

THE SPATIAL ANALYSIS OF RESIDENTIAL DENSITY IN BABIL GOVERNORATE USING GEOGRAPHIC INFORMATION SYSTEMS (GIS)

Prof. Dr. Ayad Ashour Hamzah Altaie

College of Education, Ibn Rush for Human Sciences, University of Baghdad

Zahraa Radhi Khalaf Udah

Lecturer at College of Education, Ibn Rush for Human Sciences, University of Baghdad

Abstract:

The research aims to uncover variations in the number of residential units in Babil Governorate and highlight the diversity in residential density and occupancy density in those units, using the inductive method that starts with details and concludes with generalizations. Additionally, digital maps within Geographic Information Systems (GIS) programs were utilized to clarify these variations and conduct spatial analysis operations.

The research concludes that there are variations in the number of residential units in Babil Governorate. Furthermore, there is a variation in the overall residential density and occupancy density among administrative units at the level of regions within the governorate.

Keywords: Spatial Analysis, Number Of Residential Units, Residential Density, Occupancy Density.

Introduction :

Maps are an important and effective means of conveying and analyzing geographic information. They enable readers to quickly comprehend the data represented in them and condense many complex tables and statistics that may be challenging to understand. With the digital transformation in the modern era, shifting from manual preparations to digital data, the information represented on maps has become more accurate and faster. The method of relative density is one of the most important representation techniques used to show spatial variations. Therefore, it has been employed along with quantity distribution maps to scientifically study the number of residential units, their density, and occupancy rate. This precise scientific approach allows decision-makers to devise solutions for problems and formulate future strategies for the housing sector in Babil Governorate.

Study questions

There is variation in the number of residential units and residential densities in Babil Governorate. This issue can be clarified through the following questions:

1. Is there spatial variation in the number of residential units in the study area at the level of administrative units (regions)?
2. Is there variation in residential density in the study area?
3. Is there variation in the occupancy rate for residential units in the study area?

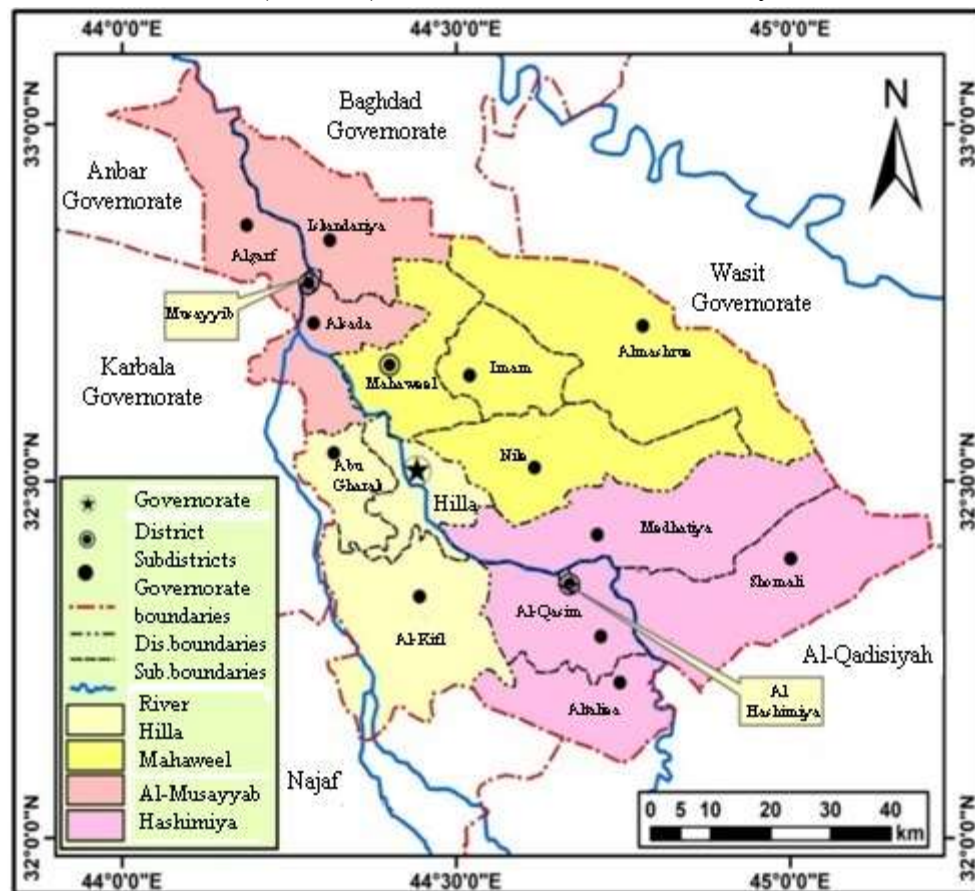
Study objective:

The research aims to determine the number of residential units in Babil Governorate and assess their suitability with the population distribution through cartographic representation. Additionally, the study seeks to understand the variation in residential densities among administrative units and the occupancy rate within those units.

Study Area:

The research targets the study of Babil Governorate, located in the central part of Iraq between the latitudinal coordinates (32°06' - 33°08') north and longitudinal coordinates (43°57' - 45°12') east. The province is considered one of the Middle Eastern provinces, bordered to the north by Baghdad Governorate, to the east by Wasit Governorate, to the south by Qadisiyah and Najaf Governorates, and to the west by Karbala and Anbar Governorates. The total area of the governorate is 119 square kilometers, and it includes four districts: Hilla, Al-Mahawil, Al-Hashimiyah, and Al-Musayyib, comprising a total of 16 sub-districts (nahiya), as shown on Map 1.

