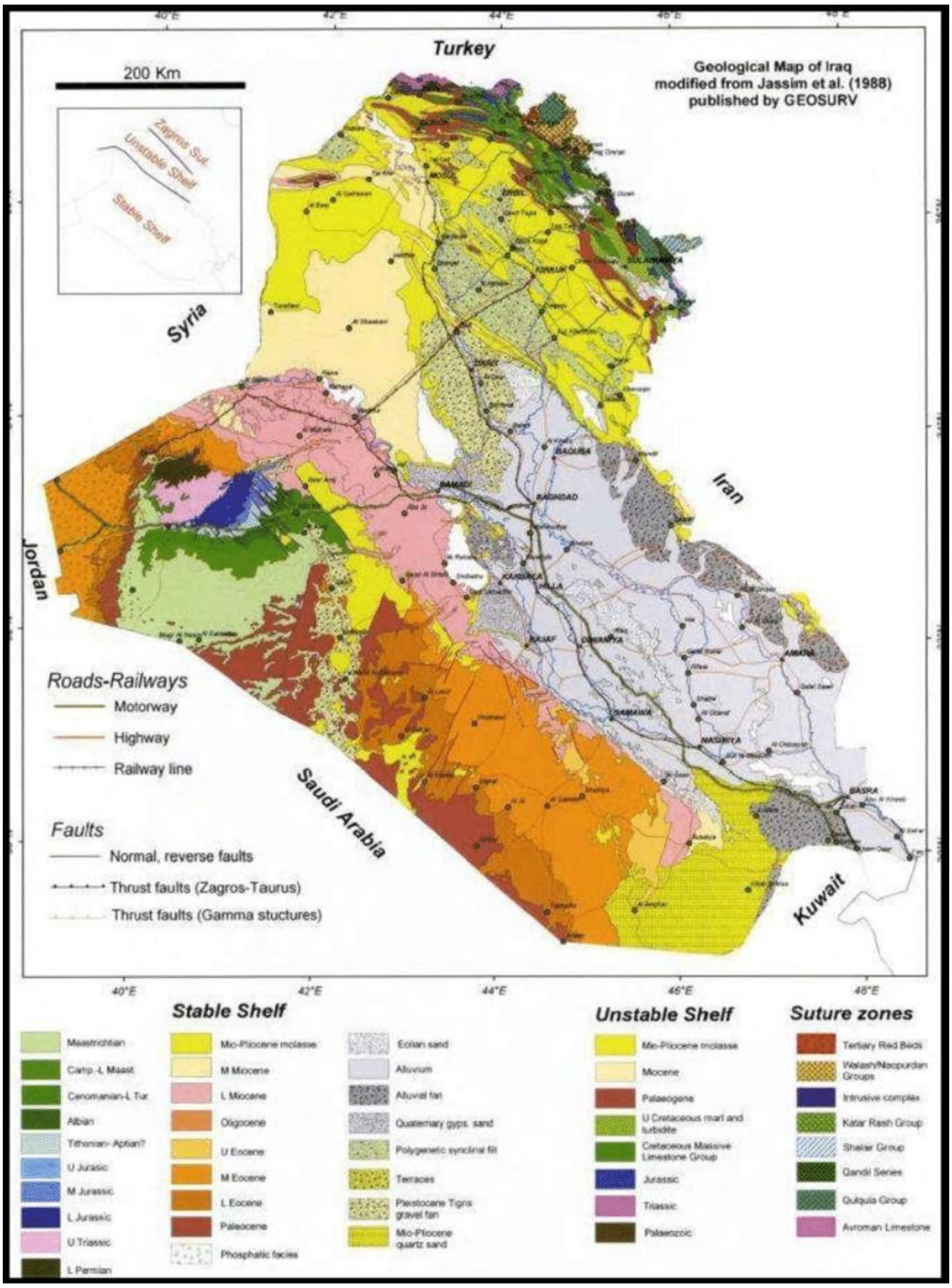
6. Theoretical Framework

6.1 Stratigraphic and Structural Geology of Babylon Governorate

The Babylon Governorate completely covers the deposits of the Quaternary period, which are divided into Pleistocene deposits and newer ones dating back to the Holocene, where modern surface deposits are particularly abundant in the floodplain areas spread throughout the governorate. Structurally, the governorate lies within the unstable shelf range and within the sedimentary plain range and the Tikrit – Amara belt, as well as the urban Salman range, within the Najaf – Abu Jir – Khidr belt[2], which is part of the unstable shelf associated with Alpine tectonic movements. The geological structure contributes to increasing surface water flow in areas composed of low-permeability rocks such as clay