



## spatial distribution pattern of green areas in the holy city of Karbala

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### ABSTRACT

Green areas in all cities of the world serve their population at various levels of planning from neighboring residential, district residential, and other levels, It achieves several benefits at the environmental, climate, recreational, and aesthetic levels, in addition to the social and economic benefits. To determine the pattern of the spatial distribution of green areas in the holy city of Karbala, defining serviced and non-served areas with green areas, to find out the reasons for the shortage of green areas, this study was prepared. In it, residential districts, population densities, availability of green areas, as well as vacant lands are determined. As there was a significant shortage of green areas in the city, which is due to the weak implementation of the master plan and the lack of exploitation of allocated areas as green areas, which if they were calculated as green areas, making them achieving the approved standard in Iraq. This study depends on modern geographic information systems techniques as tools for analysis and measurement.

**Keywords:** *Implementation, Green, City, Shortage, System*

### INTRODUCTION

Due to the recent climate changes in various countries of the world, including Iraq, and also because of a large number of pollutants, carbon emissions, and the high degrees of temperatures significantly annually, the importance of green areas and plants emerged to face these risks. The focus increases on studies related to these fields because they are linked to human existence and public health, as it is clear today that the green areas in cities are the lungs in which the cities breathe and the population enjoys and amuse themselves with it. It purifies the city's air,

improves its climate, and provides shade through its trees. It is one of the important places that strengthen social interaction, rapprochement, and social relations. The population increase and the huge demand for land in the holy city of Karbala, in light of the poor service of the municipal departments, led to the deterioration and decline of green areas in the city.

Green areas in all cities provide a service to their residents at several levels gradually within the city and have several environmental, climate, entertainment, and aesthetic benefits in addition to social and economic benefits (1).

The expansion of planting parks, gardens, trees, and green spaces inside and outside cities is very important to purify the air and improve the environment (2).

The decline in the areas of agricultural and green lands in cities had negative repercussions on the environment, biological diversity, and natural life in addition to the great effects on climate and high temperatures. (3)

Green and open areas have an important role in human health and quality of life, and it helps to face the challenges that humanity faces in climate change, as it works to absorb the carbon emissions that produce in cities and provide pure oxygen instead, as well as being places to meet and interact with the population with each other, they have social benefits Environmental and even economical through green areas multi-function. (4) It is a space within population centers in which the plant element is dominant, it is a physical and environmental basic need for the city that works to purify its air, it diversifies the extensions of the urban fabric, gives aesthetic to the city's structure and appearance, it is multi-

species, and is one of the most important activities that must be provided in cities that seek to achieve comfort and the luxury of its residents. The most prominent functions of green areas are in the health, cultural, social, recreational, and aesthetic aspects. (5)

The green areas of public gardens and cultivated green squares (which have a public domain that is not occupied by buildings and are used by the public) must be integrated on the one hand with transitional spaces, street networks, and the rest of the urban spaces, on the other hand, to achieve an infrastructure for open urban spaces to support the development and sustainability of cities and urban centers. (6) The research focuses on the spatial distribution pattern of green and cultivated areas in the holy city of Karbala.

**Iraqi standards**

The urban and rural housing standards for the year 2018 include the standards for the area's park and square for the residential district, as shown in Table (1):

**TABLE 1: Green Zones Park standards**

	<b>Indicators</b>	<b>The region's park and its square</b>
1	Serviced residential area size	Residential district (9600-14400) residents
2	Users age	all ages
3	User age ratio	%100
4	area for each inhabitant	(0.75 – 2.25) m <sup>2</sup>
5	The diameter of the serviced area	800 m

Source: Researcher, relying on the urban and rural housing standards, 2018

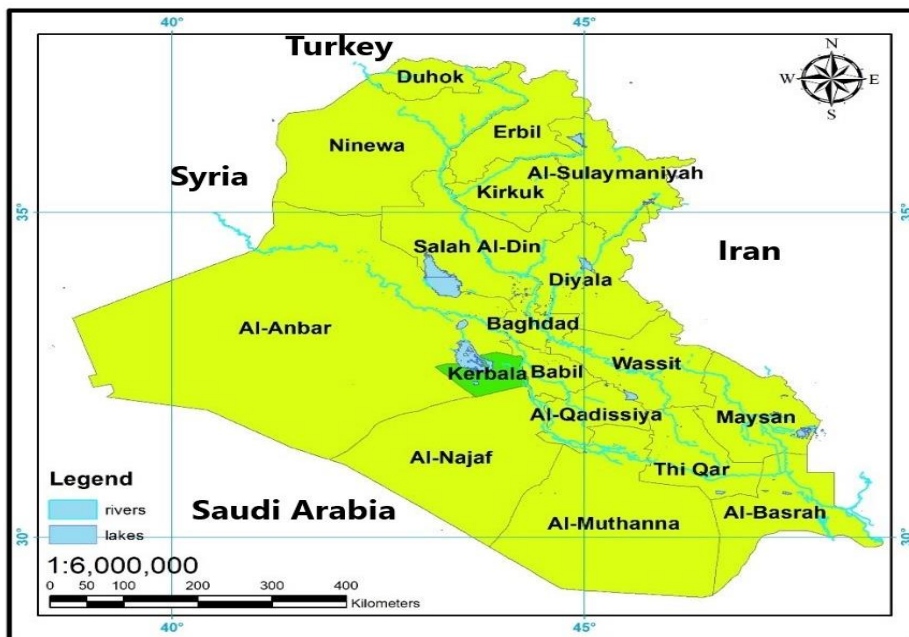
It is noted from the above table that parks and squares serve the residential district, where the percentage of people served is (100%), and an area of (0.75 - 2.25 m<sup>2</sup>) is allocated for each inhabitant of this use. (7)

**study area**

It will include a description of the location, climate, population, population densities, and determine the reality of green areas.