Map (1) Administrative units (districts) in Babil Governorate for the year 2019.



Source: Ministry of Water Resources, General Directorate of Survey, Maps Department, Babil Governorate Map, Scale 1:500,000, for the year 2008.

5. Percentage distribution of population:

The term "relative distribution" refers to the percentage of the population of small administrative units in relation to the total population of administrative units. It is also known as the percentage of the total population of small areas to the total population of large areas. This ratio is utilized to identify areas of population dispersion and concentration, which are of significant importance in political and strategic studies (Al-Taie, 2021, p. 365).

The relative distribution of the population is considered one of the simplest methods employed by demographers and geographers to calculate the percentage of the population residing in a specific area. By using this method, one can obtain results to describe the geographic distribution of the population (Al-Eissawi, 2001, p. 45).

As shown in Table (1) and Map (2), the map is represented using the relative shading method. It is observed that there is variation in the relative distribution of the population in Babil Governorate. The highest percentage is in the central district of Hilla (28.5%), while the lowest percentages are recorded in the Al-Imam district (1.8%) and the central district of Al-Hashimiyah (1.9%) of the total population of the governorate. The percentages for the remaining administrative units ranged between the mentioned values.

From Map (2), the following levels can be observed:

- **Level One:** This level includes administrative units (sub-districts) with a relative population distribution ranging from (3% to 1.9%). It comprises the sub-districts (Al-Jurf, Al-Imam, At-Talai'a, central district of Al-Hashimiyah, central district of Al-Musayyib, and Al-Nil sub-district).
- **Level Two:** This level includes administrative units (sub-districts) with a relative population distribution ranging from (6.4% to 4.3%). This level represents five sub-districts (Al-Shumali, As-Sadda Abu Gharq, central district of Al-Mahawil, and Al-Mashroo sub-district).
- **Level Three:** This level includes administrative units (sub-districts) with a relative population distribution ranging from (8.1% to 6.8%). It includes sub-districts (Al-Iskandariyah, Al-Kifl, Al-Qasim, and Al-Mudhatiyah).
- **Level Four:** This level includes administrative units (sub-districts) with a relative population distribution of (28.5%). It encompasses the sub-district of the central district of Hilla.

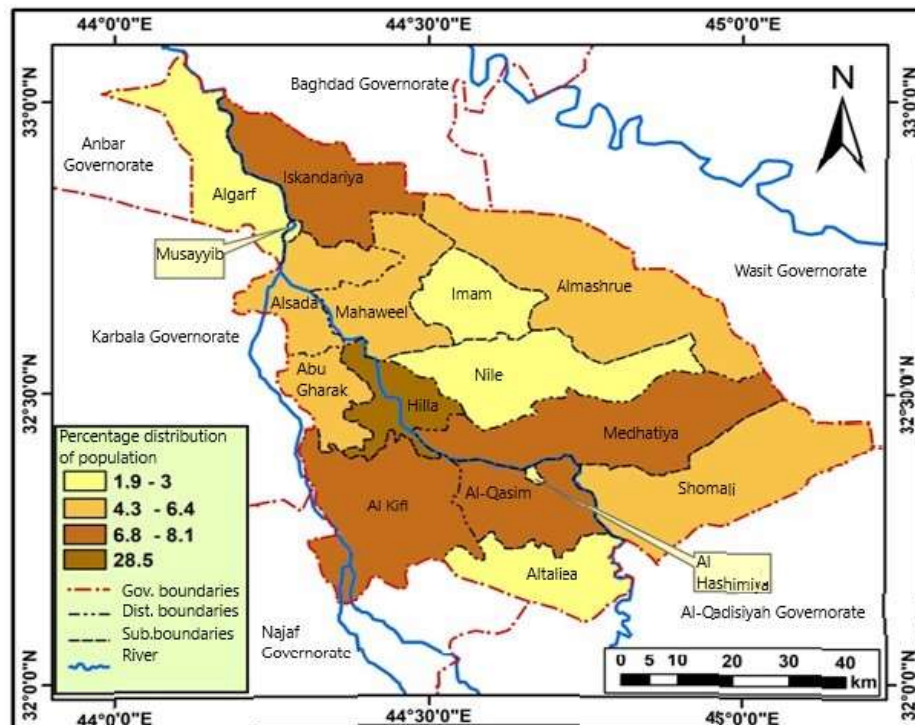
Table(1) Numerical and relative distribution of administrative units (districts) in Babil Governorate for the year 2019.

Administrative units		Population	Percentage %
Subdistricts	District		
Hilla District Center	Hilla	625404	28.5
Al-Kifl		152887	7

Abu Gharak		118797	5.4
Mahaweel District Center	Al Mahawil	127985	5.9
Almashrue		139613	6.4
Imam city		40519	1.9
Nile		64045	2.9
Al-Hashimiya District Center		Hashimiya	40408
Al-Qasim	176127		8
Medhatiya	149779		6.8
Shomali	95279		4.3
Altaliea	42562		1.9
Musayyib District Center	Musayyib	62159	2.8
Alsada		127390	5.8
Algarf		51399	2.4
Iskandariya		177010	8.1
Total		2191363	100

Source: The researcher's work, relying on the Ministry of Planning, Babylon Statistics Directorate, Studies and Planning Division, Technical Section, 2019.

