

Expansion and Direction of Urban Areas in Al-Diwaniyah City

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ABSTRACT

Objective: Population growth and changes clearly impact any city's expansion and urban development, regardless of its natural and geographical characteristics. Despite the economic development and growth witnessed by Al-Diwaniyah after 2003, it suffers from many problems. Al-Diwaniyah experiences significant urban challenges, including traffic congestion, insufficient public services, the proliferation of informal settlements, and ongoing environmental degradation. The unregulated urban expansion has resulted in a significant increase in the built-up area over time, creating pressure on land use and existing infrastructure. Therefore, this study was conducted to determine the causes of these problems. **Method:** The use of Geographic Information Systems (GIS) was to explore the development in the urban areas to 2023, **Results:** the result shows that there is an expansion in the land used, as the area in 1958 was 1.5 03 km², in 1972 the area reached 10.035 km², while the area became 14.486 km² in 2001, in 2008 the area became 17.4 38 km². In 2014, the area increased to 26.1 111 km², while the expansion of land use increased to 32.361 km² in 2023, with expansion in the direction of the east of the city. This increase in land use is due to the population growth and economic growth in Iraq after the increase in oil revenues after 2003. **Novelty:** Among the most important reasons was that Diwaniyah is characterized by high population density and random expansion by encroaching on the lands adjacent to the city center.

INTRODUCTION

Geographic Information Systems is used in urban planning to assist and guide planners in systematically developing communities and infrastructure within and outside urban areas. The growth of population in urban centers necessitates the expansion of urban space for the planning of physical and social infrastructures to serve the community based on the principles of sustainable development. Utilizing GIS in this field involves a unique method focusing on spatial aspects, development, design, analysis, and modelling of processes inside space and the relationships between these processes or spatial developments [1]. Urban planning plays a vital role in a city's sustainability. A planned idea without compromising future demands helps bring equilibrium demands for growth with the need to protect the environment. One of the major issues in urban planning is transport [2][3]. Urban planning and administration are primarily based on information, especially spatial information. The majority of data that planners utilize in design is geographic; that is, it uses topographic maps or is connected to a specific place via coordinate references, street addresses, or administrative areas. An information system that integrates, stores, modifies, analyses, shares, and displays spatial or geographic data is known as a geographic information system or GIS. These systems have been a more commonplace feature of urban design and construction during the last few decades [4]. Since 1990s, GIS technologies have

become more common in research because of the availability of low-cost GIs with user-friendly interfaces [5][6][1]. GIS can store, exchange, and manage large amounts of data efficiently [7][8]. Integrating GIS into development plans helps achieve the main goals of predicting and establishing future development strategies and policies by combining physical, environmental, and socio-economic factors in planning, particularly regarding the spatial context [9]. Geographic Information Systems properly transforms tabular data into map representations, adding visual dimensions to statistical analysis and presentation. Sustainability is the global goal for urban areas, focusing on developing nations in particular [10]. Careful and appropriate planning for urban growth, which includes making the best use of available land resources to attain the highest possible degree of sustainability—is a crucial consideration in urban planning. Al-Diwaniyah City in Iraq is exposed to a severe scarcity of both urban and residential areas, which leads to a noticeable increase in indiscriminate expansion and encroachments on neighboring lands [11]. The above indicators were also calculated for the city of Al-Diwaniyah by [12] to assess the spatial and temporal Urban growth and transport changes in addition to calculating the Modal Split Change index (MSCI). The results showed that Al-Diwaniyah is witnessing rapid population growth, spatial expansion, and a change in land use. After drawing changes in the city for 2014 and 2023, another study by [11] on Al-Diwaniyah City came to the conclusion that RS data and GIS could play an essential role in studying and monitoring changes in land cover and urban growth and providing decision makers with more accurate, less expensive, and timely information. The present residential zones were lacking by approximately 12.11 km² according on Iraqi requirements. This work's main goal was to monitor and Analyze the long-term urban growth of Al-Diwaniyah City and its development in eight directions, and the areas needed to meet the housing deficit in the city center.

RESEARCH METHOD

Data of Geographic Information System

Geographic Information Systems is used in urban planning to assist and guide planners in systematically developing communities and infrastructure within and outside urban areas. It provides an enabling environment for recording and storing spatial and attributive data, which are used in every field of study [13]. GIS is a crucial tool for gathering data and is essential to the evaluation of land use suitability [14]. This study examines the housing deficit, changes in the urban area of Al-Diwaniyah City between 1958 and 2023, and growth directions derived from satellite photos. The satellite images were obtained between 1958 and 2023 to conduct a regional analysis of the whole Al-Diwaniyah city [15].

Maps

The first part of this study depends on the data that must be available from the municipal directorate in Al-Diwaniyah City. Satellite images have been used for several periods for the purpose of knowing the spatial and temporal expansion in the urban areas of Al-Diwaniyah. These images were obtained from the Municipal Administration

of Al-Diwaniyah for the years 1958,1972,2001,2008,2014,2023. In addition, other data were collected, such as the master plan of the city of Al-Diwaniyah.

Change in urban area in Al-Diwaniyah City from 1958 to 2023

The city of Al-Diwaniyah has recently witnessed a rise in urban land due to the recent economic growth, which caused a creep on the agricultural lands surrounding the city. Therefore urbanization was studied to review the change that occurred during the years 1958 to 2023. This is found out using the GIS program, where satellite images were added to the program and land uses were plotted to calculate the total area in km² units for each period, in addition to calculating the rate of increase for one year and the percentage of increase between each two time periods, in addition to calculating the percentage of increase for one year compared to the total area of the City center boundaries. The city has been divided into eight directions (north, east, northeast, southeast, south, southwest, west, and northwest) as shown in Figure 1, and the urban area is estimated in each direction for all years.

