

Utilizing Digital Mapping Technologies to Analyze the Characteristics of the Population of Ramadi City: Patterns and Trends

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KEYWORDS

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ABSTRACT

This study aims to employ digital mapping technologies to analyze the characteristics of the population of Ramadi city. Demographic data were collected from official sources and analyzed using digital mapping tools to provide a comprehensive overview of population distribution, population density, and growth rates in the city. The population of Ramadi city in 2022 was approximately 25,770, with the Othman bin Affan district being the most populous, with 31,703 residents. Population distribution was represented using dot maps to illustrate the numerical distribution of the population across different neighborhoods. The population density in the city was 55.3 persons per hectare, with Al-Khansaa district having the highest population density at 210.1 persons per hectare. Population density was represented using choropleth maps to highlight differences between neighborhoods. The population growth rate was 3.1% for the city of Ramadi. The western neighborhoods of the city, which experienced the highest growth rates of 8% and 7.5%, were the main destination for internal migration from other neighborhoods, significantly affecting population distribution and density. The study concluded that the use of digital mapping technologies provides effective tools for analyzing and interpreting demographic patterns, contributing to improved urban planning and equitable distribution of services across neighborhoods.

1. Introduction

Cartographic representation is the first step in geographical study. Through accurate and appropriate representation, a geographer can study distribution patterns and understand relationships between different phenomena, as well as spatially display study data. The technological advancements achieved worldwide in various fields have driven various scientific branches, including geography, to keep pace with this development and try to benefit from the great capabilities it provides in storing, classifying, representing, and analyzing spatial data. Many information management systems have emerged, such as image processing systems (ERDAS), computer drawing systems (AutoCAD), and design programs (CorelDRAW). However, the best and most comprehensive for map production are geographic information systems (GIS). Despite the modern technical developments that have saved time and effort in map production, which the cartographer should benefit from and follow up on all that is new, map drawing still requires the cartographer's skill, thinking, and considerable effort to choose the best way to convey the idea to the user in the least amount of time. There are various methods for representing spatial data, including population data on administrative units, and any method can be used to represent them, considering that the importance of using any method lies in the perceptual aspects that serve the quick understanding of the information represented on that map rather than the essence of the symbol represented on the map in use.

Problem Statement

What is the reality of the population distribution and growth and the complexities of growing demographics within the city of Ramadi? How can cartographic representation be used as an effective tool to understand and analyze population characteristics simply and understandably? How can population density be measured and interpreted in different neighborhoods using digital mapping technologies? How can population growth rates in Ramadi city be analyzed and understood using mapping tools?

Hypothesis

Effective cartographic representation can reveal demographic patterns, trends, and relationships between the population and their geographical environment. Digital mapping programs for drawing population characteristics maps surpass traditional methods. Cartographic analysis can reveal differences in population density between different neighborhoods in Ramadi city. Digital mapping technologies can contribute to a better understanding of population growth rates and internal migration trends in Ramadi city.

Importance of the Study

Providing a deeper understanding of population distribution and patterns in Ramadi city. Identifying population needs and guiding urban planning policies and resource management more effectively. Enhancing decision-making capabilities based on evidence. Analyzing and documenting population characteristics in Ramadi city. Exploring effective methods for representing this population data using cartographic representation. Determining the best methods for cartographic representation of population characteristics at the neighborhood level.

Research Methodology

The descriptive method was relied upon to analyze the maps prepared using digital and computer programs, as shown in the following study steps: Collecting population data for Ramadi city. Analyzing data and extracting main results. Using cartographic representation techniques to effectively visualize this data. Reviewing and analyzing the produced maps to determine preferences and possible improvements. Applying cartographic representation of data using geographic information systems (GIS) programs. Evaluating and analyzing the produced maps Map: A precise drawing of the Earth's surface or part of it using a reduced scale and a mathematical method of projection, showing geographical facts. It is a visual depiction of natural and human geographical data. Digital map: A term used for any map produced with factors giving numerical outputs and represented by precise coordinates and numbers, transforming graphical image features into ratios and numerical values that can be stored and displayed at any time using a computer. Cartographic representation: The process of visualizing geographical data in a way that aids analysis, providing information visually to clarify relationships, patterns, and distributions among different phenomena. The cartographer selects the best possible methods for representing phenomena, enhancing the perceptual value of the map through good design and appropriate representation methods. (Mushref, Khalaf, Al-Ani .2021)