Map(2) Percentage distribution of the population of administrative units (districts) in Babil Governorate In a misleading way for the year 2019.



Source: The researcher based on:

- 1- Geographic database of the study area.
- 2- Data from Table.(1).

6. Number of families in the governorate:

Household: It refers to a group of individuals living in a housing unit (a room or a set of rooms) who share various activities, most notably food preparation and household management.

Family: This is a group of individuals living in a housing unit, connected by kinship ties. Families can be divided into two social structural categories:

1- Nuclear Family: Comprising parents and children, representing an independent unit within the local community.

2- Extended Family: Comprising two or more families linked by kinship, such as parents and married children living together in the same housing unit.

From Table (2) and Map (3) depicting the numbers of families in the area for the year 2019, represented through a simple column chart, it is evident that family numbers are not evenly distributed among the administrative units in the study area. This variation is due to differences in population size from one area to another. The total number of families in the study area was 333,633. The highest total was in the district of Hilla, with 147,280 families, accounting for 44.1% of the total families in the study area. On the other hand, the lowest total was in the district of Al-Mahawil, with 51,035 families, constituting 15.3% of the total families in the study area.

In terms of sub-districts, the first rank was held by the central district of Hilla with 32.5%, followed by Al-Iskandariyah with 8.6%, and Al-Qasim with 7%. The Kifl and Al-Mudhatiyah sub-districts followed with 6.3% of the total families for the study area.

The second rank was taken by the As-Sadda sub-district, reaching the highest percentage of 5.8%, followed by Al-Mahawil with 5.7%. However, these percentages decreased in the Abu Gharq and Al-Mashroo sub-districts, reaching 5.3% of the total families for the study area.

In the third rank, Al-Shumali sub-district represented 3.7%, followed by Al-Musayyib with 3.3%, Al-Nil with 2.6%, and Al-Jurf with 2.3%. The fourth rank included the Al-Hashimiyah sub-district with 1.9%, and the Al-Imam and At-Talai'a sub-districts with 1.7% each of the total families for the study area .

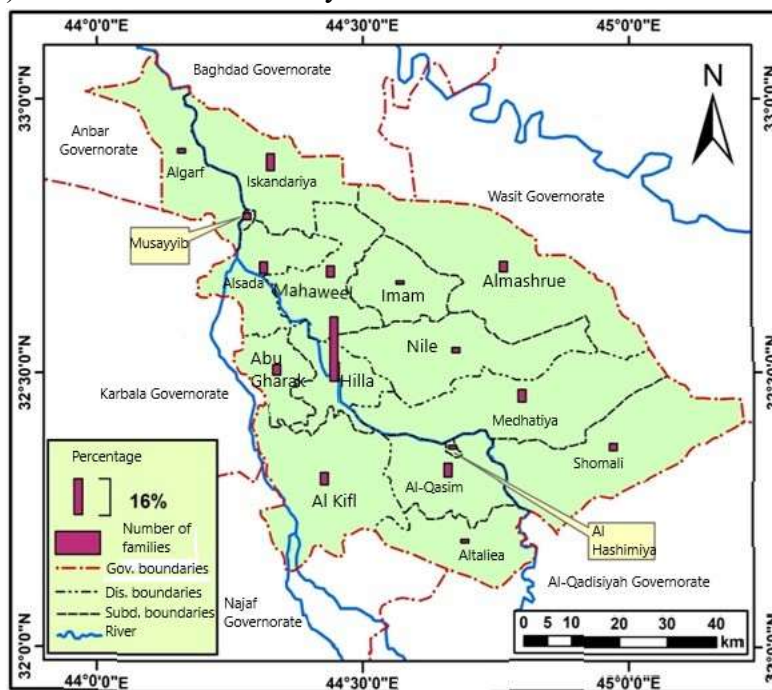
Table(2) Number of families in administrative units (districts) in Babil Governorate for the year 2019.

Percentage %	Total	Number of families		Administrative Units	
		Rural	Urban	Subdistricts	District
32.5	108513	22137	86376	Hilla District Center	Hilla
6.3	21142	17242	3900	Al-Kifl	

5.3	17625	13103	4522	Abu Gharak	Al Mahawil
5.7	19135	13937	5198	Mahaweel District Center	
5.3	17585	11650	5935	Almashrue	
1.7	5785	3543	2242	Imam city	
2.6	8530	7401	1129	Nile	
1.9	6291	-	6291	Al-Hashimiya District Center	Hashimiya
7	23469	10722	12747	Al-Qasim	
6.3	21002	11427	9575	Medhatiya	
3.7	12502	9809	2693	Shomali	
1.7	5741	4350	1391	Altaliea	
3.3	10851	-	10851	Musayyib District Center	Musayyib
5.8	19390	13530	5860	Alsada	
2.3	7583	6521	1062	Algarf	
8.6	28489	10972	17517	Iskandariya	
100	333633	156344	177289	Total	

Source: From the researcher's work, based on: Ministry of Planning, Babylon Statistics Directorate, Studies and Planning Division, Technical Department, 2019.

Map (3) Number of families in administrative units (districts) in Babil Governorate Using the simple (individual) column method for the year 2019.



Source: The researcher based on:

- 1- Geographic database for the study area.
- 2- Table data(2).