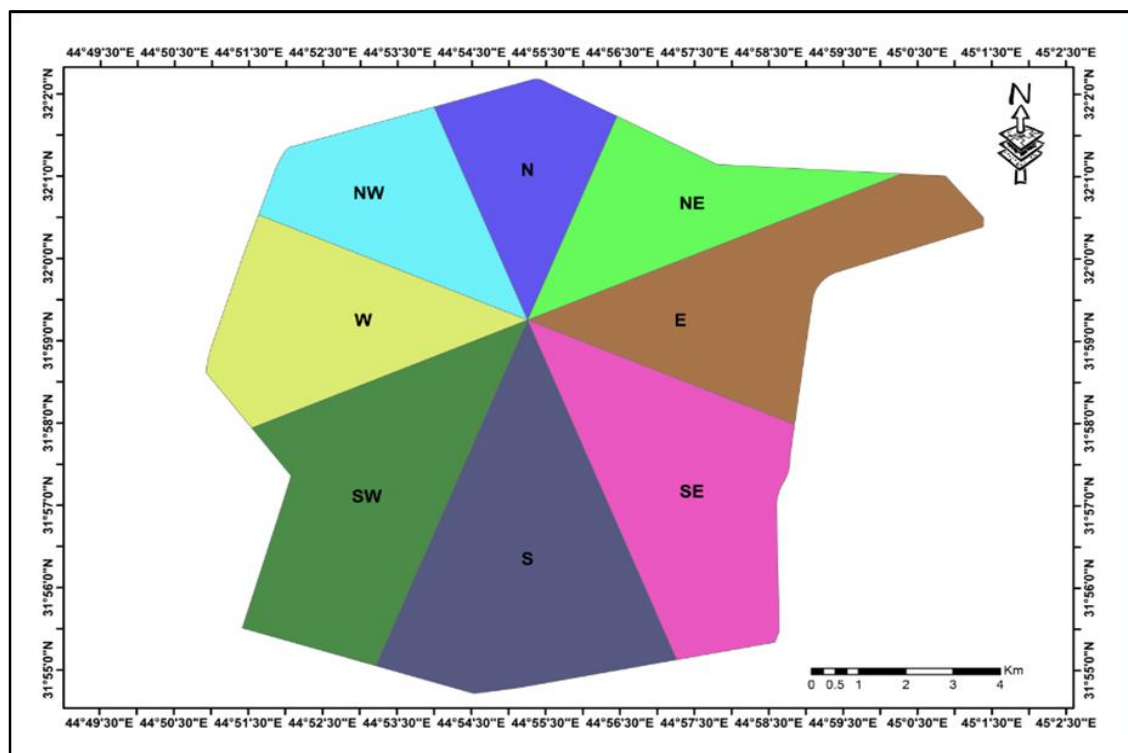


Figure 1. Land use distribution trends for the city of Al-Diwaniyah (researcher preparation)

Areas Needed to Meet the Housing Deficit in the Al-Diwaniyah City by the Target Year 2033:

The housing deficit for the city of Al-Diwaniyah is estimated based on the difference between the current area of the population and the area that is supposed to be available according to the total number of residents based on the area allocated to each person 100 m² / person for all housing needs (approved by the Urban Planning Commission in Iraqi City planning). Figure 2 shows the population number from 1958

to 2023, which was obtained from the Department of Statistics in Al-Diwaniyah and the Department of Ration Cards.

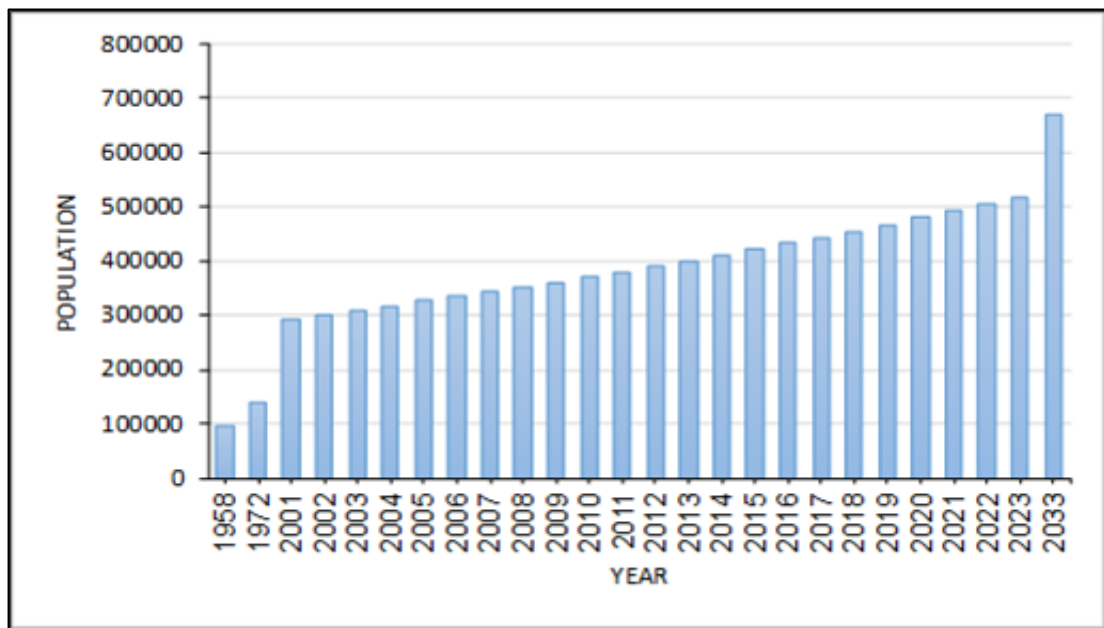


Figure 2. Population estimates for the years from 1958 to 2023 in Al-Diwaniyah District.

Study Area

Al-Diwaniyah is a city in southern Iraq. All governmental and administrative institutions are located, serving as the political, economic, and administrative of the Al-Diwaniyah City Governorate. It is 180 km north of Basra and 320 km south of Baghdad. Al-Diwaniyah City is located between latitudes of -32.5 degrees north and longitudes of 44.5 degrees, covering an area of 8153 km². Consequently, it makes up around (1.9%) of the nation's total area and around (8.1%) of the governorates in the Middle Euphrates region. The number of collisions that happen on highways has increased recently. Increasing attention has been given to traffic issues in Al-Diwaniyah. It has been shown that the reasons for these occurrences are related to driver error, the state of the road system, and other elements. Congestion is another issue affecting the road system in Al-Diwaniyah City's major business sector. The area was selected for this study to carry out investigations and collect data on the dynamic elements influencing the urban transportation system. Figure 3 shows the study area represented by the city of Al-Diwaniyah and the residential areas within the city.