**Site**

The city of Karbala is located 100 km southwest of the capital, Baghdad, as explained in a map (1).

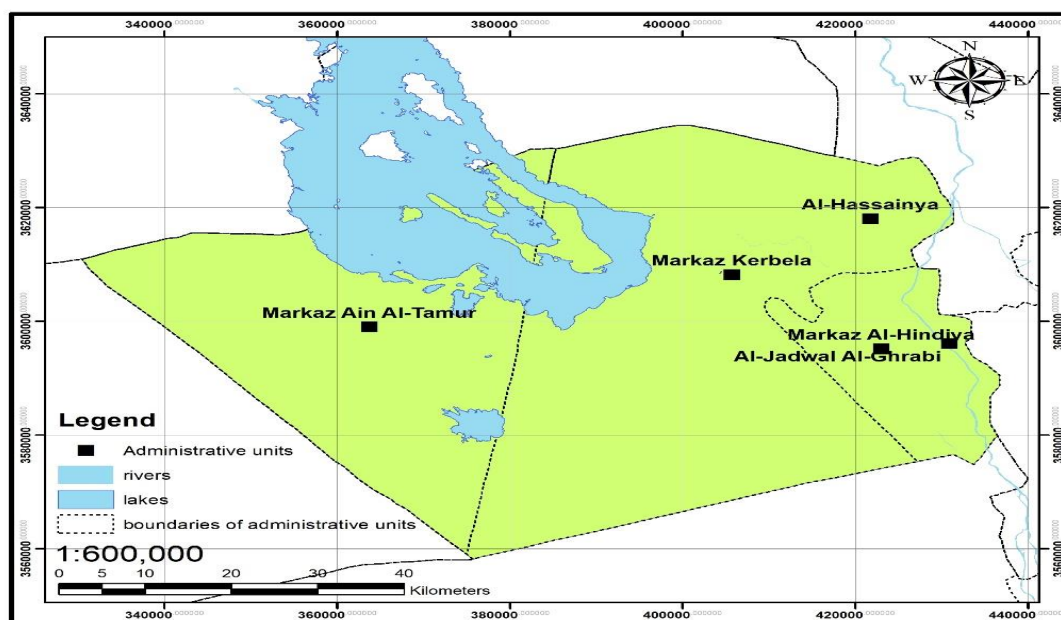


**MAP 1:** Karbala Governorate location

Source: The researcher, depending on the Ministry of Water Resources, the General Directorate of Survey for the year 2022

It is bordered to the east by the cities of Al-Husayniyyah and Al-Hindiya, to the west and south by desert lands, and to the north by the city of Al-Hur, as shown in the map (2). The city of

Karbala is located between longitudes (43°57') - (44°4') and between latitudes (32°33') - (32°39'). It is the main administrative center of Karbala Governorate. (8)

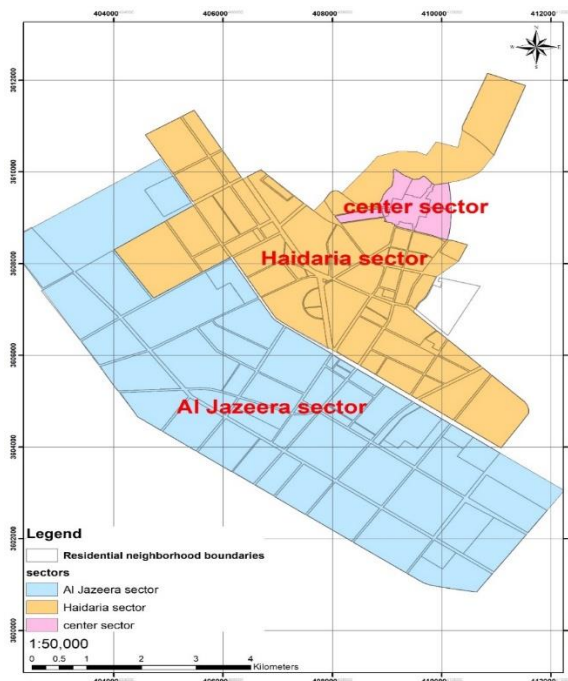


**MAP 2:** administration units of Karbala Governorate

Source: The researcher, depending on the Ministry of Water Resources, the General Directorate of Survey for the year 2022

The city of Karbala consists of three main sectors that represent the stages of its growth, which are (the old city sector, the Al-Haidariya sector, and the Al-Jazeera sector), Where the Old City sector, which is the old city center, includes the shrines of Imam Hussein and his brother Aba Al-Fadl Al-Abbas, peace be upon them, it consists of hotels, commercial and residential areas. Some of its parts were formed at the beginning of the emergence of The city of Karbala, It consists of old dwellings and narrow alleys. Thus, some

changes occurred, some modifications were made to other parts of this sector, and due to the scarcity of land in it, therefore there are almost no green areas in it. The study will include these three sectors of the holy city of Karbala. (9) As shown in a map(3) . These three main sectors represent the reality of the situation and include the implemented residential districts, as there are modern residential districts within the master plan of the city, but they are not implemented, so they were excluded from this research.