7. Number of housing units in the governorate:

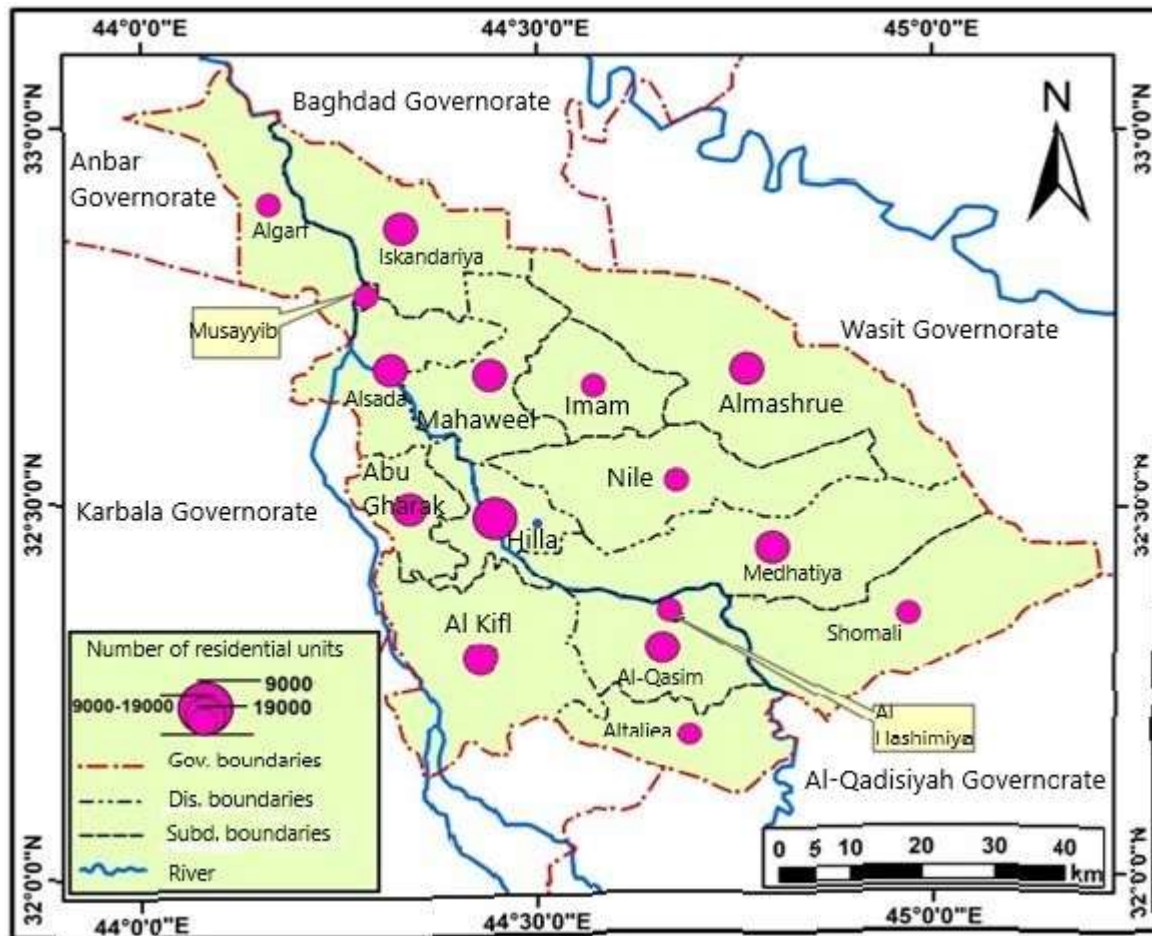
Providing suitable housing is one of the basic human needs that has been sought after, and housing continues to have a direct impact on the available services in a city. The size and distribution of housing can affect the type of services provided and their efficiency and adequacy for the population. From Table (3) and Map (4), there is a significant variation in the number of housing units within the administrative units of Babil Governorate. This map has been represented using a proportional circle chart.

Table(3) Comprehensive distribution of housing units according to administrative units (districts) in Babil Governorate, resolution 2019.

Percentage	Number of families	Number of families		Administrative Units	
		rural	Urban	Subdistricts	District
31.3	93589	19198	74391	Hilla District Center	Hilla
6.7	20092	16839	3253	Al-Kifl	
5.4	16154	12180	3974	Abu Gharak	
5.7	17162	12403	4759	Mahaweel District Center	Al Mahawil
5.6	16630	11633	4997	Almashrue	
1.7	5238	3239	1999	Imam city	
2.6	7773	6762	1011	Nile	
1.9	5585	-	5585	Al-Hashimiya District Center	Hashimiy a
7.1	21329	9788	11541	Al-Qasim	
6.4	19258	10433	8825	Medhatiya	
3.9	11672	9126	2546	Shomali	
2.1	6286	5097	1189	Altaliea	
3.1	9252	0	9252	Musayyib District Center	Musayyib
5.8	17420	12405	5015	Alsada	
2.3	7000	6062	938	Algarf	
8.4	25030	9519	15511	Iskandariya	
100	299470	144684	154786	Total	

Source: From the researcher's work based on: Ministry of Planning, Babylon Statistics Directorate, Studies and Planning Division, Technical Section, 2019.

Map(4) Numerical distribution of housing units according to administrative units (districts) in Babil Governorate using the relative circle method for the year 2019



Source: The researcher based on:

- 1- Geographic database for the study area.
- 2- Table data(3).