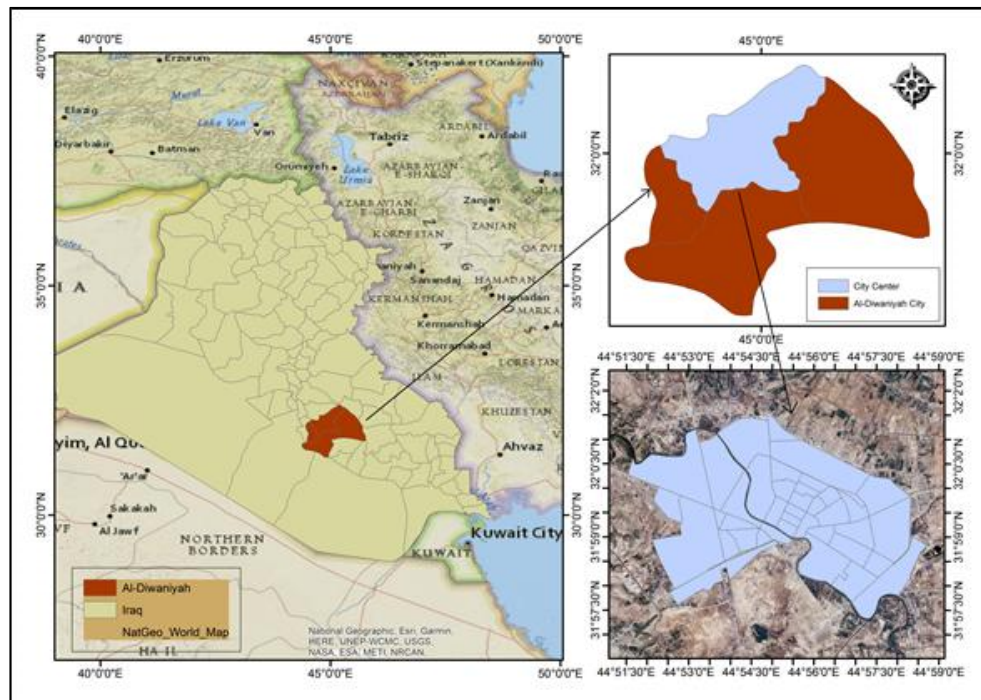


Figure 3. Extracting the location of the study area represented by the Center of Al-Diwaniyah Governorate (researcher preparation)

RESULTS AND DISCUSSION

Results

Urban area development in Al-Diwaniyah City from 1958 to 2023

The changes in the urban areas in the City of Al-Diwaniyah distributed over six sectors were studied according to the plan of the Municipal Directorate to provide a clear view of the situation in the city center. The areas used for the city center were drawn with slums that occurred due to urban sprawl on agricultural lands surrounding urban areas. The last boundary represents the boundaries of the city center, and its area is 145.045km². Thereafter, the areas used were drawn for each period from 1958 to 2023. In 1958, this stage witnessed the beginning of using urban planning as a tool in developing cities through the assistance of some foreign consultants. In 1958, the company Doxiades Urban Development developed the first urban plan for the city of Al-Diwaniyah. After calculating the change in urban areas to 2023, the result is shown in Figure (4, 5, 6, 7, 8, 9, and 10). It is noted that there is an expansion in the land used, as the area in 1958 was 1.5 03 km², in 1972 the area reached 10.035 km², while the area became 14.486 km² in 2001, in 2008 the area became 17.4 38 km² and in 2014 the area increased to 26.1 111 km², while the expansion of land use increased to 32.361 km² in 2023, this increase in land use is due to the population growth and economic growth that occurred in Iraq after the increase in oil revenues after the year 2003.

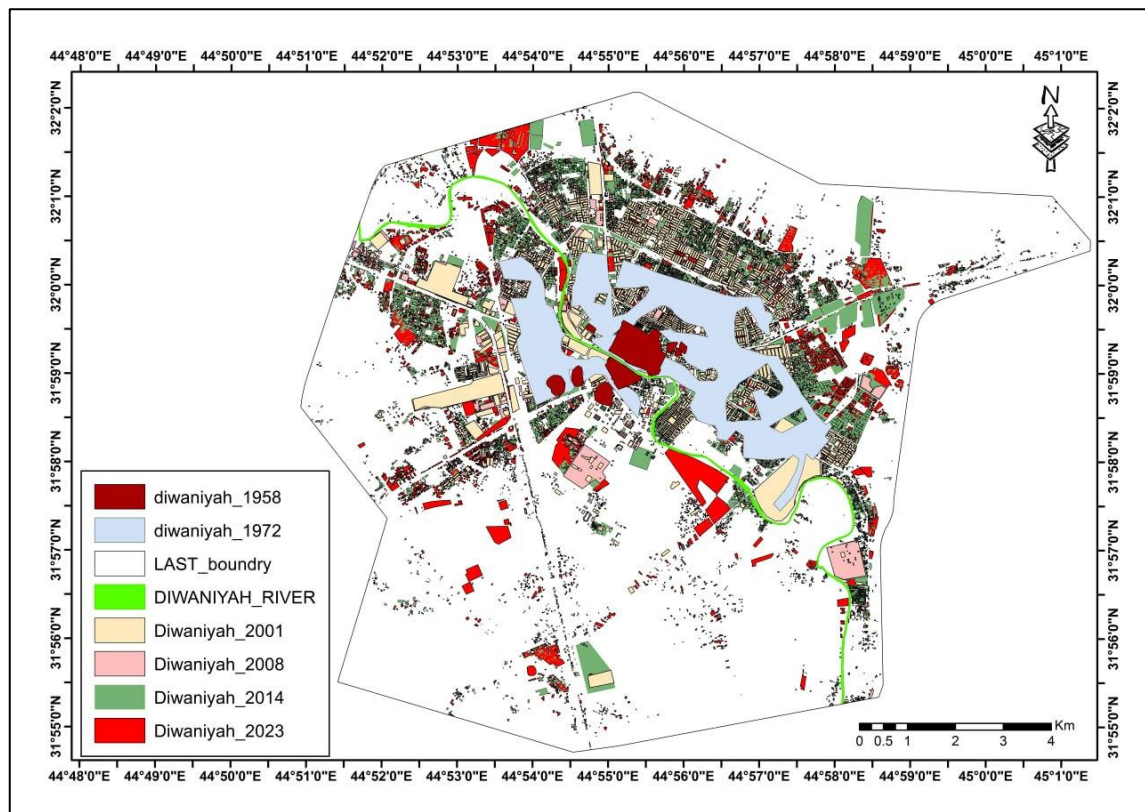


Figure 4. Urban extent in Al-Diwaniyah City from 1958 to 2023(researcher preparation)