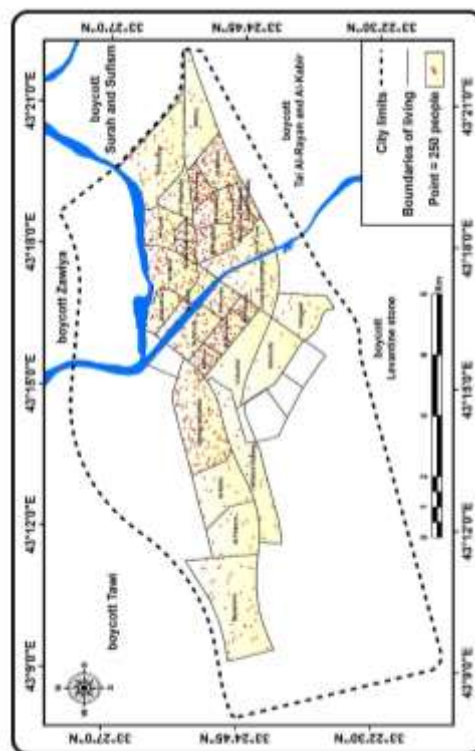
Numerical distribution of population

The number or size of the population that has been counted in a specific place and within a known time frame. This concept primarily considers the quantitative and volumetric basis in classifying areas and determining their ranks and levels. Numeric distribution is usually measured by calculating the number of inhabitants in specific areas such as states, cities, or villages. The numeric distribution of the population can be homogeneous when the number is equal across all areas. However, distribution is often heterogeneous, with some areas having high population density and others having low population density.

Regarding the estimates for 2022, the population of the city of Ramadi was 25,770 people. The Othman bin Affan neighborhood ranked first with 31,703 people due to the exploitation of a larger number of lands and the emergence of large housing complexes. The Al-Walid neighborhood came in second with 17,692 people due to the conversion of some agricultural lands for residential purposes and the neighborhood's proximity to the central area. The population of the Al-Jumhuri neighborhood decreased to 11,779 people due to the commercial function competing with the residential function, as the commercial function is stronger than the residential one. The neighborhoods of Al-Tawasul and Al-Firdous were no longer in the last rank after the city expanded outward and utilized the land for housing, especially after the development of transportation routes and the provision of basic and community services. The University neighborhood ranked last with 648 people, as the housing in this area is

distributed among some university affiliates in a limited manner. The Industrial neighborhood had 216 residents, as the housing was limited to some workers and their families, as shown in Table 1.

The cartographic representation by points is one of the simplest, most important, and most widely used methods for population distribution as it provides a good sense of the density of the phenomenon. It is used in both quantitative and qualitative representation or both together. The concept of these points is based on the repetition of a point of uniform size and a known fixed value on the administrative units of the study area, and the total value of the points represents the value of the population of the phenomenon (Rashid, 2016, p. 357). The researcher relied on a value of 250 people per point. Researchers have differed on the method of distributing points within the study area (administrative units on the map) as shown in Figure 1. Some prefer to distribute the points uniformly across the study area (the map), while others prefer to distribute them randomly. However, a significant proportion of researchers, including the researcher, believes that the second method (random distribution) is the best.



Population Distribution 2022 Using Dot Method

Source: Based on Arc GIS (10.8)

Table 1. Population Distribution by Neighborhood

Population 2022	Residential Neighborhood
10081	Al-Quds
17692	Al-Walid
6274	Al-Khadraa
3644	Al-Taqaddum
13720	Al-Khansaa
9359	1st of June
12789	Al-Andalus
11779	Al-Jumhuri
15362	Al-Malaab
3729	Eastern Railway
13309	Mohammed Mazloun

5778	Al-Aziziya
3965	Al-Qatana
5845	Al-Hurriya
4867	Al-Warar
8374	Al-Noor
5406	Al-Hussein
14018	Al-Mu'tasim
2857	Al-Firdous
11095	Expansion
3169	Al-Amin
216	Industrial
10822	Al-Ta'mim
31703	Othman bin Affan
4705	Western Railway
8360	Local Government
1205	University
3456	Refugees
11249	Al-Soufiya
2952	Military
25779	Total

Source: Ministry of Planning, Anbar Statistics Department. Population estimates based on the 2009 census and enumeration.