and marl, and it also affects the direction of the river drainage network and determines its patterns, resulting from the relationships between the prevailing climate, the nature of the terrain, the type of rocks, and their structure[3]. This

range includes active geological formations that have influenced the distribution of waterways and patterns of urban and rural settlement, with notable structures including faults that have led to changes in the course of the Euphrates River and its branches, such as the main fault that intersects the river at strategic locations in the governorate.

Geological Map (2) of the Study Area

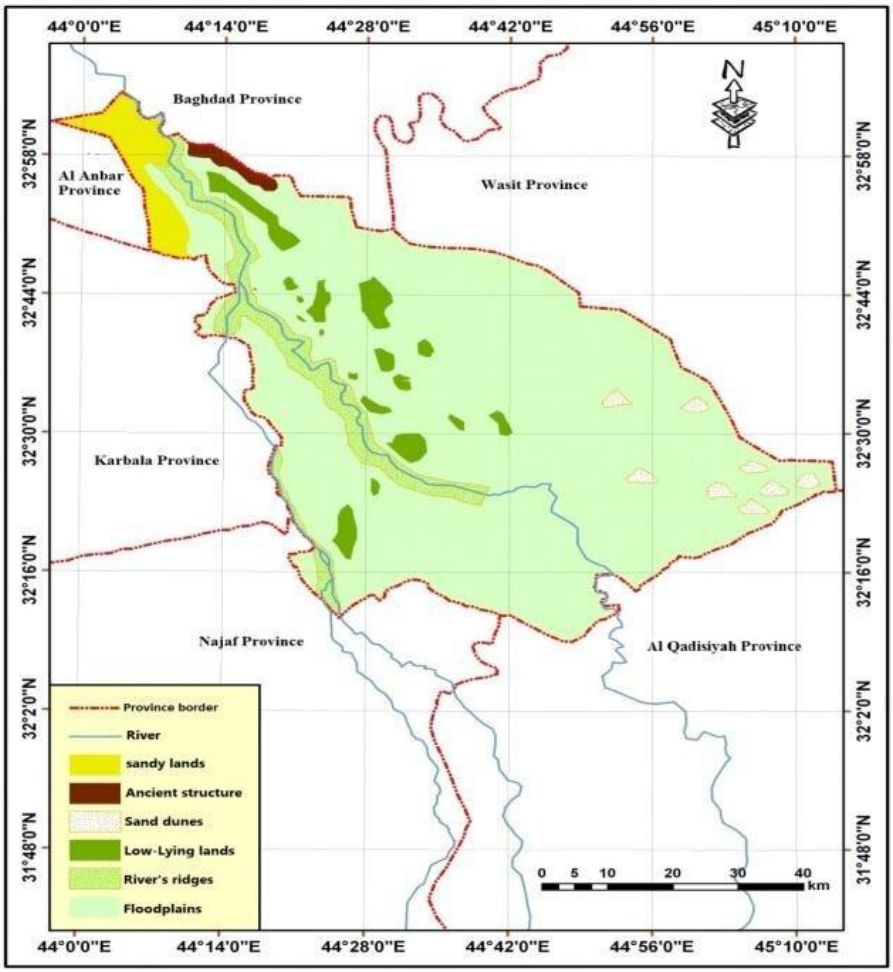


Source: Ministry of Industry and Minerals, General Commission for Geological Survey and Mineral Exploration, Geological Map of Iraq, scale 1:1,000,000, 2000.