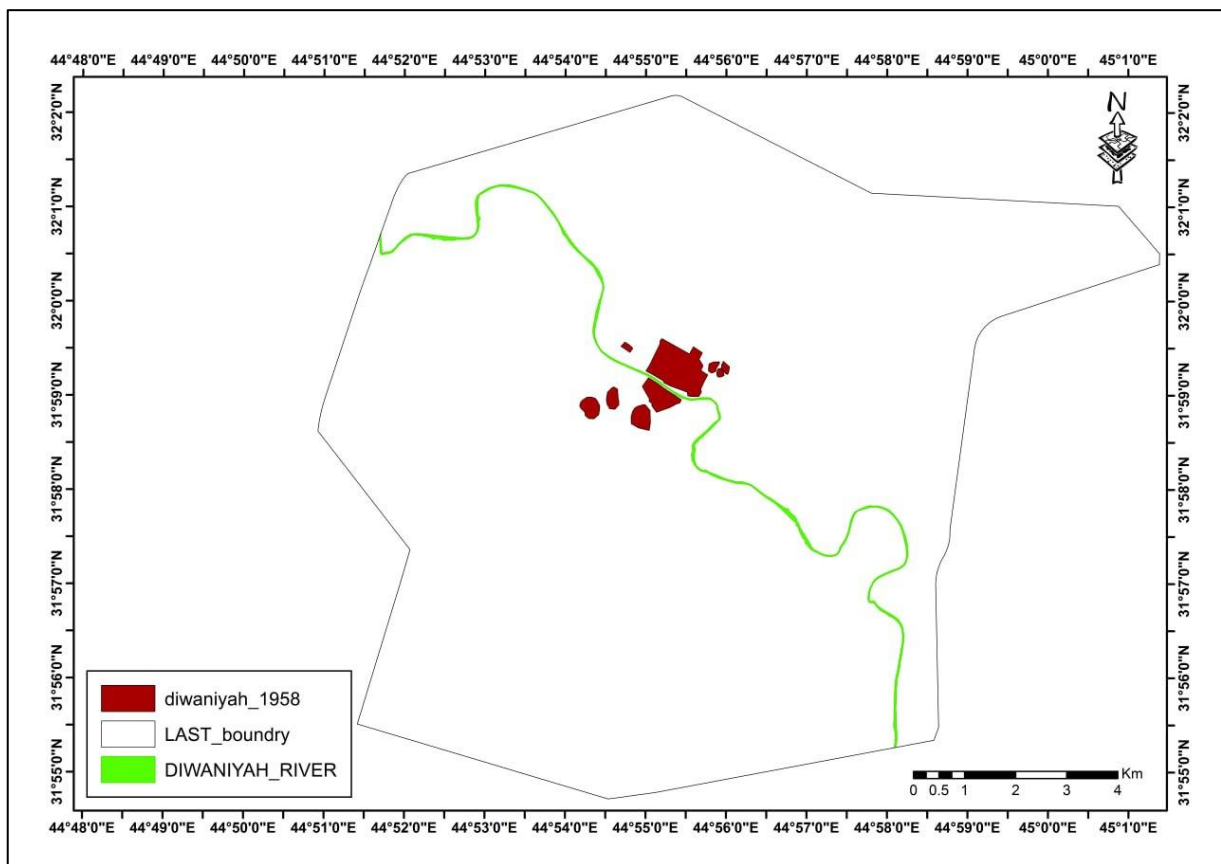


Figure 5. Spatial distribution of land use in Al-Diwaniyah City in 1958(researcher preparation)