**MAP 3:** sectors of the city of Karbala currently implemented

Source: The researcher based on the Karbala Municipality Directorate for the year 2022

**climate**

The climate is a major influence on green areas and vegetation in general, as the city of Karbala has a desert climate and temperatures rise in summer, as temperatures reach 45 °C, especially in the middle of the day, and the maximum temperature is rising annually, as the governorate recorded in 2022 the highest temperature in the world, which is 52°C. As for the winter, the temperatures decrease significantly and sometimes reach zero. The city was affected by the desert climate. Because it is exposed to the desert and in terms of the sedimentary plain as well, the prevailing winds, are northwest, which

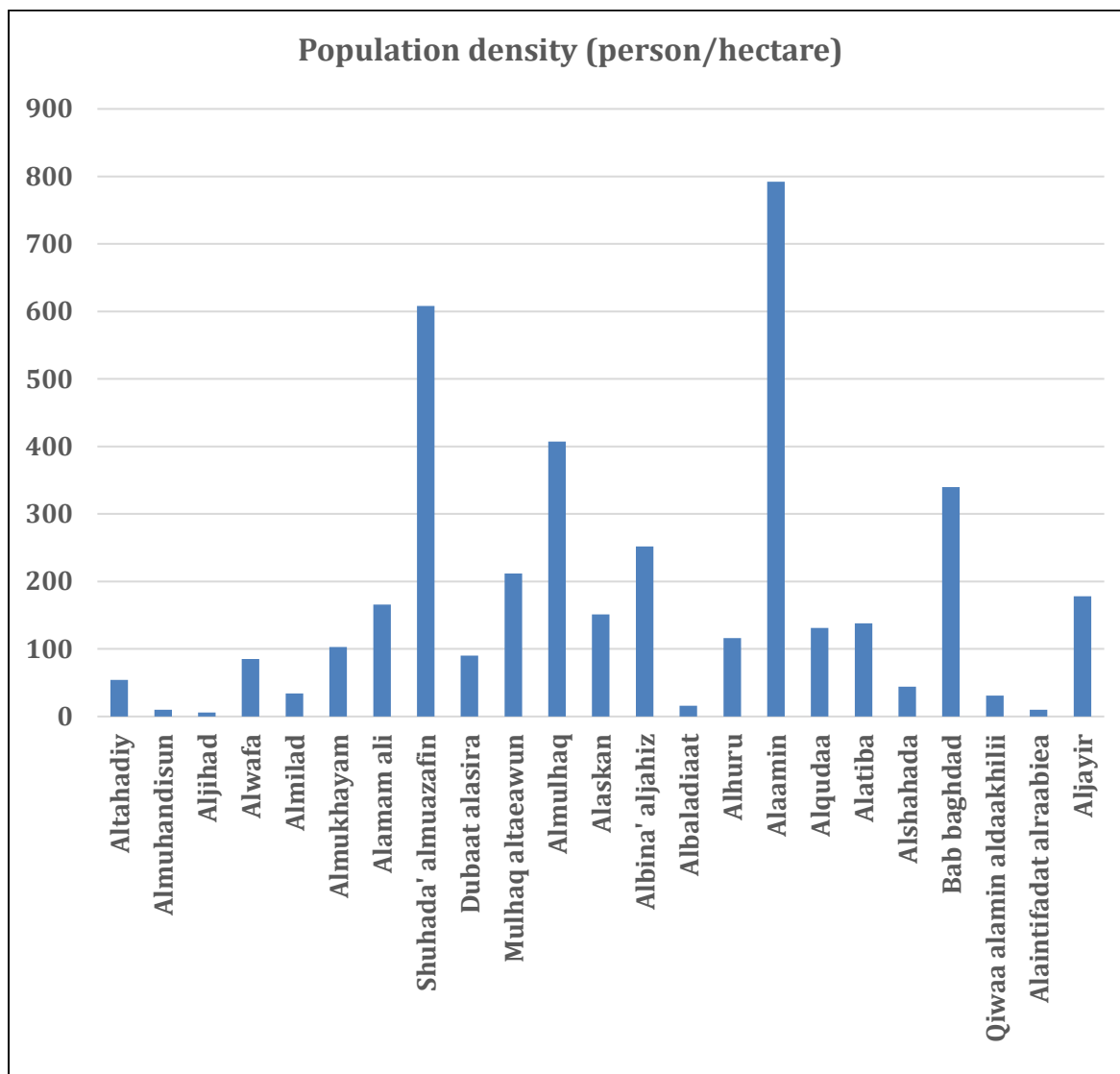
is warm and dry. These winds arise from depressions that arise in the Mediterranean Sea, and because of their passage over large desert areas, they are dry. As for solar radiation, its intensity rises and is high in the summer, because the angle of elevation of the sun is based on the city of Karbala (10).

**Population for district residential**

The city's population is estimated at (557,023) people for the year 2022, According to the city's local government data (11).