6.2 Surface Characteristics

The surface of Babil Governorate is characterized by a gradual flatness and slight descent from the northwest towards the southeast, with higher relative elevations in the northern and central regions, contrasted by lower elevations in the southern and southeastern areas that overlap with marshland and swamp areas. The governorate is almost flat, with minor differences in elevations. The area surrounding the river and its branches rises in the form of a sedimentary strip along the extension of the river valley, known as riverbanks, due to sedimentary processes resulting from recurrent river floods where deposits accumulate on either side of the river[4]. The general elevation ranges between 25-50 meters above sea level, with areas near the Euphrates River being less than 30 meters, while western and northern areas may reach about 45-50 meters. Hills appear sporadically across the governorate, such as in the archaeological hills north of Hillah and in its southwestern part, where the main hill rises about 17 meters above the level of the surrounding lands[5]. (Map 3) shows that Babil Governorate contains diverse geomorphological formations including floodplains, riverbanks, river islands, and river basins, alongside natural phenomena such as

Map (3) Surface of the study area



Source: 1-General Directorate of Survey, Babylon Governorate topographic map ,standard 1;000005,1985. 2-Abdu Al-Ilah Razouqi Karbal ,Agriculture and future of vegetables in Al-Hillah District , Unpublished MA Thesis, Collage of Literature, University of Baghdad ,1967,p.84.

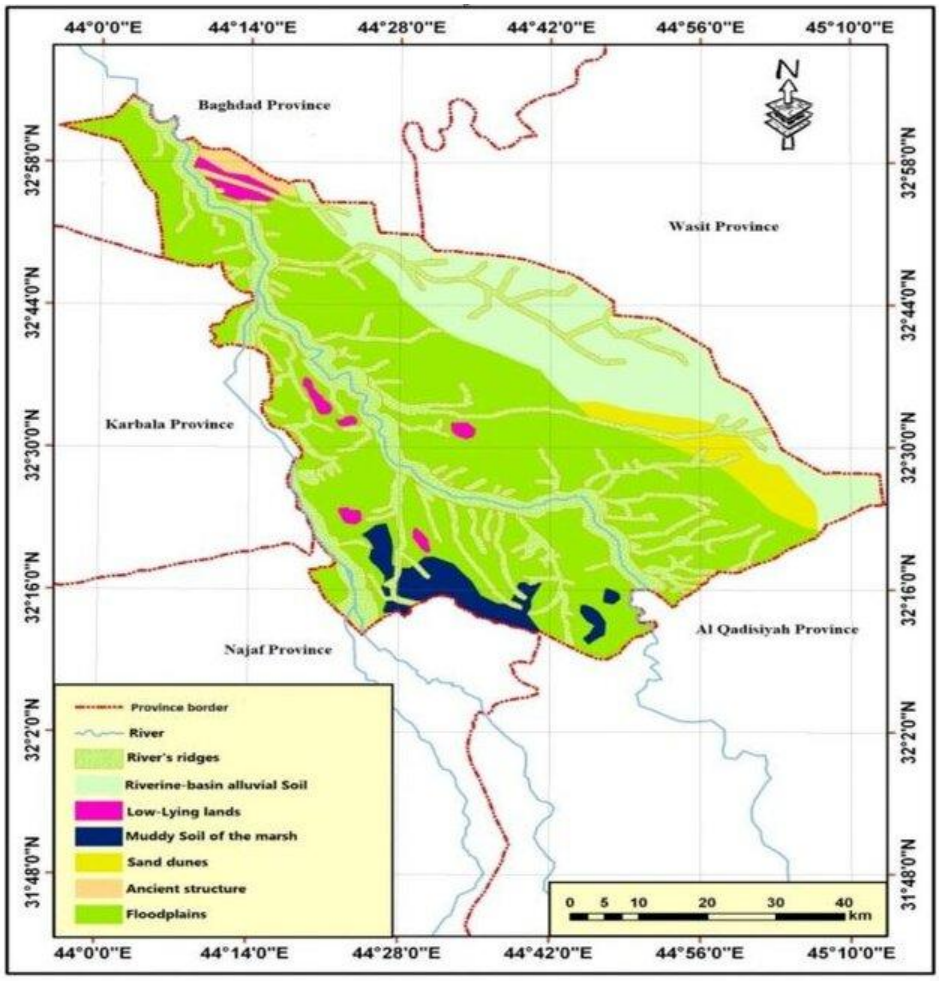
(IJPS) 2025, Vol. No. 20, Jul-Dec **e-ISSN: 2455-6270 p-ISSN: 2455-7455**