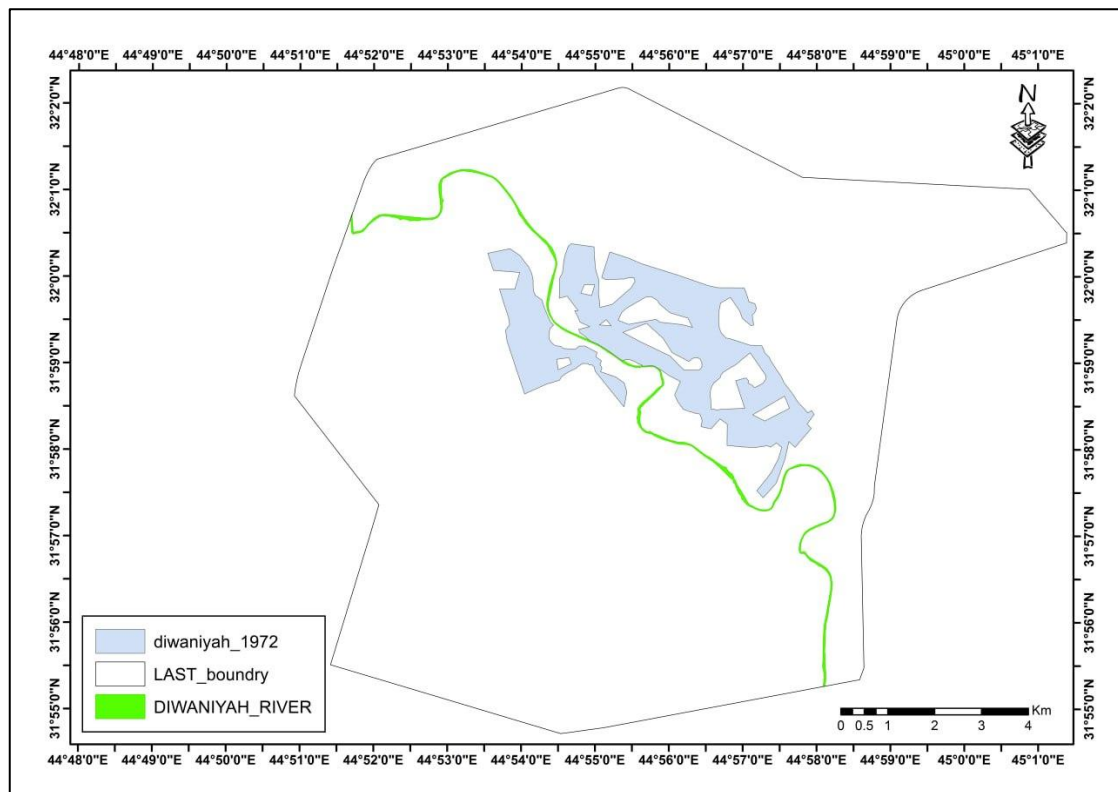


Figure 6. Spatial distribution of land use in Al-Diwaniyah City in 1972(researcher preparation)

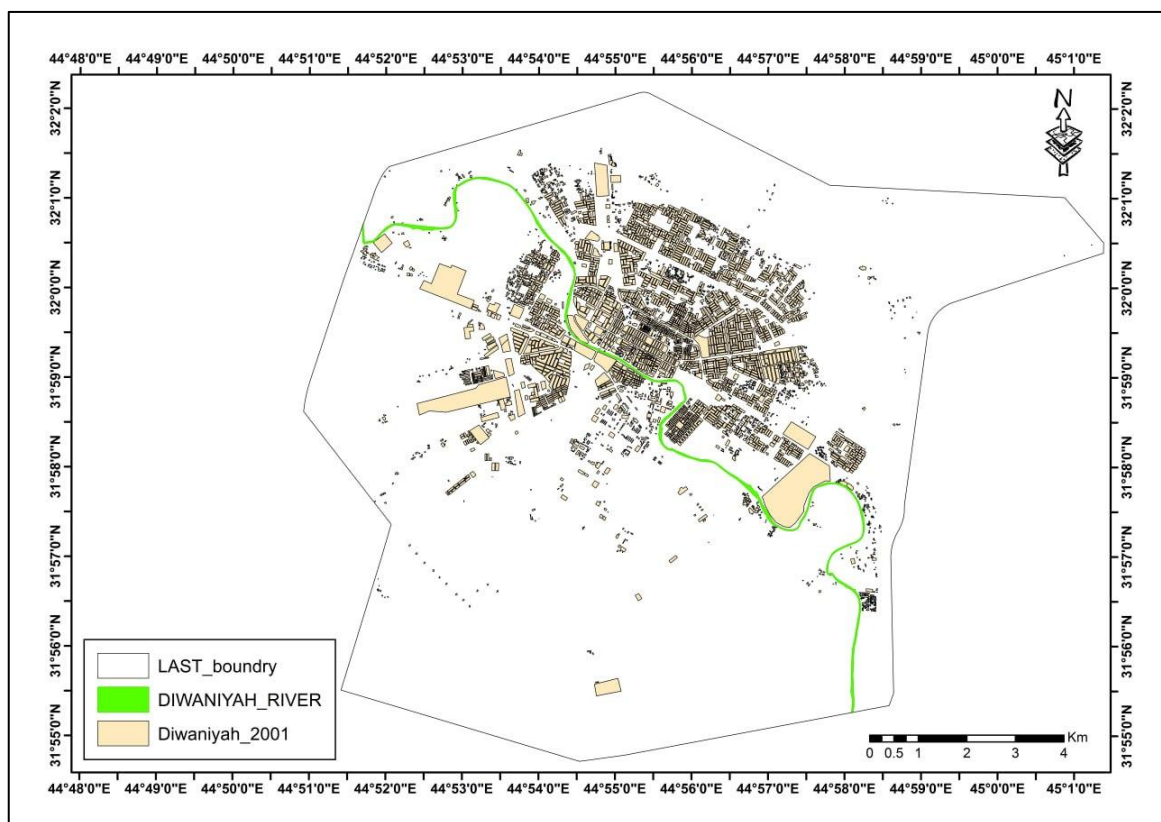


Figure 7. Spatial distribution of land use in Al-Diwaniyah City in 2001(researcher preparation)