The significant disparity between the population and the number of housing units creates substantial problems in terms of the quality, efficiency, and increased demand for infrastructure services. Table (3) illustrates the variation in the size of housing units and their relative importance from one area to another. Based on this, the administrative units (sub-districts) of Babil Governorate can be categorized into several levels depending on the number of housing units in each administrative unit. This is depicted in Map.(4)

- **Level 1: More than 19,000 housing units:**

Ranking first is the sub-district (Nahiyah) of Al-Hillah, with a total of (93,589) housing units, constituting a relative importance of (31.3%). The sub-district of Alexandria follows with (25,030) housing units and a relative importance of (8.4%), and then the sub-district of Al-Qasim with (21,329) housing units and a relative importance of (7.1%). Subsequently, there are the sub-districts of Al-Kifl with (20,092) housing units and a relative importance of (6.7%) and Al-

Mudhatiyah with (19,258) housing units and a relative importance of (6.4%). This reflects significant urban expansion within the administrative units (sub-districts).

- **Level 2: Ranging from (19,000-9,000) housing units:**

This level includes sub-districts such as As-Sadah, with (17,420) housing units and a relative importance of (5.8%), and the sub-district of Al-Mahawil with (17,162) housing units and a relative importance of (5.7%). It is followed by the sub-districts of Al-Mashru with (16,630) housing units and a relative importance of (5.6%), Abu Gharq with (16,154) housing units and a relative importance of (5.4%). Finally, the last sub-district is Al-Shumli with (11,672) housing units and a relative importance of (3.9%), and Al-Musayyib with (9,252) housing units and a relative importance of (3.1%).

- **Level 3: Fewer than 9,000 housing units:**

This level includes sub-districts with the fewest housing units, such as An-Nil with (7,773) housing units and a relative importance of (2.6%), Al-Jurf with (7,000) housing units and a relative importance of (2.3%), At-Talihah with (6,286) housing units and a relative importance of (2.1%). Following them are the sub-districts of Al-Hashimiyah with (5,585) housing units and a relative importance of (1.9%), Al-Imam with (5,238) housing units and a relative importance of (1.7%). The decrease in the number of housing units in these sub-districts is attributed to the lack of services needed by the population, especially in newly designated residential areas.

8. Administrative Unit Area for the Governorate:

The area of Babil Governorate is (5,119 km²) (Ministry of Planning, 2019). This area is distributed among (16) sub-districts that vary in size and the percentage they occupy of the study area, as shown in Table (4) and Map (5). The map has been represented using proportional shading, with the researcher utilizing four color gradients to distinguish between levels based on the areas of the administrative units (sub-districts).

- **Level 1:** Includes sub-districts with a small area ranging from (75-6 km²). This level includes three sub-districts (Al-Imam, Al-Musayyib, Al-Hashimiyah).

- **Level 2:** Encompasses sub-districts with an area ranging from (249-158 km²). This level represents four sub-districts (Al-Jurf, An-Nil, Al-Hillah, Abu Gharq).

- **Level 3:** Includes sub-districts with an area ranging from (388-283 km²), consisting of the sub-districts (Al-Iskandariyah, Al-Qasim, As-Sadah, At-Talihah).

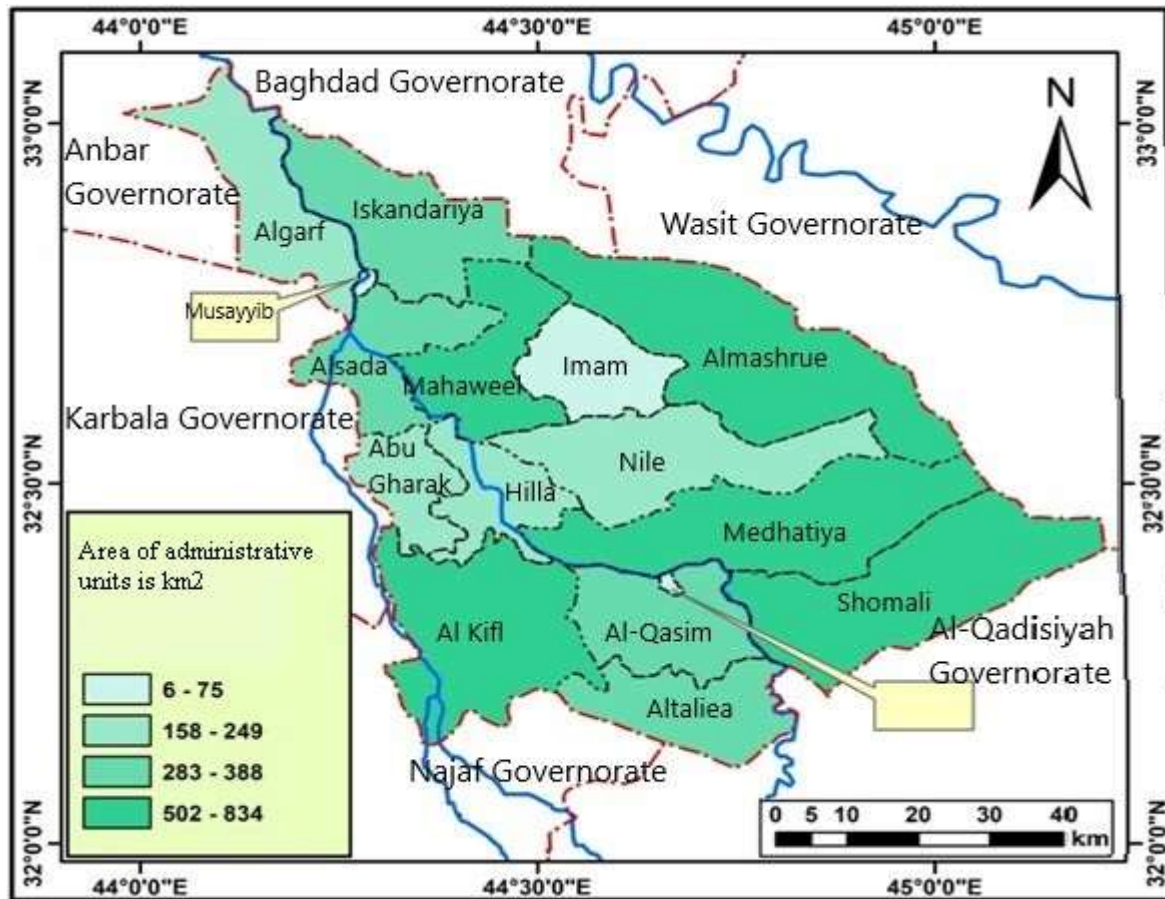
- **Level 4:** Encompasses the largest sub-districts in terms of area, ranging from (834-502 km²). This level includes the sub-districts (Al-Mahawil, Al-Mashru, Al-Mudhatiyah, Al-Shumli, Al-Kifl).

