The population structure of the holy city of Karbala, a study in population geography

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الخلاصة

يعتبر الهيكل المكاني لترتيب وتنظيم الظواهر أحد أهم الأقسام الديموغرافية للدراسات الجغرافية التي تبحث في توزيع السكان في منطقة مكانية. قضية مهمة هنا هي هيكل التوزيع المكاني للسكان. السكان عنصر أساسي في البرامج الاقتصادية والاجتماعية والثقافية. لذلك ، يعد تنظيم الفضاء المتوازن في المدن نوعًا من الاستدامة الحضرية وسيتم تحقيقه عندما يكون هناك تنسيق منطقي بين توزيع السكان وتوزيع الخدمات في المدن. في مدينة كربلاء ، يوجد جزء كبير من السكان في منطقة صغيرة من المدينة ونمط التوزيع السكاني لكل وحدة مساحة غير متوازن. وعليه ، فإن الغرض من هذه الدراسة هو التعرف على توزيع التركيبة السكانية في مدينة كربلاء والعلاقة بين هذا الهيكل التوزيعي وتوزيع الخدمات الحضرية. البحث الحالي هو منهج تطبيقي ووصفي-تحليلي وكمي يتضمن دراسة وثائق المكتبة والمراجع للمنظمات والمؤسسات ذات الصلة وتحليل البيانات. في الأسس النظرية والأدبيات البحثية ، ودراسة المكتبة وفي مراحل لاحقة لاستكمال المعلومات ، يتم استخدام مواقع OSM وخدمات Google المكانية ، والمعلومات الضرورية في شكل خدمات دينية ورياضية وثقافية وخدمات يومية ومرافق ترفيهية ومنتزه و تم جمع المساحات الخضراء والصحة والتدريب. ومن موقع https://data.humdata.org/ تم تحميل خريطة الكثافة السكانية لكربلاء. باستخدام Zonal Statically ، ترتبط معلومات الخدمة والكثافة السكانية مكانيًا بشبكات سداسية.تم استخدام طريقة Moran العالمية للتوزيع المكاني للسكان وتم استخدام طريقة انحدار الوزن الجغرافي لتقييم البنية السكانية للمدينة وعلاقتها بتوزيع الخدمة . تشير نتائج طريقة موران إلى أن التركيبة السكانية مجمعة وأن مؤشر موران يساوي I = 0.9514. كما ان العلاقة بين الكثافة السكانية وتوزيع الخدمة تساوي ٠,٨١٤ مما يدل على الدقة المقبولة لمتغيرات الدراسة الحالية في نمذجة التركيب المكاني للتوزيع السكاني في مدينة كربلاء. وهذا يعني أن النموذج كان قادرًا على تقييم ما يصل إلى ٨١٪ من العلاقة الحالية ولديه نسبة عالية من معامل كفاية وملاءمة نموذج انحدار الوزن الجغرافي في توزيع التركيبة السكانية.

الكلمات المفتاحيه : الهيكل الديموغرافي التوزيع المكاني ، مدينة كربلاء ، الخدمات البلدية ، نظم المعلومات الجغرافية(GIS)

Abstract

Spatial structure of the arrangement and organization of phenomena is one of the most important demographic sections of geographical studies that examines the distribution of population in a spatial area. An important issue here is the structure of the spatial distribution of the population. Population is one of the fundamental elements in economic, social and cultural programs. Therefore, balanced space organization in cities is a kind of urban sustainability and will be achieved when there is a logical coordination between the distribution of population and the distribution of services in cities. In the city of Karbala, a large part of the population is located in a small area of the city and the pattern of population distribution per unit area is unbalanced. Accordingly, the purpose of this study is to identify the distribution of population structure in the city of Karbala and the relationship between this distribution structure and the distribution of urban services. The present research is applied and descriptive-analytical and quantitative method, which includes the study of library documents and references to relevant organizations and institutions and data analysis. In theoretical foundations and research literature, library study and in

later stages to complete the information, OSM sites and Google spatial services are used, and the necessary information in the form of religious services, sports, culture, daily services, recreational facilities, park and green space, health and education has been collected and downloaded from https://data.humdata.org/ population density map of Karbala city. Using Zonal Statically, service information and population density are spatially connected to hexagonal networks. The global Moran's method is used for spatial distribution of population and geographical weight regressions method is used to evaluate the population structure of the city and its relationship with service distribution. The results of Moran's method indicate that the population structure is clustered and Moran's index is equal to Moran's I = 0.9514. Also, the relationship between population density and service distribution is equal to 0.814, which indicates the acceptable accuracy of the variables of the present study in modeling the spatial structure of population distribution in the city of Karbala. This means that the model has been able to evaluate up to 81% of the existing relationship and has a high ratio of this coefficient of adequacy and appropriateness of the geographical weight regression model in the distribution of population structure.