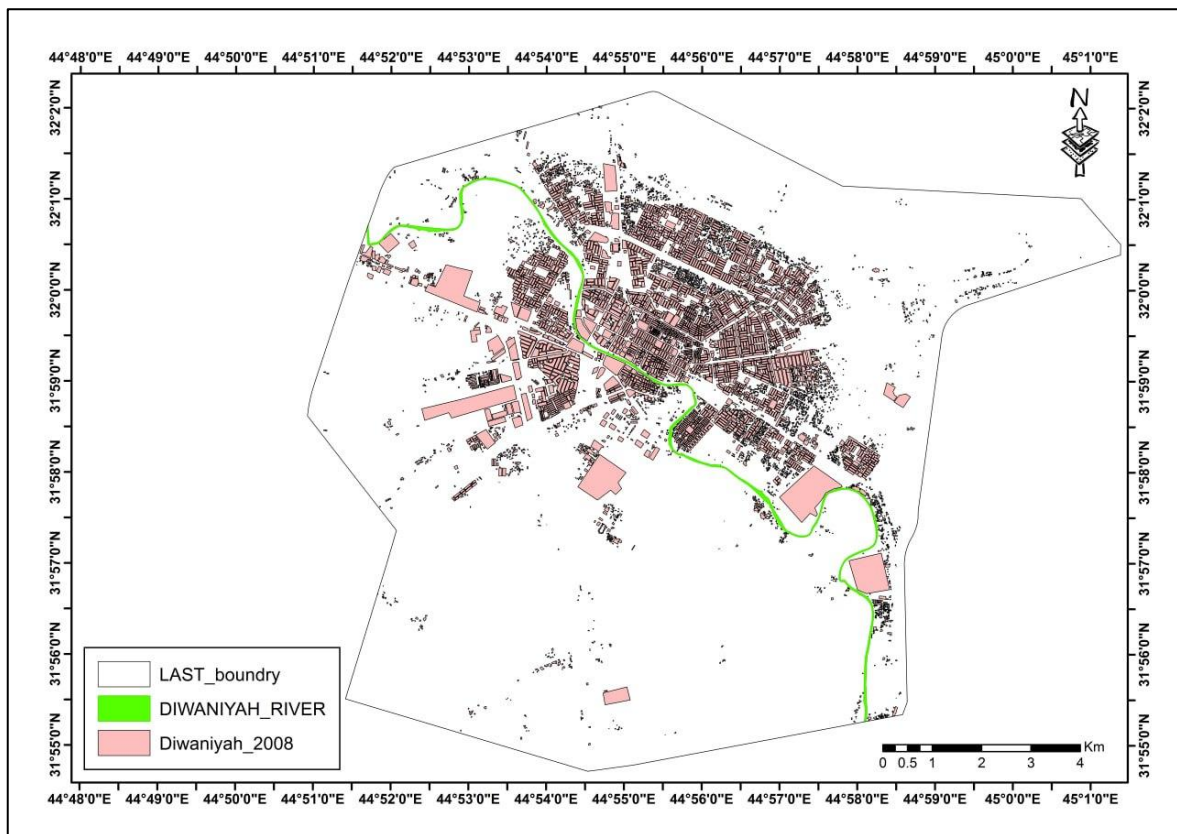


Figure 8. Spatial distribution of land use in Al-Diwaniyah City in 2008(researcher preparation)



Figure 9. Spatial distribution of land use in Al-Diwaniyah City in 2014(researcher preparation)

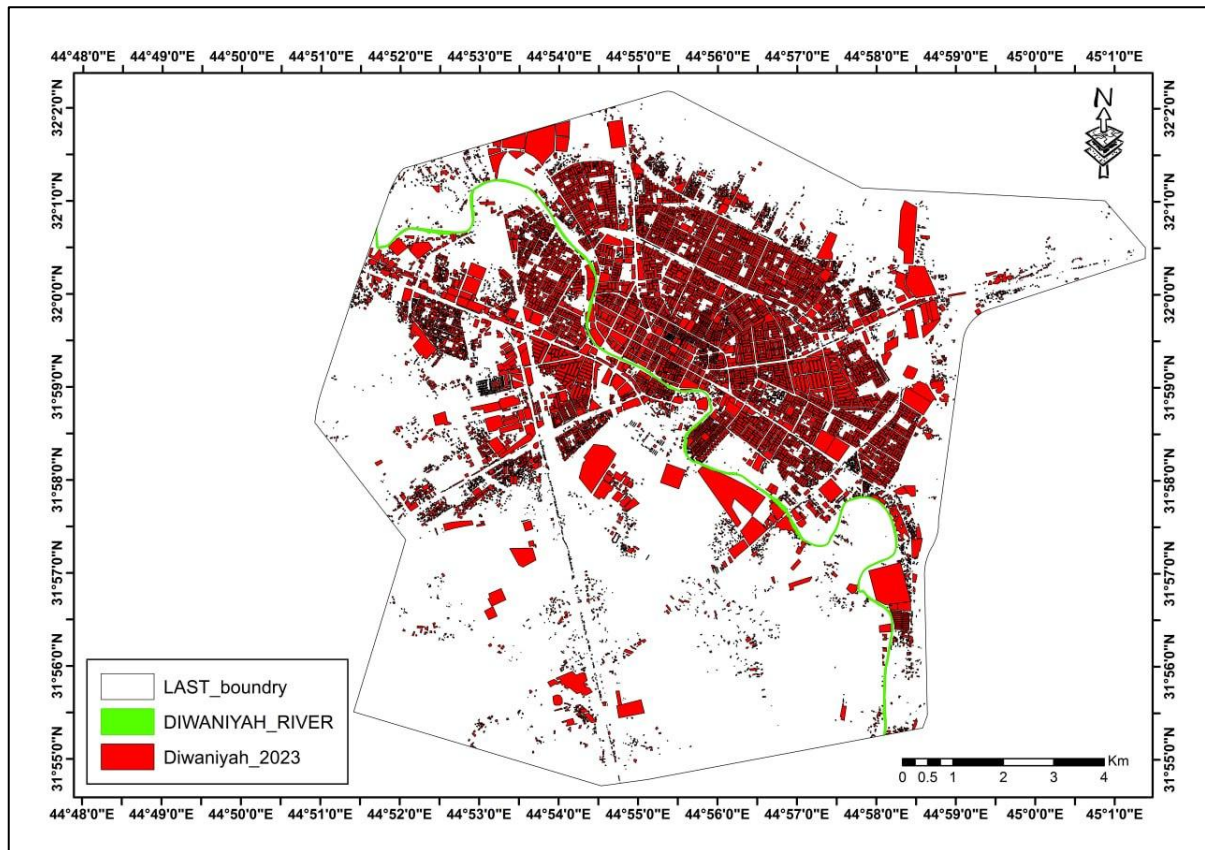


Figure 10. Spatial distribution of land use in Al-Diwaniyah City in 2023(researcher preparation).

Table 1 shows the results of estimating the change in areas and the rate of increase for each year. The results were $0.609 \text{ km}^2 \text{ yr}^{-1}$ for years (1958-1972), $0.153 \text{ km}^2 \text{ yr}^{-1}$ (1972-2001), $0.422 \text{ km}^2 \text{ yr}^{-1}$ for years (2001-2008), and $1.446 \text{ km}^2 \text{ yr}^{-1}$ for years (2008-2014), in addition to the rate of change for each year became $0.694 \text{ km}^2 \text{ yr}^{-1}$ for years (2014-2023) and $0.475 \text{ km}^2 \text{ yr}^{-1}$ for years (1958-2023). The rate increases between every two periods was 0.850%, 3.052%, 2.02%, 5.946%, 4.285%, and 21.157% for the above periods, respectively. The ratio of increase for each year was also estimated compared to the total area of the City center boundaries of 145.852 km^2 . Therefore the change rates were 0.416%, 0.105%, 0.289%, 0.991%, 0.4716%, 0.325% for the above consecutive years. The rates of change were studied to give a clear vision of the development that took place in the city during the years from 1958 to 2023. It is noted from the results that the rate of change has decreased significantly for the years (1972-2001) due to the situation in Iraq during this period, where there was the eight-year Iraq-Iran war (1980-1988), the first Gulf War in 1990, as well as the imposition of an economic blockade on Iraq.