Table(4) Area of administrative units (districts) in Babil Governorate for the year 2019

Percent %	Area km2	Administrative Units	
		Subdistricts	District
3.1	161	Hilla District Center	Hilla
10.3	526	Al-Kifl	
3.7	191	Abu Gharak	
11.7	600	Mahaweel District Center	Al Mahawil
16.3	834	Almashrue	
1.5	75	Imam city	
3.1	158	Nile	
0.1	6	Al-Hashimiya District Center	Hashimiya
6.5	334	Al-Qasim	
9.8	502	Medhatiya	
9.8	503	Shomali	
5.9	301	Altaliea	
0.2	8	Musayyib District Center	Musayyib
7.6	388	Alsada	
4.9	249	Algarf	
5.5	283	Iskandariya	
100	5119	Total	

Source: The researcher's work based on: Ministry of Planning, Babylon Statistics Directorate, Studies and Planning Division, Technical Section, 2019.

Map(5) Area of administrative units (districts) in Babil Governorate using the relative shading method for the year 2019



Source: The researcher based on:

- 1- Geographic database for the study area.
- 2- Table data.(4)

9. Residential density of the governorate:

9.1. General residential density:

The general housing density is calculated by dividing the number of housing units by the area of the governorate. The average general housing density in the sub-districts of Babil Governorate for the year 2019 was 59 housing units per square kilometer. This density results from variations in the distribution of housing units within the administrative units (sub-districts), leading to an increase in population density in some sub-districts of the study area and a decrease in others. The reason for this variation lies in the differences in land areas, land uses, and the number of housing units in each sub-district, as evident from Table (5) and Map (6). The map was represented using proportional shading, employing four color gradients to distinguish between the identified levels in the study.

- **Level One:** This level includes administrative units (sub-districts) with low density ranging from 20 to 29 housing units per square kilometer. It comprises nine sub-districts (Al-Shumali, Al-Tali'a, Al-Mashroo', Al-Muhawwil, Al-Jaraf).

- **Level Two:** This level encompasses administrative units (sub-districts) with densities ranging from 38 to 49 housing units per square kilometer. Sub-districts at this level include Al-Kifl, Al-Mudhatiya, Al-Nil, and Al-Sada.
- **Level Three:** Representing administrative units (sub-districts) with densities ranging from 64 to 88 housing units per square kilometer. Included in this level are Al-Iskandariya, Al-Imam, Abi Gharq, and Al-Qasim.
- **Level Four:** This level includes the highest-density administrative units (sub-districts), represented by a darker color in the color gradient. It comprises sub-districts with densities ranging from 581 to 1157 inhabitants per square kilometer, including Al-Hashimiyah, Al-Musayyib, and Al-Hillah. The high density in these areas is attributed to their smaller size and higher number of housing units.