6.3 Soil

The lands of Babil Province are characterized by alluvial soil formed by river floods, divided into two main types: riverbank soils that are highly fertile and have low salinity, and river basin soils that are characterized by high silt and clay content and drainage issues that have led to salinization of some areas, especially in the low and southern regions of the province, where the salinized lands constitute about 30-35% of the agricultural areas. These areas vary between silty clay soils suitable for agriculture and saline soils that require reclamation. The soils in the study area are distinguished by their depth and salt accumulation due to climatic influences and high groundwater levels, as well as inadequate drainage and surface cracking of the soil [6]. The Euphrates River and the streams and rivers associated with it are the main source of water resources in the province and play a vital role in meeting household, agricultural, and industrial needs, especially in light of the semi-arid and changing climate that the region suffers from. Additionally, the nature of the land slope and its topographical distribution directly affect the movement and direction of water, resulting in positive effects that manifest in the ease of movement, accessibility, the use of machinery, expansion of the invested areas, and reduced production costs.

The variation of the type of soil and its characteristics has a significant impact on determining the extent of its ability to withstand the pressure caused by urban expansion, in terms of the type and size of construction and the number of floors on which it is built, as well as its suitability to extend and develop the network of infrastructure services[7] .

Map (4) Soil Classification in the Study Area



Source: Seher abd Al-Hadi Hussien Al-Shariefy, The educational composition of the inhabitants of Babylon, Unpublished MA Thesis, Faculty of Education, University of Babylon,2009,p.54.

6.4 Water Resources

Water Resources: The Euphrates River is the main source of surface water in the governorate, where there is a network of rivers and canals that branch off from it. It is used for irrigating agricultural lands and providing drinking water. In addition, there is groundwater in the southwestern areas, but there may be issues with its quality due to pollution or salinity. As for rains, they play a role in replenishing the surface and groundwater resources, but they may not be sufficient to meet the water needs of the governorate. The Central Euphrates region is among the most important areas in the country that rely on the surface water available through the newly designed Indian Dike irrigation system that was redesigned in 1989 to regulate the delivery and distribution of water between Al-Hilla River and the canals branching south of the dam. Specifically, it includes Al-Hilla River as well as the canals that branch off from the Euphrates River after entering the administrative boundaries of the study area north of the Indian Dam into several canals[8] .

1- The Alexandria Canal: The canal is located within the Alexandria district north of Babil Governorate. It branches off from the left bank of the Euphrates River to the north of Al-Hindiyah, about 27 km away, and flows southeast over a length of (18 km) with a total length of (23.100 km).

2- The Great Al-Musayyib Canal (Project Column): It branches off from the left bank of the Euphrates River at kilometer (9.500) north of the Al-Hindiyah dam and kilometer (596 km) on the Euphrates River, with a total length of (49.500 km).

3- Al-Nasiriya Canal: It branches off from the Euphrates in the Musayyib area and flows southeast with a length of (12.802 km) and a discharge of (4.7 km).

4- Al-Ruwaiya Canal: It branches off from the right bank of the Euphrates River at kilometer 23 km before the Al-Hindiyah dam, with (583) on the Euphrates River. It extends southwest for a distance of (8.450 km) and has two main branches (Al-Ruwaiya and Al-Sa'idat).