Density is one of the most important strategies that follow when planning a sustainable residential district, it is an important variable in planning urban land uses. affects the exhaustion of land, infrastructure, and the allocation of current and future services, The population density is used to measure the suitability of services for the number of residents at the level of the planning unit (residential district-residential neighborhood). (12)

The population is distributed among the districts of the city of Karbala with different densities, as in Figure (1), where through the population densities of the residential districts, it is possible to identify districts with a high population density that are not serviced by green areas, and vice versa as well, as this indicates whether the distribution is studied or not.



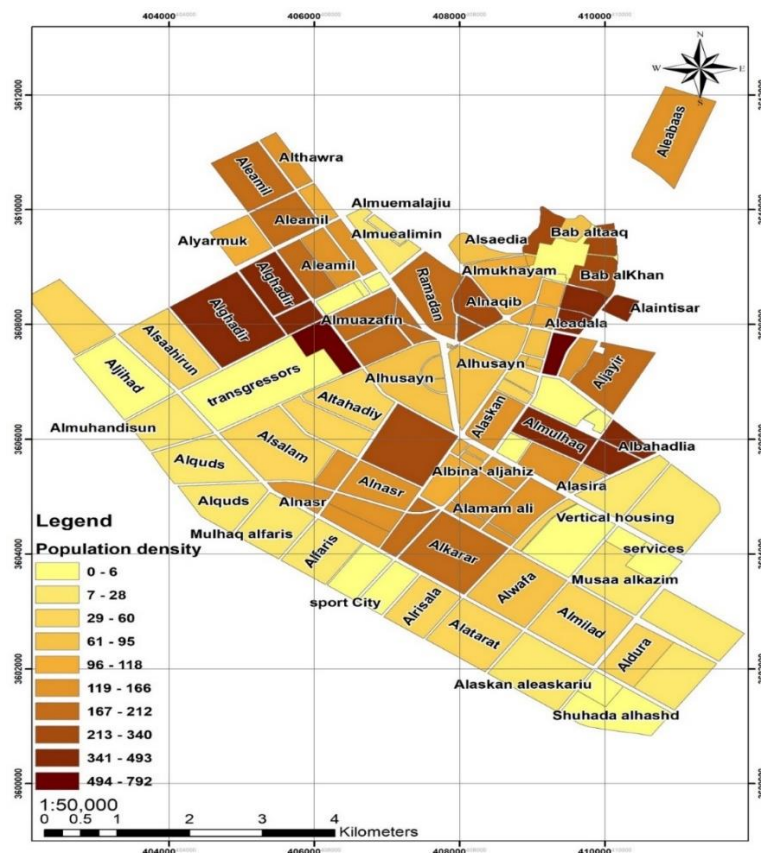
**FIGURE 1:** population densities for the residential districts of the holy city of Karbala

Source: The researcher based on the data of the District Commissioner of Karbala Center for the year 2022

Where it is clear that Alaamin district is the most densely populated residential district in the holy city of Karbala, as it reached (792) people/hectare, followed by Shuhada' almuazafin

district (608) people/ha. And the least densely populated districts are the Alaintifadatalraabiea district and Almuhandisun district with the same population density, which is (10) people/hectare.

We also notice the great difference between the districts of Karbala in terms of density, as shown in Map (4).



**MAP 4:** The population densities of the residential districts of the holy city of Karbala

Source: Researcher based on geographical information systems

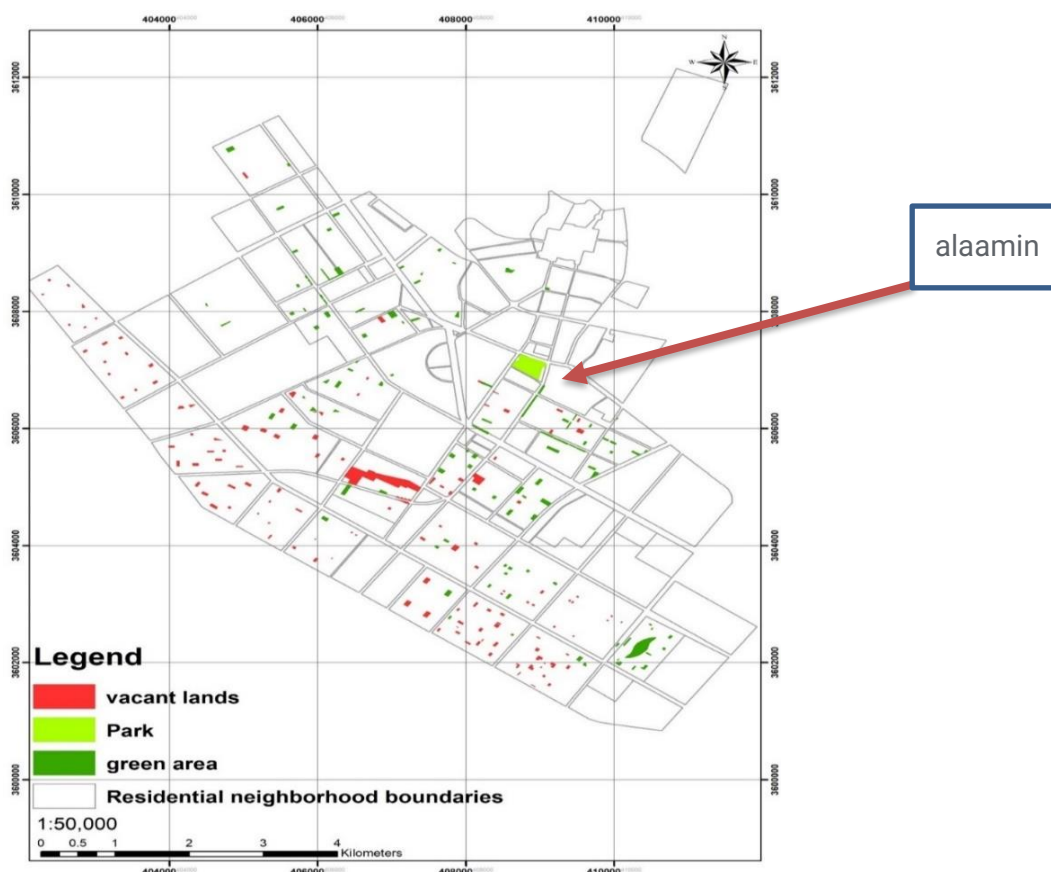
***Green areas in the holy city of Karbala***