Population distribution

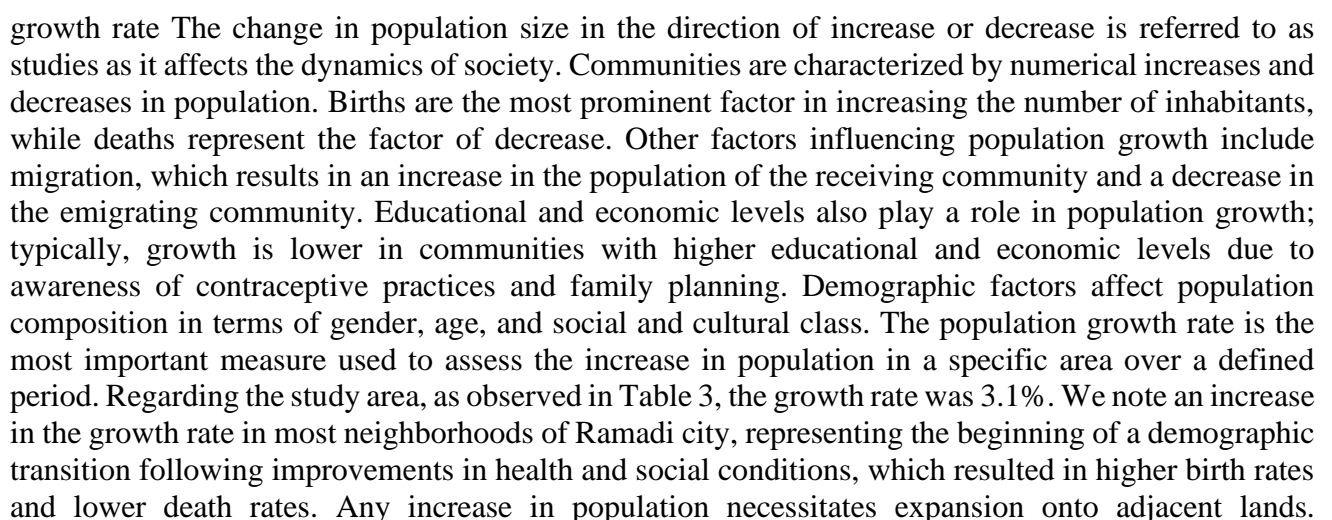
General Arithmetic Density: This type is one of the most common and widely used due to its simplicity. It is the relationship between the total population in a specific area and the total area of that region, regardless of the economic potential and productive capacity of the land. It is also used to determine the degree of population inflation and their capacity for support (Al-Khayyat, 1965, p. 101). Researchers rely on studying population density and consider it a practical criterion for linking the number of people to the area they inhabit. Through this, the variation in population distribution between different areas can be understood . The variation in distribution, whether concentrated or scattered, has economic, social, and natural reasons that vary in importance from one place to another, between countries and within regions of the same country. The general arithmetic density in the city of Ramadi was 55.3 hectares according to 2022 estimates. The researcher represented the population density in the city of Ramadi using choropleth maps. This type of map is known by several names, including density maps and shadow maps. It is a type of cartographic representation that uses shadows or colors to visualize the distribution of a phenomenon within administrative units. A choropleth map is created by converting numerical values into specific colors and applying color gradients to the map (Al-Eisawy, 2000, p. 190). Typically, a color scale consisting of different gradients is used to represent density levels, with lighter colors representing areas of low density and darker colors representing areas of high density.(Mushref, abd, Mikhilif, Abed. 2022)

Table 2: Population Density for 2022

Density 2022 (People per Hectare)	Area (Hectares)	Residential Neighborhood
73.4	137.4	Al-Quds
90.4	195.7	Al-Walid
67.7	92.7	Al-Khadraa
39.1	93.1	Al-Taqaddum

210.1	65.3	Al-Khansaa
64.6	144.8	1st of June
114.4	111.8	Al-Andalus
108.0	109.1	Al-Jumhuri
124.0	123.9	Al-Malaab
156.0	23.9	Eastern Railway
142.6	93.3	Mohammed Mazloun
174.6	33.1	Al-Aziziya
108	36.7	Al-Qatana
75.1	77.8	Al-Hurriya
47.2	103.2	Al-Warar
48.1	48.1	Al-Noor
143.8	37.6	Al-Hussein
155.1	90.4	Al-Mu'tasim
12.7	224.5	Al-Firdous
24.6	450.7	Expansion
13.1	242.3	Al-Amin
1.0	206	Industrial
77.6	139.4	Al-Ta'mim
79.90	396,8	Othman bin Affan
18.3	256.9	Western Railway
41.7	200.3	Local Government
5.5	218.6	University
25	137.5	Refugees
29.2	385.8	Al-Soufiya
101.6	198.9	Military

Source: From the work of the researcher based on 2022 population estimates



Neighborhoods such as Al-Firdous, Expansion, and Othman bin Affan had high growth rates, reaching 8% and 7.5% respectively, due to the city's expansion westward, lower land prices compared to within the city, and the tendency of low-income individuals to move there due to the high cost of living in the city center, primarily represented by rent costs. This high rate was driven by migration rather than natural increase. The expansion was directed westward due to human obstacles preventing the city's expansion in other directions.