Keywords: Demographic structure; Spatial distribution, city of Karbala, municipal services, GIS.

Introduction

Spatial structure refers to the position and location of each element (phenomenon) in relation to another element (phenomenon) and in relation to the placement of other elements. In other words, the spatial structure, spatial arrangement and configuration shows the elements in the space. (Shamaei et al., 2017: 100). Geography is the study of the spatial arrangement of phenomena (space science) (Movahed, 2000: 9). Spatial structure of the arrangement and organization of phenomena is one of the most important parts of the demography of geographical studies that examines the distribution of population in a spatial area (Moradi Nejad et al., 1390: 47). In fact, the result of the space process on Earth will be a spatial structure. An important issue here is the structure of the spatial distribution of the population. The spatial structure of the population is a guide for long-term economic projects (Masoumi Eshkevari, 2006: 150). Population is one of the fundamental elements in economic, social and cultural programs. Accordingly, population size and recognizing the structure of its dimensions and spatial extent are important tools for decision-making and planning (Molaei Hashjin, 2007: 1). Due to the fact that the spatial structure of a city is a problem of components and elements that interact with each other, the instability of each of these components will affect the entire structure (Savage and Ward, 2001: 90). The fundamental approach of geographical sciences, especially human geography, has been to achieve balance by maintaining balance among human communities in the direction of well-being. Geographical justice is one of the categories of geographical planning that aims to meet the needs of residents of geographical areas. The distributive dimension of justice has been most in harmony with geographical justice (Kaviani Rad, 2005: 32). Therefore, balanced space

organization in cities is a kind of urban sustainability and will be achieved when there is a logical coordination between the distribution of population and the distribution of services in cities. Therefore, the distribution of services in cities, which is a clear result of ecological segregation, has affected the spatial distribution of the population in urban areas. As a result, proper and optimal distribution of social, economic, cultural and health facilities among regions and districts is one of the most important factors in preventing inequalities and gaps in development and proper spatial distribution of population in the land. In this regard, an important issue in establishing sustainable urban development is to pay attention to the economic, environmental and social health indicators of cities in the context of planning (2001: 577, marcotillio). Also, by examining the level of inequalities in the distribution of services and identifying the pattern of injustice in the city, it can be found out which services are in a better situation and in which part of the city the injustices are more concentrated. And social benefits, reduce inequalities and improve the quality of life of citizens (Dadashpour and Rostami, 1390: 3). In the city of Karbala, the problems of imbalance between population density per unit area can be seen; As a large part of the population is located in a small area of the city and the pattern of population distribution per unit area is unbalanced and the process of spatial development of services and how the population is distributed is unbalanced. Continuation of the current trend and ignoring the problems that will arise for the city, can disrupt the space organization of the city's population distribution. In addition, the continuation of the existing trend causes the existing services of the city not to be used properly. Accordingly, the purpose of this study is to identify the distribution of population structure in the city of Karbala and the relationship between this distribution structure and the distribution of urban services. The research hypothesis also suggests that in the city of Karbala, the spatial distribution of the population is consistent with the distribution of services.

Theoretical Foundations

Understanding the distribution and dynamics of population in space can have many applications in geographical planning. Spatial studies, as the main tool on the basis of which the region is studied in a very tangible and tangible way from various aspects, has a special place among the types of planning (Masoumi Eshkevari, 2006: 20). Trends and changes in population in recent years have led to changes in the spatial structure of the country and the system of establishment of population centers and its activities (427: 2012, Tieshan et al). Changes in spatial structure may occur due to population trends and changes in two different species, each of which requires its own spatial structure. In the first type, the over-concentration of services and employment opportunities in large cities leads to the domination of centrist forces and the emergence of large-scale migrations from small towns and villages to provincial, regional and national centers, creating rapid urban growth in urban areas. In another type, under the influence of centrifugal forces, the population migrates to the suburbs by leaving large cities, which is due to the phenomenon of suburbanization with decentralization of the population and leads to many changes in

the spatial structure of the region (Dadashpour and Valashi, 2017: 200). At present, spatial planning as a method that deals with land, space and geography has become widespread throughout the world (Tawfiq, 2017: 19). The discovery of theories related to spatial organization and spatial equilibrium is more relevant to development issues, elements, and functions of places. These theories explain how the optimal relationship between the factors and the desired pattern of space organization, and their ultimate goal is to create a desirable, balanced and orderly space organization with the desired function and performance economically at the lowest possible cost. Most theories related to space organization somehow determine the location of economic activities or settlements and their spatial composition in the region (Kalantari et al., 2017: 197).