It has been scientifically proven that the most dangerous factors of desertification is soil erosion, and because it is formed very slowly, it takes (1400-7000) years to form soil with a thickness of 8 cm. Therefore, we must avoid the activities that lead to that, such as bulldozing orchards to build houses or leaving the spaces designated for green areas, which leads to its deterioration (13). according to the urban and rural housing standards for the year 2018 (table 1), the green spaces that must be provided for a population of (557,023) people are (417,767) square meters as a minimum and (1,253,302) square meters as a maximum, because the age of the beneficiaries is 100% (all residents ).

The research used the geographic information systems program (Arc Map), which is one of the modern methods that are used in collecting and analyzing data related to natural phenomena and various land uses based on satellite and aerial images, which have proven their accuracy through the preparation of various researches and studies. Which includes the most important geospatial techniques that are used in drawing geographical maps, analyzing the land, analyzing human societies through satellite images, and remote sensing(14). The researcher relied on this program to draw and identify the cultivated green areas within the borders of the master plan for the holy city of Karbala, based on satellite images taken in the year 2022, and audited and compared with the data of the Directorate of Urban

Planning in the Holy Karbala Governorate, as in Figure (2). It was found that the total green and cultivated areas that were counted by the sectoral plans of residential districts as a green area (455,492) square meters, and that there are areas of land designated as green areas within the sectoral plan for each residential district, but they are not cultivated (vacant lands), and that many of them have been encroached on and others are still empty Whereas, the total vacant land areas until 2022, allocated to green areas, were (477,876) square meters, which are represented in red in Map (5). In addition to the presence of a relatively large park (Karbala Municipality Park), which is the only park within the city, with an area of approximately (106,966) square meters. Accordingly, the area of the cultivated green areas is (455,492) square meters in the city, which achieved the assumed area according to the approved standards (417,767) square meters

as a minimum, and this is not suitable for a city like Karbala, as there must be spaces for green areas close to the areas of the upper limit standard. In the case of calculating all areas of cultivated green areas with vacant lands (not implemented) within the sectoral plans for residential districts only, which were calculated (933,368) square meters shown in Map (5). Therefore, it is within the criterion, and it is closer to the maximum standard according to the current population of the city, and this is at the level of the residential districts of the city. As for the city level, spaces have been allocated for green areas, most of which are not permeable, as shown in Figure (2), all of this indicates that planning in that city takes into account the standards, but implementation and delay in it lead to these problems and encourage encroachment on these important areas for the city and its inhabitants.