Table 3: Population Growth Rate

Groth rate	Population 2022	Population 2010	Residential Neighborhood
2.4	10081	7553	Al-Quds
4.2	17692	10754	Al-Walid
1.9	6274	5001	Al-Khadraa
2.0	3644	2857	Al-Taqaddum
2.6	13720	10036	Al-Khansaa
0.3	9359	9068	1st of June
2.6	12789	9403	Al-Andalus
-2.7	11779	16269	Al-Jumhuri
2.6	15362	11350	Al-Malaab
3.1	3729	2594	Eastern Railway
1.2	13309	11539	Mohammed Mazloun
2.5	5778	4317	Al-Aziziya
2.6	3965	2928	Al-Qatana
2.7	5845	4270	Al-Hurriya
2.1	4867	3813	Al-Warar
2.4	8374	6334	Al-Noor
2.7	5406	3923	Al-Hussein
2.1	14018	10892	Al-Mu'tasim
8.0	2857	17	Al-Firdous
8.0	11095	0	Expansion
2.6	3169	2337	Al-Amin
-0.9	216	241	Industrial
2.6	10822	7917	Al-Ta'mim
7.5	31703	13307	Othman bin Affan
2.6	4705	3466	Western Railway
2.4	8360	6304	Local Government
5.3	1205	648	University
2.6	3456	2531	Refugees
2.6	11249	8263	Al-Soufiya
8.0	2952	564	Military

Conversely, neighborhoods with low growth rates include Al-Jumhuri (-2.7) due to functional changes where some houses were converted to commercial use, and the Industrial neighborhood (-0.9) due to the migration of most residents as the area became purely industrial. Generally, the city of Ramadi experienced an increase in population, especially after the military operations in 2014 and the settlement of new residents from the western areas of the province. The researcher used 3D columns

to map the growth rate, a method that displays geographical and statistical data on maps using three-dimensional columns. This adds a third dimension to the information, enhancing the reader's ability to analyze and understand the spatial and temporal relationships between different data. 3D columns are particularly effective in representing large quantitative changes across different geographical areas, facilitating the comparison of data between regions. They add depth and accuracy to the presentation of geographical data, with each column representing a specific quantitative value associated with a defined geographical location, reflecting the size of that value. This technique helps clarify differences and similarities between different areas through a direct visual representation of quantitative relationships. Various colors and sizes of columns are used to enhance the visual understanding of the data.

2. Conclusion and future scope

population in the city of Ramadi is distributed uniformly, as indicated by the maps, due to the similarity of natural and human conditions affecting the distribution. Population growth and city expansion have occurred towards the western part of the city due to the availability of suitable residential lands and the establishment of housing complexes. This has led to an increase in the growth rate in the western areas of the city and a decrease in the older neighborhoods. Geographic Information Systems (GIS) technologies play a significant role in map design and production according to visual perception principles, as they offer multiple options for shapes and symbols. The study showed that the correct choice of cartographic representation methods and appropriate techniques has a significant impact on representing phenomena on maps and highlighting relationships among them. Regularly sized points are the most suitable for representing the geographical distribution of the population. The study indicated that choropleth maps with graduated colors are the best cartographic representation methods for depicting population density. The method of proportional columns, represented by 3D columns, is one of the best types of representation for population growth at the neighborhood level, as it provides high visual perception for the audience.

Recommendations

Develop urban planning policies based on current population distribution and future growth projections to ensure a balanced distribution of the population and improve the utilization of available resources. Direct new housing projects towards the western areas where suitable residential lands are available, while ensuring the development of old neighborhoods to stimulate balanced growth across all parts of the city. Use regularly sized points as the best method for representing the geographical distribution of the population on maps to ensure clear and precise visual perception. Train urban planning personnel on the use of Geographic Information Systems (GIS) to enhance their capabilities in data analysis and accurate map production. Adopt the use of choropleth maps with graduated colors to represent population density, as they provide clarity and ease of data interpretation. Utilize graphical representations such as 3D columns to represent population growth at the neighborhood level, ensuring high visual perception and ease of understanding demographic changes.

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