5- Al-Hilla Canal: which branches off from the Euphrates River to the south has been designated a discharge of (250 m3/s) allocated for irrigating the agricultural lands located on the left side parallel to the extension of Al-Hindiya Canal, as water reaches them through a large number of river channels branching from both banks of Al-Hilla Canal [9].

6- Al-Kifl Canal: this canal branches off from the left bank of the Euphrates River at a distance of 120 meters north of Al-Hindiya Dam and is considered one of the canals of Al-Hindiya Dam. The current canal runs in a line parallel to the middle bank of the Euphrates at a distance of 69 km.

• Groundwater: Groundwater in Babil Governorate is stored in layers of sandstone and chalk that have good porosity, allowing the accumulation of large quantities of water. It is distributed in several sedimentary layers, with depths ranging from 10 to 100 meters. Groundwater levels vary significantly, ranging from 2 to 10 meters in low areas, increasing in higher areas.

7. Research Methodology :

The research utilized a descriptive methodology, analytical method, and a desktop work approach supported by documentary field visits. Data and theoretical information were collected based on similar studies and relevant government departments, as well as downloading Landsat imagery and Digital Elevation Model (DEM) data for the study periods from the Geological Survey (USGS) website, and carrying out data derivation, analysis, and processing, such as geometric correction, matching, radiometric calibration, enhancement, classification, and others using RS and GIS technologies. This was done to ensure continuous monitoring of the area and extract the importance of these characteristics for optimal investment in Babil Governorate. Understanding the geological and stratigraphic distribution, in addition to the topographic and hydrological features of Babil Governorate, forms the basis for making successful strategic decisions in land and water resource investment. The application of Geographic Information Systems (GIS) technologies allows for precise analysis and assessment of these features, facilitating the identification of highly fertile areas, evaluating salinity and flood risks, and planning irrigation and drainage networks, thereby supporting investment decisions founded on solid scientific principles for use.

Through the analysis of the reality of land and water resources in Babylon, it was found that there are geomorphological influences on urban and agricultural planning, as the geomorphological characteristics of Babylon Governorate are a key determinant in directing urban and agricultural development. The gradient of the slope and elevation affect the distribution of surface and groundwater, which reflects on the quality of agricultural lands and opportunities for their utilization. Areas with low slope and uniform level create an ideal environment for intensive agriculture and urbanization, while areas with varying slopes or proximity to marshes require special planning to avoid the risks of flooding and salinity. Babylon Governorate has faced environmental challenges including soil salinization and a rise in groundwater levels in vast areas, particularly in low-lying lands adjacent to river courses and marshes,

which reduces the quality of agricultural soil and threatens productivity. Additionally, factors of climate change and rainfall variability affect the availability of water resources, exacerbating the need to use advanced analysis tools such as GIS to develop sustainable management plans.

Based on the geomorphological and environmental analysis of Babil Province, multiple strategies for optimal investment in Babil Province can be proposed, including:

• Directing agricultural development towards high-fertility land with good drainage capacity, while applying smart agriculture technologies to conserve water resources

.• Investing in dry or saline land to grow drought- and salinity-resistant crops or transforming it into agricultural areas for other uses such as pastures or industrial forests.

• Developing water infrastructure, such as modern irrigation and sewage systems, using geographic data to improve water distribution and reduce loss

.• Protecting sensitive areas like streams and wetlands as important environmental resources that support biodiversity and safeguard against natural disasters

.• Exploiting river islands and newly created lands from sedimentation in agriculture, housing, and eco-tourism, while considering environmental sustainability.

8. Results

The following table illustrates the key elements of the SWOT analysis regarding the optimal investment of land and water resources in Babil Governorate using Geographic Information System (GIS) technologies. SWOT Analysis Elements Table .