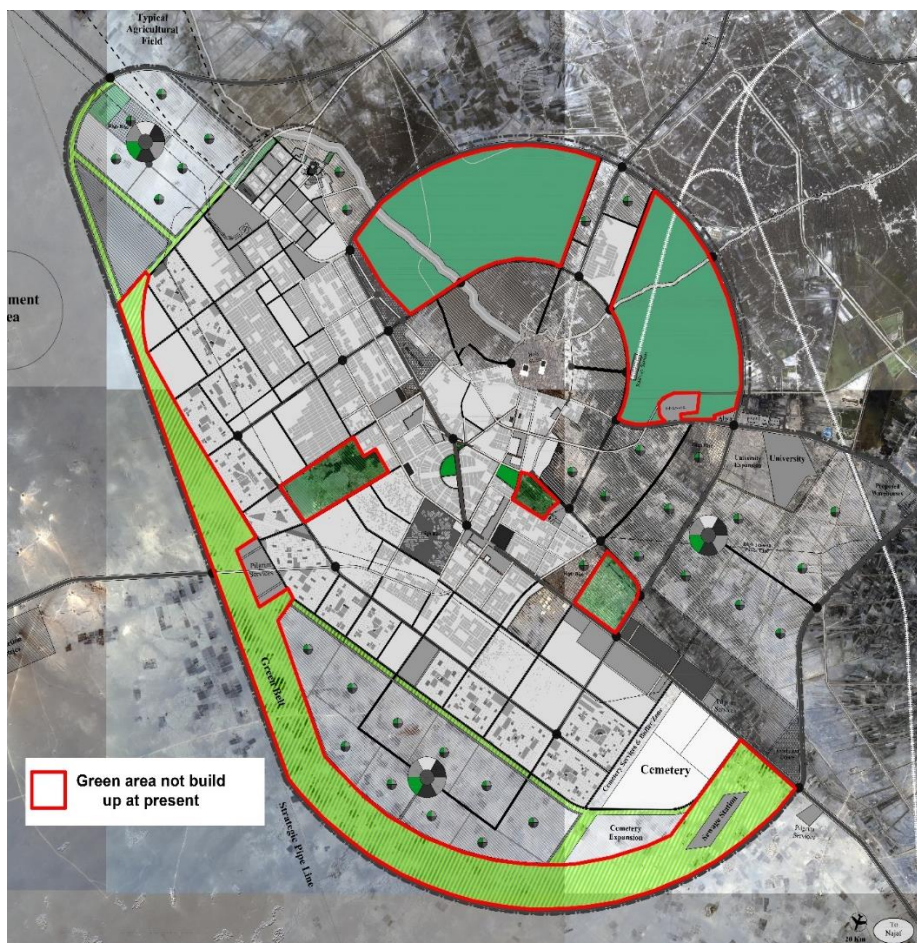


**MAP 5:** The green areas in the city of Karbala, the reality of the situation for the year 2022

Source: The researcher based on satellite images and the data of the Urban Planning Directorate of the Holy Karbala Governorate for the year 2022

It is clear from the foregoing that the Alaamin district, which is the most densely populated district, does not have green areas, which are one of the basics of a decent life. Likewise, other districts do not have green areas that are compatible with population numbers and population densities.

Figure (2) below shows the green areas approved by the approved master plan for the year 2030, which in fact most of them do not exist, and if they existed, they would work to enhance the green areas within the residential districts.



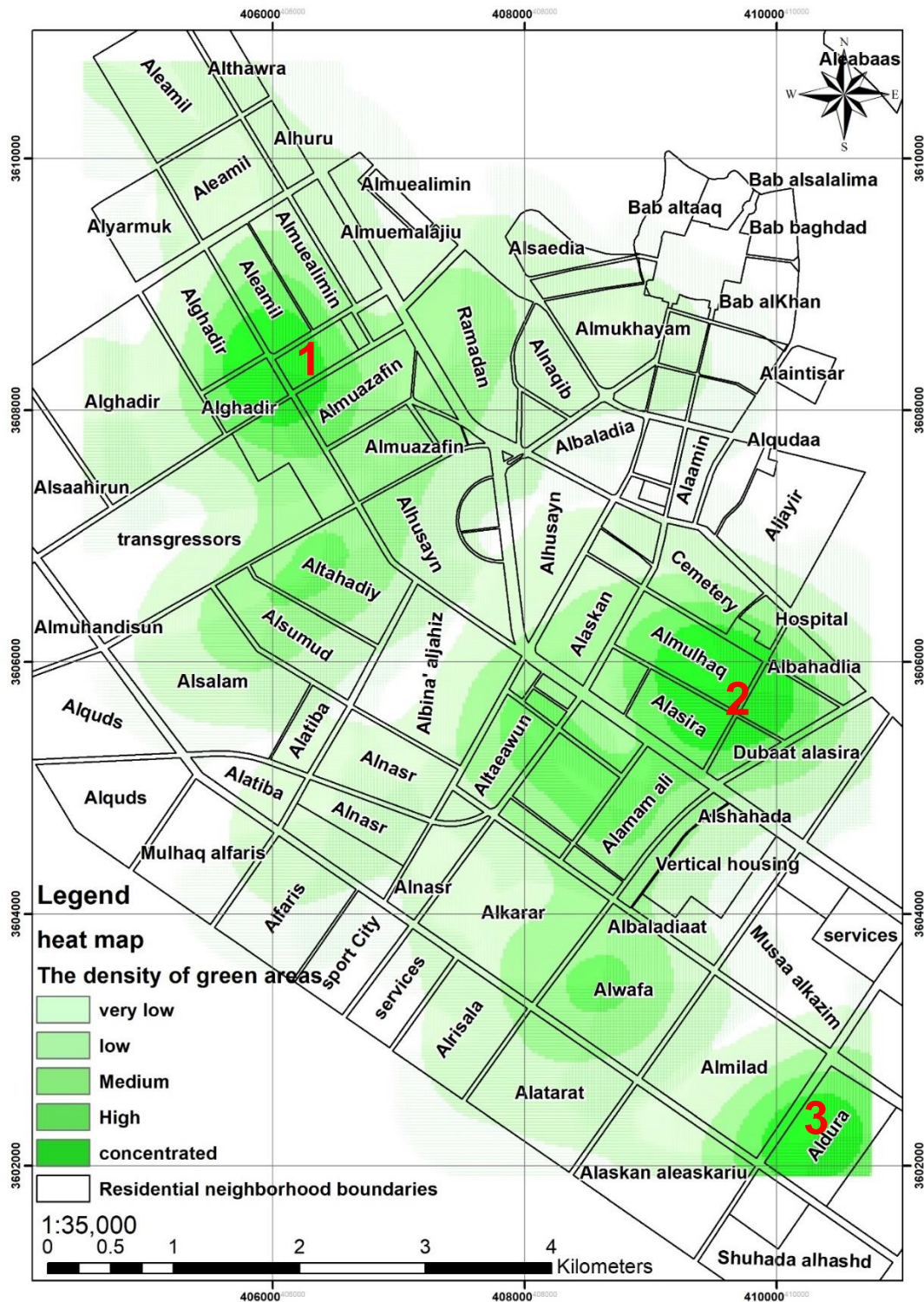
**FIGURE 2:** Green areas in the current master plan for the holy city of Karbala until 2030