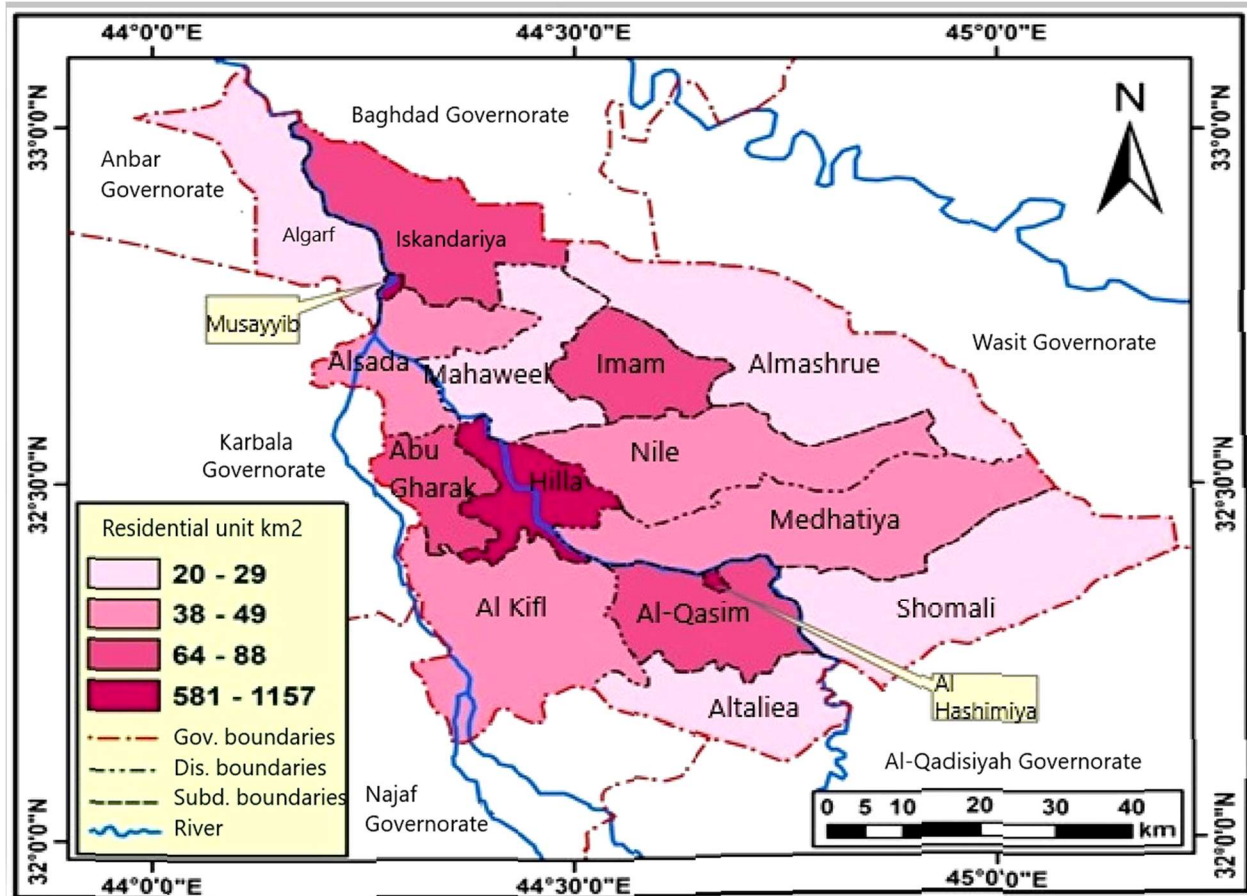
Table(5) General residential density of administrative units (districts) in Babil Governorate for the year 2019

General population density/housing unit km2	Area km2	Administrative Units	Administrative Units	
			Subdistricts	District
581	161	93589	Hilla District Center	Hilla
38	526	20092	Al-Kifl	
85	191	16154	Abu Gharak	
29	600	17162	Mahaweel District Center	Al Mahawil
20	834	16630	Almashrue	
70	75	5238	Imam city	
49	158	7773	Nile	
931	6	5585	Al-Hashimiya District Center	Hashimiy a
64	334	21329	Al-Qasim	
38	502	19258	Medhatiya	
23	503	11672	Shomali	
21	301	6286	Altaliea	
1157	8	9252	Musayyib District Center	Musayyib
45	388	17420	Alsada	
28	249	7000	Algarf	
88	283	25030	Iskandariya	
59	5119	299470	Total	

Source: The researcher based on:

Ministry of Planning, Babylon Statistics Directorate, Studies and Planning Division, Technical Section, 2019.

Map(6) General residential density of administrative units (districts) in Babil Governorate in a misleading way for the year 2019



Source: The researcher based on:

- 1- Geographic database for the study area.
- 2- Table data.(5)

9.2. Occupancy density (overcrowding rate):

It is expressed by the number of individuals within the housing unit and is also indicated by the overcrowding rate in the residential unit (population density or crowding ratio). In Babil Governorate for the year 2019, this ratio was (7.31) individuals per unit. However, it varies from one area to another, as shown in Table (6) and Map (7), illustrating the occupancy density in the study area for the year 2019. This map was represented using proportional shading, utilizing four color gradients to distinguish the levels identified by the study.

- **Level 1:** Represented by the pink color to indicate administrative units (districts) with low population density, ranging between (6.77 - 6.68) individuals per unit. This level includes three districts: Al-Hilla, Al-Musayyib, and At-Talai'a.

- **Level 2:** This level includes administrative units (districts) with population densities ranging between (7.45 - 7.07) individuals per unit. It encompasses five districts: Abu Ghraib, Al-Mahawil, Al-Jarf, As-Sada, and Alexandria.
- **Level 3:** This level includes administrative units (districts) characterized by population densities ranging between (7.77 - 7.60) individuals per unit. It consists of three districts: Al-Kifl, Al-Mudhatiya, and Al-Imam.
- **Level 4:** Represented by dark green color, this level includes the highest population densities ranging between (8.39 - 8.16) individuals per unit. It includes the districts of Ash-Shumali, Al-Qasim, Al-Mashroo', and An-Nil.
- The occupancy rate in the study area is high compared to the overall rate set by the Ministry of Construction and Housing, which is (6) individuals per unit. This high density creates psychological pressure and family problems within individual housing units, leading to family fragmentation due to the high number of households in residential units .