Strengths	Weaknesses	Opportunities	Threats
Availability of advanced Geographic Information Systems (GIS) enabling accurate analysis of land and water resources.	Limited use of GIS technologies in decision-making.	High potential for applying GIS to identify suitable lands for investment.	Climate change and rainfall fluctuations.
Geomorphological diversity allowing multiple agricultural uses.	Shortage of specialized technical staff.	Government support for food security projects.	Desertification and sand encroachment.
Availability of diverse water resources such as the Euphrates River and canals.	Problems in irrigation and agricultural drainage networks.	Global trend toward optimal resource management.	Lack of funding for project implementation.
Strategic geographical location of the governorate.	Encroachment on agricultural lands.	Possibility of attracting investments through accurate maps.	Population and urban pressures.
Availability of an initial database from previous studies.	Weak coordination among concerned authorities.	Availability of projects to finance GIS mapping.	Absence of legislation encouraging GIS-based investment.

Based on the analysis of the table, the following points can be concluded:

1. The strengths show the availability of technical and natural potentials that can be effectively exploited in agricultural investment.

2. The weaknesses reflect the existence of institutional and technical challenges that require reform and support from government entities.

3. The opportunities indicate a promising investment environment if strategic plans are directed based on geographic information systems.

4. As for the threats, they highlight the need for proactive plans to address the impacts of climate change, population pressures, and legislative challenges.

9. Conclusions:-

1. The province of Babil offers significant natural and technical potential that can be effectively harnessed through geographic information systems .

2 Institutional and technical challenges require continuous support from government entities to improve performance. It is recommended to establish unified databases among planning departments, water resources, agriculture, and universities for data sharing and geographic analysis .

3. Geospatial systems can enhance strategic planning and improve resource distribution to achieve sustainable development .

4. Climate changes and population pressures necessitate the adoption of proactive plans for optimal investment.

10- Recommendations:-

1. Direct agricultural development towards areas with high fertility and good drainage capability, while applying smart farming techniques to conserve water resources.

2. Invest in saline or reclaimed lands to cultivate drought and salt-resistant crops or transform them into other agricultural areas such as pastures or industrial forests.

3. Develop water infrastructure such as modern irrigation and drainage systems using geographical data to improve water distribution and reduce losses .

4. Protect sensitive areas such as streams and wetlands as they are important environmental resources that support biodiversity.

4. Protect sensitive areas such as streams and wetlands as important environmental resources that support biodiversity and provide protection from natural disasters.

5. Utilizing river islands and newly created lands from sediment deposits in agriculture, housing, and eco-tourism, while considering environmental sustainability.

11. Conflict of Interest

The authors declare that they have no conflict of interest.

12. Funding Declaration

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

13. References

Al-Bairmani, D. B. R. (2019). *Climate impact on hydrological properties and suitability for various uses in Babylon* [Unpublished doctoral dissertation]. University of Kufa, College of Arts.

Al-Khashab, W., Hadid, A. S., & Al-Hadithi, A. H. (1980). *Applied geomorphology* (Vol. 2, 1st ed.). Dar Al-Kutub.

Al-Musawi, A. S. (1989). *Geographical study of irrigation systems in Babylon* [Unpublished master's thesis]. University of Basra.

General Commission for Geological Survey and Mining. (1996). *Structural map of Iraq* [Map]. Ministry of Industry and Minerals. Scale 1:1,000,000.

Ibrahim, J., et al. (1994). *Soil map of Baghdad and Babylon governorates*. Ministry of Irrigation, Water and Soil Research Center, Soil Surveys Department.

Kamel, M. M. (2013). *Spatial variation of protected vegetable cultivation in Babylon* [Unpublished master's thesis]. University of Babylon.

Karbal, A. I. R. (1986). *Geomorphology*. Basra University Press.

Obaid, N. M., & Al-Shammary, A. A. A. S. (2022). Urban geomorphology and its impact on urban expansion trends in Kut City using GIS. *Res Militaris, 12*(2), 4006.

Republic of Iraq, Ministry of Planning and Development Cooperation, Central Statistical Organization and Information Technology. (2017). *Annual compilation*.