Source: Directorate of Urban Planning of the Holy Karbala Governorate 2022

Map (6) shows places where the green areas are concentrated in the city of Karbala, and it gradually reaches the places where there are no green areas, it was found that the green areas were concentrated in the city in three locations mainly, which are (1- Almuazafin district, Shuhada' Almuazafin district, Aleamil district, and part of Al-Ghadir district -2- The district of Alasira, Dubaat-Alasira, Almulhaq, and Shuhada'-Almulhaq -3- Al-Durrah Residential

Compound). Site 1 and site 2 are located in the AL-Haidaria sector, and site 3 is in the AL-Jazeera sector, which is a residential investment compound and is considered one of the modern residential districts, it is concluded that residential compounds are usually implemented in accordance with planning criteria, including green areas. The map relied on the (heat map) technique to show the concentration of green areas.





**MAP 6:** concentration of green areas in the holy city of Karbala (heat map) for the year 2022

Source: Researcher

**Average Nearest Neighbor**

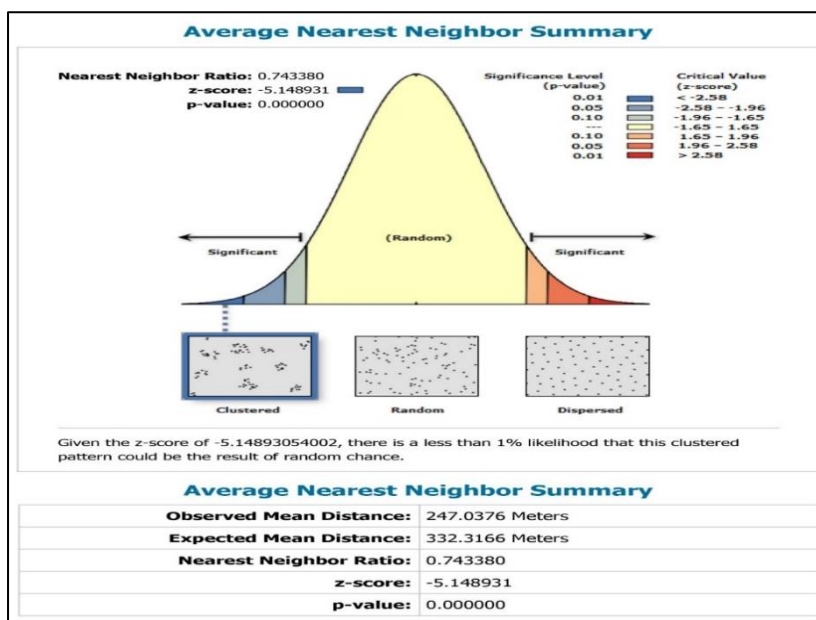
Spatial distribution is the essence of planning work, meaning the distribution of various phenomena on the surface of the earth, where planners and geographers before the existence of

modern analysis tools when describing spatial distribution depended on their personal estimates, and therefore it is not possible to give a clear definition of the characteristics of spatial distribution in the absence of objective criteria,

what is important here is to determine whether the distribution of phenomena is in the form of a specific pattern or a random distribution. If it is in the form of a pattern, then this means that there are factors and causes, but if it is random, then it is unplanned. In general, the distribution of phenomena has three types: Clustered, Random, and Dispersed. The Average Nearest Neighbor analysis depends on measuring the distances between each point in an area and the points closest to it, then these distances are collected and their average is taken, which represents the sum of the distances divided by their number(15). The average nearest neighbor analysis is used to determine the extent of concentration, dispersion, or random distribution of the phenomenon, and it is used to give a judgment as close to reality as possible for the distance between points This analysis is used as a quantitative standard, where its results are confined between (0 - 2.15) if the result is between (0 - 1), then the distribution pattern is clustered, but if its result has a value of (1), it indicates random distribution, and as for the result confined between (1 - 2.15), it means that the distribution of the phenomenon is dispersed, i.e. diffuse (16). This analytical indicator is used to measure the extent of the dispersion of the distribution of the points of the

phenomenon around itself and to measure the distances between the nodes that represent the centers of the spread of the phenomenon and between the nearest neighboring nodes in order to find out the spatial distribution pattern of the studied phenomenon (17).

After applying the Average Nearest Neighbor analysis to study the spatial distribution pattern of the green areas in the city of Karbala, it was found that the distribution pattern is clustered and close to random, as the value of (Nearest Neighbor Ratio) was equal to (0.743) and as shown in Figure (3), where it is noted that the real average distance between the green areas was (247) meters, while the expected average distance is (332) meters, as this indicates a large overlap in the green areas service areas in the city of Karbala, in a way that leads to additional costs or waste in the same areas, while other places lack this, and this means that green areas are concentrated in districts more intensively than other districts. And it reinforces the results of the heat map that showed the concentration of green areas in three locations, two of which are in the Al-Haidariya sector and the third in the Al-Jazeera sector.