Pattern of spatial structure

The physical, spatial structure of the ossification of the region takes place in different patterns. These various patterns are geometric and regular or have irregular and organic sheets. It is influential in the formation of different patterns of natural and artificial factors as well as different functions and cultural, social and economic characteristics (Healey, 2004: 5). A set of relationships between activity, population, communication network in space and how they are formed and distributed that occur in a geographical space. These relationships lead to the formation of a structure that is dominated by spatial-activity patterns. Thus, spatial patterns with economic activity, occupations, other economic factors and relationships shape population density and how spatial patterns are distributed in regions. These patterns are different in each region (13, 2003, Basolo). Environmental capabilities (natural and human) provide the basis for patterns of human habitation in geographical spaces, and the spatial structure of each place is a manifestation of the interaction between human society and the physical environment around it (Coats et al, 1972: 253). Space has a dynamic and continuous process that is influenced by various economic, social and physical factors that these factors in close relationship with each other form specific ways of habitat bio-performance and the type of relationships and activities established in space, which in general pattern They form the spatial structure. It can be concluded that the economic transformation of the region has resulted from changes and transformations and also the population structure has caused different spatial patterns to be observed in the regions (Kalantari, 2003: 48).

The spatial structure of the population

Environmental capabilities provide the basis for patterns of human habitation in geographical spaces, and the spatial structure of each place is a manifestation of the interaction between the population structure and the surrounding physical environment (Singh, 2014, 253). The distribution of population in geographical spaces can be studied from two dimensions: one is the distribution of population per unit area and the other is the settlement of population in different parts of the region which is necessary to understand the spatial organization and settlement pattern of rural and urban population (Qalibaf et al., 2012: 83). The effects of demographic

changes in spatial-spatial structures are of special importance in understanding the formation and organization of geographical spaces, as it is called the first step towards spatial organization and its consequences (Saeedi, 2009: 71). | The effects of demographic changes in spatial-spatial structures are of special importance in understanding how to form and organize geographical spaces (Latifa et al., 2021: 109).

Demographic change is a dynamic phenomenon related to the spatial structure of the environment. Considering that the spatial structure and geographical spaces and the relationship between them change over time along with other socio-economic developments of societies, and according to the interrelationships within the social and economic systems, various structures and practices are formed in the meantime. Population and its movements are of special importance as one of the most important factors of change (Saeedi et al., 2017: 45). The emergence of areas with high population density as well as the constant mobility and movement of population in the region, cities and villages, the need to have accurate knowledge of population distribution and its analysis (Zamani, 1390: 108). In studying the spatial structure of regions, not only the number of population but also its structure and characteristics are considered, which over time due to the rapid increase in population in the land area and dispersion and consequently the increase in migration is considered. Lack of attention to demographic indicators in regional and national policies and planning, causes that region and land is not commensurate with its population and creates many problems to achieve balanced development at the national and regional levels (Bigleripour et al., 2014: 6). One of the most important sections of demography is the study of geography, which studies the population in a spatial area in which factors such as geographical location, climate, water resources, soil, mines, etc. and the concentration of economic activities in natural areas and the existence of roads. Appropriate communication is effective (Ghadiri Masoom et al., 2013: 58). Demographic studies are very important, population is a phenomenon that is always changing and this change will have a permanent change in both spatial and temporal mobility (Soltani and Nabiullah, 2001: 85). In demographic structural studies, spatial-spatial attitude is very important. Because the movement of human beings leads to the creation of new spatial patterns of distribution and population structure (Ahmadian, 2004: 8).

Social justice in urban geography

In urban planning, with a more physical and practical view of the issue, social justice is defined more based on the spatial distribution of people and resources. Spatial justice can therefore be defined as an equal distribution of resources and services, which refers to the issue of balancing on the basis of who achieves what and how. Or it can be defined as the implementation of territorial justice or equalization in access to public goods and services (Dadashpour and Rostami, 2012: 6), refers to the spatial theory of urban spaces and the events that occur in it. That is, categories that include the implication of land, buildings and transportation, and their uses and

relationships with each other, and in some cases, economic and social factors (Ziari, 2004: 20). Inadequate and unequal distribution of services in cities due to the development of the city from its growth, is currently one of the challenges of urban management in responding to citizens. By examining the level of inequalities in the distribution of services and identifying the spatial pattern of injustice in the city, it can be seen which services are in a more unsatisfactory situation and which injustices are more concentrated in which part and neighborhood of the city. In this way, urban management by conscious action in the spatial distribution of public services and social benefits, reduce spatial inequalities and improve the quality of life and ensure sustainable urban development (Dadashpour and Rostami, 2012: 2). Equal distribution of urban public services is one of the most important signs of social justice in the city and an important issue in the fair distribution of facilities as a social justice strategy is how services and capabilities are distributed among urban areas (Hekmatnia et al. 2012: 166).