Table 1. Change in urban area in Al-Diwaniyah City from 1958 to 2023 based on the area 145.852 km^2

Urban in km^2			Change in km^2 Land from 1958 to 1972		
1958	1972	km^2	$\text{km}^2 \text{ yr}^{-1}$	%	% yr^{-1}
1.503	10.035	8.532	0.609	5.850	0.418

Urban in km ²			Change in km ² Land from 1972 to 2001		
1972	2001	km ²	km ² yr ⁻¹	%	% yr ⁻¹
10.035	14.486	4.451	0.153	3.052	0.105
Urban in km ²			Change in km ² Land from 2001 to 2008		
2001	2008	km ²	km ² yr ⁻¹	%	% yr ⁻¹
14.486	17.438	2.952	0.422	2.02	0.289
Urban in km ²			Change in km ² Land from 2008 to 2014		
2008	2014	km ²	km ² yr ⁻¹	%	% yr ⁻¹
17.438	26.111	8.673	1.446	5.946	0.991
Urban in km ²			Change in km ² Land from 2014 to 2023		
2014	2023	km ²	km ² yr ⁻¹	%	% yr ⁻¹
26.111	32.361	6.25	0.694	4.285	0.476
Urban in km ²			Change in km ² Land from 1958 to 2023		
1958	2023	km ²	km ² yr ⁻¹	%	% yr ⁻¹
1.503	32.361	30.858	0.475	21.157	0.325

After studying the urban expansion of the City in general, the urban expansion was studied in the main and secondary directions (north-south-east-west-northeast-northwest-southeast-southwest) as in Figure 11, which shows the urban expansion of the City center from 1958 to 2003, after drawing the used land was fragmented into eight directions and estimating the area for each direction using the ArcGIS program, the area was estimated for each direction between every two periods of time using the Excel program as shown in Table 2, the results indicate that there is an expansion in the direction of the east of the City as shown in Figure 12.

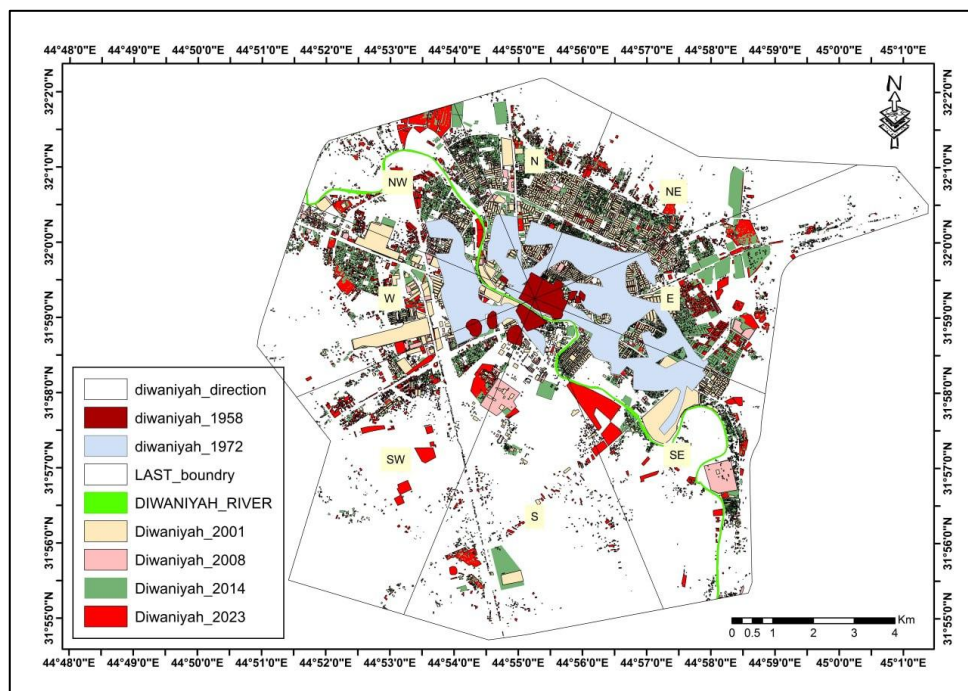
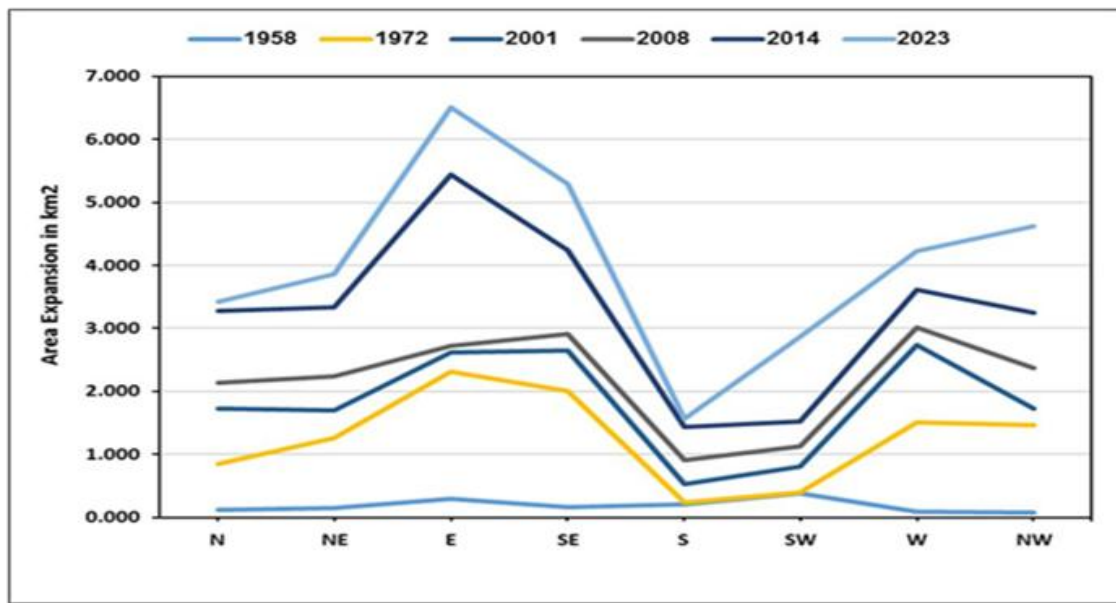


Figure 11. Direction distribution of the areas of Al-Diwaniyah City for the years from 1958 to 2023 (researcher preparation).