**FIGURE 3:** The result of the average nearest neighbor analysis of the green areas in the holy city of Karbala

Source: Researcher by Geographical Information Systems

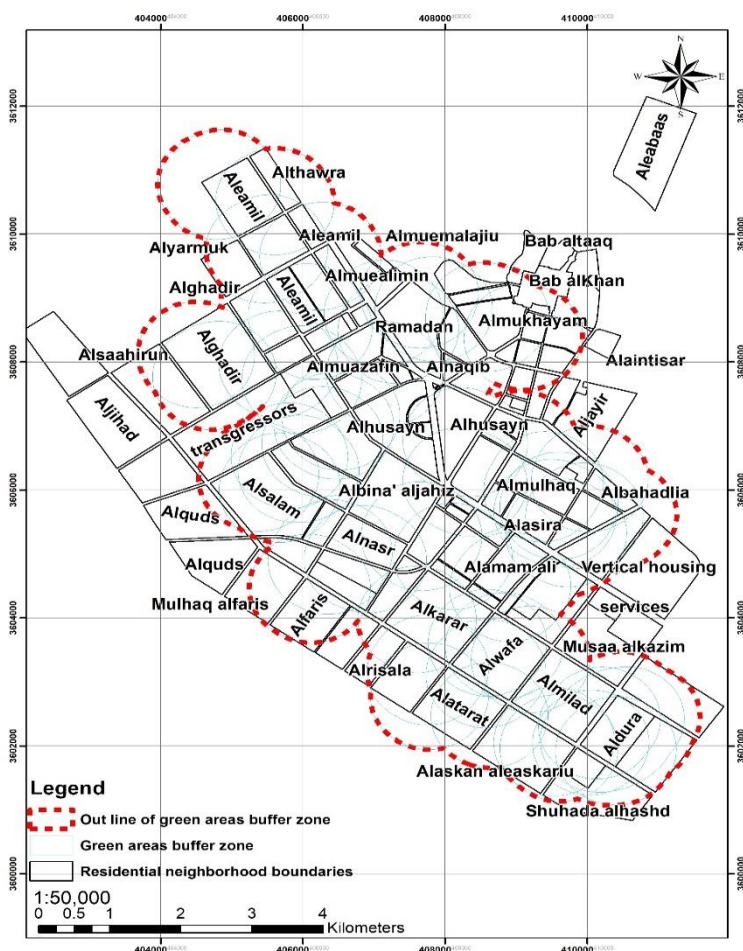
As the concentration of green areas, which are in reality below the quantitative standard in certain locations rather than others, leads to the formation of urban heat islands in many parts of the city, and thus the local climate of the city is affected, temperatures rise, areas of exposure to direct solar radiation increase, It also leads to the lack of an integrated and interconnected green urban infrastructure as a single network that improves the local climate of the city and prevents soil erosion, all of which weakens the ability to adapt to climate changes.

**buffer analysis**

They are the borders that surround a certain phenomenon with equal distances from all aspects of that phenomenon and according to the distance that the user selects. It is a GIS tool used to define an area in which a specific event takes

place that does not occur outside this area (18). It is useful in the field of urban planning in determining the scope of different services and access distances, according to approved standards.

By adopting the radius of the serviced area for the green areas according to the Iraqi urban and rural housing standards (800 m) as a maximum, it is clear to us that there is a lot of overlap between the service areas for the green areas, especially in the old residential districts that have existed since the nineties, in addition to the Al-Durra residential investment compound, which indicates a poor distribution of green areas or weakness in the implementation of non-permeable ones while there are residential areas and districts that are not served by the green areas, such as Alquds, Almuhandisun, Aljihad, and Quaalaminaldaakhili, as shown in Map (7).



**MAP 7:** Scope of serving green areas in the holy city of Karbala

Source: Researcher by Geographical Information Systems

The overlapping of service areas for green areas with this density in other areas indicates an inequity in the distribution of service in a comprehensive manner, and this leads to the existence of social and psychological differences between the different residents of the city's districts.

The area of land that is within the scope of influence of the green areas is (4670) hectares out of (4967) hectares, which is the area of all the studied residential districts, i.e. 94% of the area of the studied districts in the city. Here it should be noted that although 94% of the city's districts are within the scope of influence of the green areas, a large part of them are separated from the residents by main streets which makes access to them more difficult.

### CONCLUSION

A pattern of the spatial distribution of the green areas in the holy city of Karbala is clustered and approaches randomness

The three city sectors were as follows:

The lack of green and open areas in the old city sector, therefore it is not suitable for housing.

The Al-Haydaria sector districts achieved the largest percentage of implemented green areas.

The Al-Jazeera sector suffers from a significant shortage of green areas, despite the availability of areas suitable for this use.

The districts in the Al-Haidaria sector, which are considered relatively old districts, are the greenest areas, in addition to the investment residential Compounds.

Poor implementation and follow-up by the concerned authorities to establish and maintain green areas in the city.

The commitment of residential Compounds to planning standards related to green areas.

Unequal distribution of green areas in Karbala city districts.

The area of the studied residential district is 94% within the scope of influence of the green areas in the city of Karbala, and 6% of the area of the districts is not within the scope of influence of any green area with an area of (297) hectares.

### RECOMMENDATIONS

Modern technologies should be used in the maintenance and permanence of green areas.

Focusing the concerned authorities on establishing and preserving green areas to face climate changes and because of their importance in the welfare and comfort of the population.

Establishing a recreational green area in the northwestern part of the city in the area designated for that and which is encroached upon because this part of the city lacks a general green area that serves several districts.

Follow-up of the concerned authorities with the implementation of all green areas in the allocated and vacant lands to achieve the standard, even at the minimum level.

The spatial distribution of green areas should be according to their criteria.

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