Social and spatial justice implicitly states that there is an equal distribution of services in relation to the needs, priorities and standards of service for each resident. This study introduces an analytical and spatial perspective for the proper evaluation of urban public facilities at all times, regardless of the extent to which the distribution of facilities, the distribution of urban public facilities is fair (Zabihi 2008: 47). In fact, the proportional distribution and balanced arrangement of urban services include locating services with uses so that all certain social groups with diverse spatial characteristics can benefit from it as much as possible. The extent and manner of distribution of urban services can play an effective role in spatial population displacement and social change, and since one of the criteria for sustainable urban development and social justice is the balanced distribution of urban services and facilities, therefore, the distribution of urban services should be such that social justice To be established (Taqvaee and Kiomarsi 25-24: 2012).

Research methodology

In each research, according to the subject and the scope of the study and the effective factors in it, various methods are used. The present research is applied and descriptive-analytical and quantitative method, which includes the study of library documents and references to relevant organizations and institutions and data analysis. In the theoretical foundations and research literature, library study and in later stages to complete the information, OSM sites and Google spatial services are used, and the necessary information in the form of religious services, sports, culture, daily services, recreational facilities, park and green space, health and education has been collected and From the site https://data.humdata.org/, the population density map of Karbala 2021 has been downloaded as a raster. For analysis, in the first stage, the city is connected to hexagonal networks with an area of 0.1 km2 and population density data are spatially connected to hexagonal networks using Zonal Statically. Using Zonal Statically, they are spatially connected to hexagonal networks. In this way, all the necessary data were entered into hexagonal networks. For spatial distribution of

population, the global Moran method has been used and to evaluate the population structure of the city and its relationship with the distribution of services, the geographical weight regression method has been used.

Analyze

Spatial distribution of population with Moran spatial correlation algorithm

The main issue in spatial analysis is to quantify the degree of spatial communication. One of the most useful tools in describing the relationship of space units that has been widely used is the Moran Spatial Proximity Index. i is a standard value in relation to observations and neighboring areas that is used in the analysis of data in the Moran statistic or index (Ashton, 2007: 363). Spatial autocorrelation analysis has long been a major concern of geographical research. In a more general sense, spatial autocorrelation (spatial dependence) is the value of a variable in a place (area) in relation to the value of the variable in the adjacent place (area) (Malczewski, 2010: 79 :). Global spatial autocorrelation measures the average spatial dependence in the study area. This type of autocorrelation is useful only if the spatial dependence is uniform throughout the study area, otherwise it cannot represent reality. In this type of spatial statistics, only the average of spatial dependencies is obtained and important and fundamental local differences in the study area may be ignored. So global estimates can be misleading. To overcome these limitations, local spatial autocorrelation has been developed that measures local dependence and communication in the study area. Local spatial autocorrelation is opposed to the global spatial autocorrelation method and emphasizes spatial dependence and local differences (Zheng Du, 2012: 522).

The Moran index for spatial autocorrelation is calculated as follows:

$$I = \frac{n}{S_0} \frac{\sum_{i=1}^{n} \sum_{j}^{n} w_{i,j} z_i z_j}{\sum_{i=1}^{n} z_i^2}$$

Here $z_i$is the difference between the attribute value of feature i and its mean. $w_{ij}$is the spatial weight between feature i and j. n is the total number of geographic features in the layer used and s_o is the sum of the total spatial weights.