Table 2. Changes of urban areas in Al-Diwaniyah City from 1958 to 1972, 1972 to 2001, 2001 to 2008, 2008 to 2014 and 2014 to 2023.

Year	Directions								Total (km ²)
	N	NE	E	SE	S	SW	W	NW	
1958	0.123	0.154	0.293	0.162	0.213	0.385	0.093	0.079	1.503
1972	0.847	1.267	2.313	2.012	0.232	0.393	1.508	1.462	10.035
2001	1.724	1.700	2.613	2.648	0.526	0.813	2.735	1.727	14.486
2008	2.139	2.239	2.723	2.909	0.915	1.125	3.015	2.372	17.437
2014	3.274	3.342	5.437	4.236	1.434	1.530	3.610	3.248	26.111
2023	3.428	3.865	6.501	5.288	1.571	2.861	4.220	4.627	32.361
1958–1972	0.724	1.113	2.020	1.850	0.019	0.008	1.415	1.383	8.532
1972–2001	0.877	0.433	0.300	0.636	0.294	0.420	1.227	0.265	4.451
2001–2008	0.415	0.539	0.110	0.261	0.389	0.312	0.280	0.645	2.951
2008–2014	1.135	1.103	2.714	1.327	0.519	0.405	0.595	0.876	8.674
2014–2023	0.154	0.523	1.064	1.052	0.137	1.331	0.610	1.379	6.25
1958–2023	3.305	3.711	6.208	5.126	1.358	2.476	4.127	4.548	30.858

**Figure 12.** Changes in urban areas in Al-Diwaniyah City from 1958 to 1972, 1972 to 2001, 2001 to 2008, 2008 to 2014, and 2014 to 2023.

Al-Diwaniyah City's Housing Deficit by the Target Year 2033

With the population growth that is taking place in the city, it is necessary to know the sufficient area for this population size of residents from 1958, which represents the beginning of the master plan of the city of Al-Diwaniyah, to 2033, which represents the end of the proposed design of the city. To stand in a sufficient area to accommodate the future population growth of Al-Diwaniyah City, it is necessary to know the city's housing deficit, which corresponds to the researcher's opinion [10]. The results are

indicated in Table.3 and Figure 13, showing a housing deficit that gradually increases for each period.

Table 3. The Housing Deficit and Current Residential Area for 1958, 1973, 2001, 2008, 2014, and 2023.

Year	Population	The current residential area (km ²)	Residential area that must be Provided (km ²)	Housing deficit (km ²)
1958	97618	1.503	9.76	8.26
1972	139827	10.035	13.98	3.95
2001	294351	14.486	29.44	14.95
2008	352287	17.438	35.23	17.79
2014	410943	26.111	41.09	14.98
2023	517735	32.361	51.77	19.41
2033	669239	-----	66.92	-----

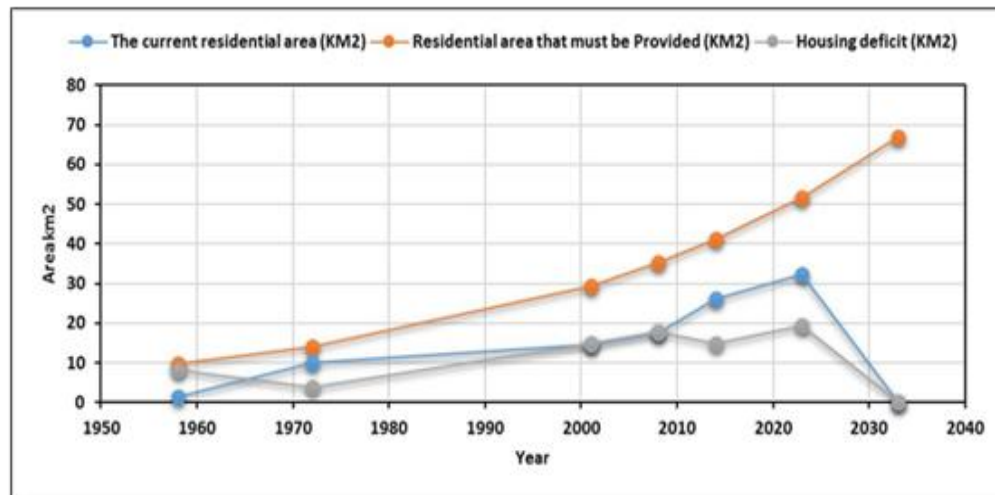


Figure 13. Illustrate The Current Residential Area and the Housing Deficit for the Periods 1958,1972,2001,2008,2014,2023.

CONCLUSION

Fundamental Finding : GIS has the potential to be a valuable tool for researching and monitoring changes in urban expansion and for providing decision-makers with faster, low-cost, and more accurate information. According to Iraqi standards, there was a lack in current residential areas for the years 1958, 1972, 2001, 2008, 2014, and 2023 by about 8.26, 3.95, 14.95, 17.79, 14.98, and 19.41 km², respectively. This deficit is expected to increase in 2033. **Implication :** Residential areas should be expanded and selected in the most suitable locations according to Iraqi standards to fulfil the deficit. To accommodate the increase in population and urbanization, the number and intensity of streets must increase in the city center. **Limitation :** Certain legislation should be taken to criminalize the random encroachments of urban areas. **Future Research :** Future research should focus on identifying the most suitable locations for residential

expansion according to Iraqi standards and assessing urban growth patterns to address the projected residential deficit in 2033.

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