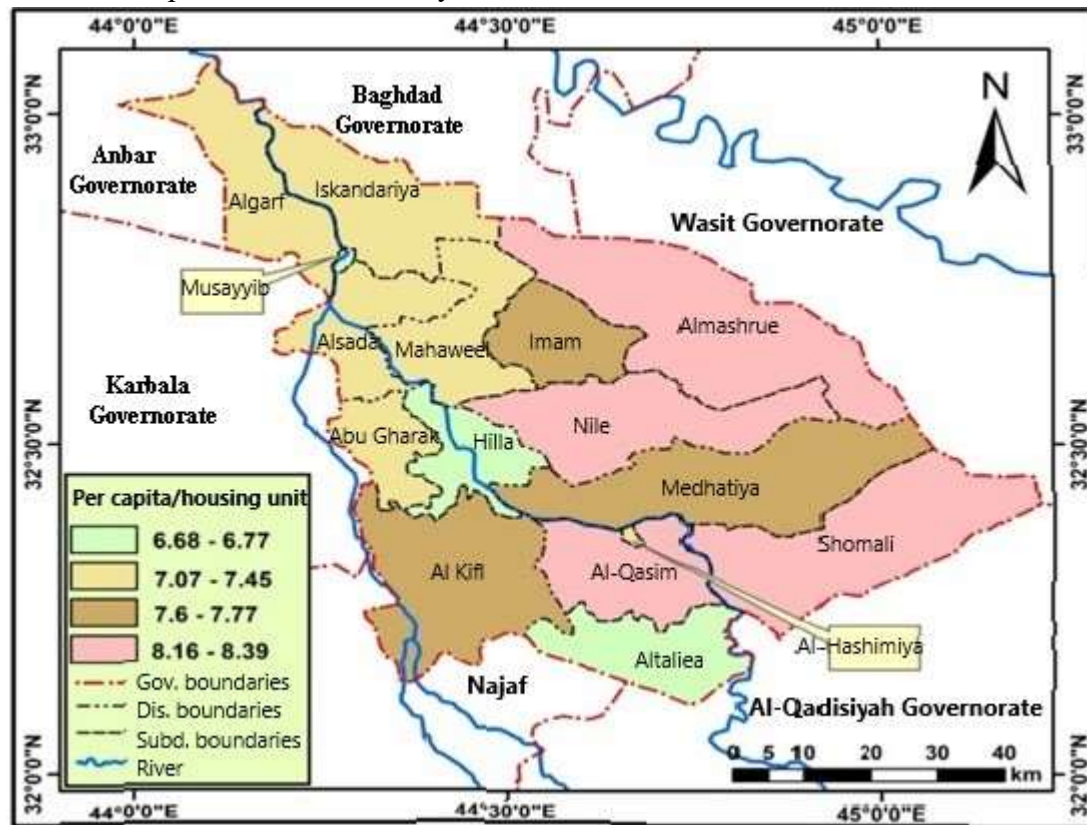
Table (6) Occupancy density of administrative units (districts) in Babil Governorate for the year 2019.

Person/Housing Unit	Residential Units	Population	Administrative Units	
			Subdistricts	District
6.68	93589	625404	Hilla District Center	Hilla
7.60	20092	152887	Al-Kifl	
7.35	16154	118797	Abu Gharak	
7.45	17162	127985	Mahaweel District Center	Al Mahawil
8.39	16630	139613	Almashrue	
7.73	5238	40519	Imam city	
8.23	7773	64045	Nile	
7.23	5585	40408	Al-Hashimiya District Center	Hashimiya
8.25	21329	176127	Al-Qasim	
7.77	19258	149779	Medhatiya	
8.16	11672	95279	Shomali	
6.77	6286	42562	Altaliea	
6.71	9252	62159	Musayyib District Center	Musayyib
7.3	17420	127390	Alsada	
7.34	7000	51399	Algarf	
7.07	25030	177010	Iskandariya	

7.31	299470	2191363	Total
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Source: The researcher based on: Ministry of Planning, Babylon Statistics Directorate, Studies and Planning Division, Technical Section, 2019.

Map (7) Occupancy density of administrative units (districts) in Babil Governorate using the relative deception method for the year 2019



Source: The researcher based on:

- 1- Geographic database for the study area.
- 2- Table data.(6).

10. Conclusions :

1. The number of residential units in Babil Governorate for the year 2019 was (299,470) housing units, varying in distribution among the districts. The highest percentage was in the center of Al-Hillah with (93,589) housing units, accounting for (31.3%), while the district of Al-Imam had the lowest percentage compared to other districts, with (5,238) housing units, constituting .(%1.7)
2. The overall population density of housing in Babil Governorate was (59 housing units/km²). However, the general residential density for administrative units varied by district for

the year 2019. The highest density was in the center of Al-Musayyib with (1,157 housing units/km²), while the lowest density was in the Al-Mashroo' district with (20 housing units/km²).

3. The occupancy rate within residential units in the governorate for the year 2019 was (8.2 individuals/room) and (7.31 individuals/housing unit).

4. The density of occupancy for residential units in Babil Governorate varied according to administrative units (districts). Al-Mashroo' district had the highest occupancy rate with (8.39 individuals/housing unit), while the center of Al-Musayyib district had the lowest occupancy rate with (6.71 individuals/housing unit).

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