$$S_O = \sum_{i=1}^{n} \sum_{j=1}^{n} w_{i,j}$$

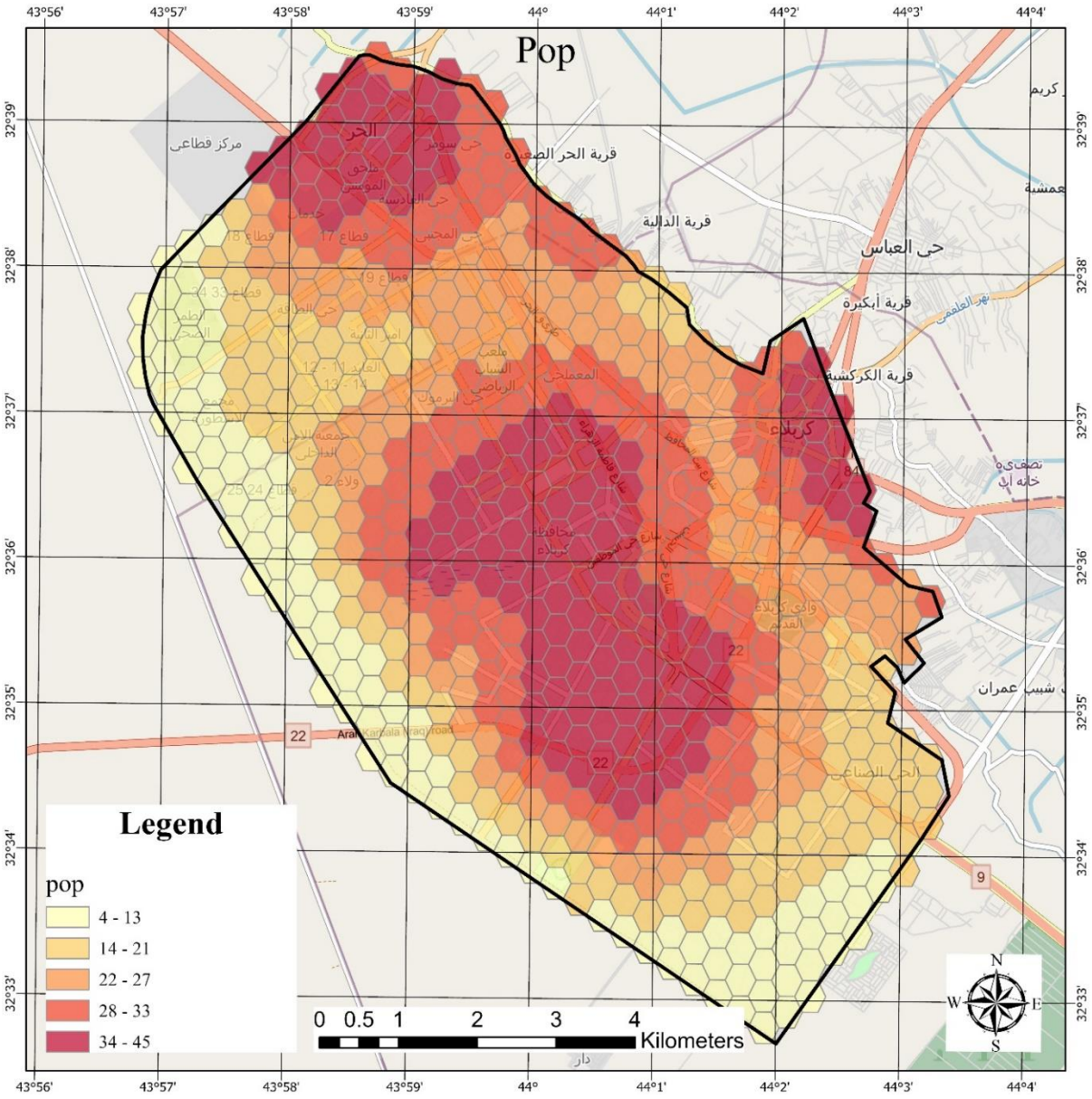
The standardz_i score for Moran statistic is calculated as follows:

$$z_I = \frac{I - E[I]}{\sqrt{v[I]}}$$

where in:

E[I]=-١/(n-١)
V[I]=E[I^2] − $E[I]^2$

n Number of area units, EI Expected coefficient. When the calculated Moran index is greater than the expected value, the spatial distribution pattern is confirmed and vice versa. In general, the closer the value of the Moran index is to the positive number one (+1), the data has a spatial autocorrelation and has a cluster pattern, and the closer the value of the Moran index is to the negative number one (1-), then the data They are fragmented and scattered. The results obtained from the application of the Moran index to the spatial distribution of population in the city of Karbala are shown in Figure 1, so that its coefficient is positive and equal to Moran's I = 0.9514, which indicates the clustering of the population distribution in the city of Karbala. Of course, this value is measured statistically. Given that the value: Z core = 32.57 and is greater than the expected value$E_I = 1.58$, so by citing the high standard score of z, we can see the existence of spatial autocorrelation between the data, resulting in a cluster of population distribution. And the Moran coefficient is confirmed. Also, the population density map in Karbala city shows that the population density has occurred in three clusters and the central cluster of the city has the highest population and the next cluster of Al-Hur region has the highest population density and a small area has been formed in the east of the city.



Map No. 1: Population density

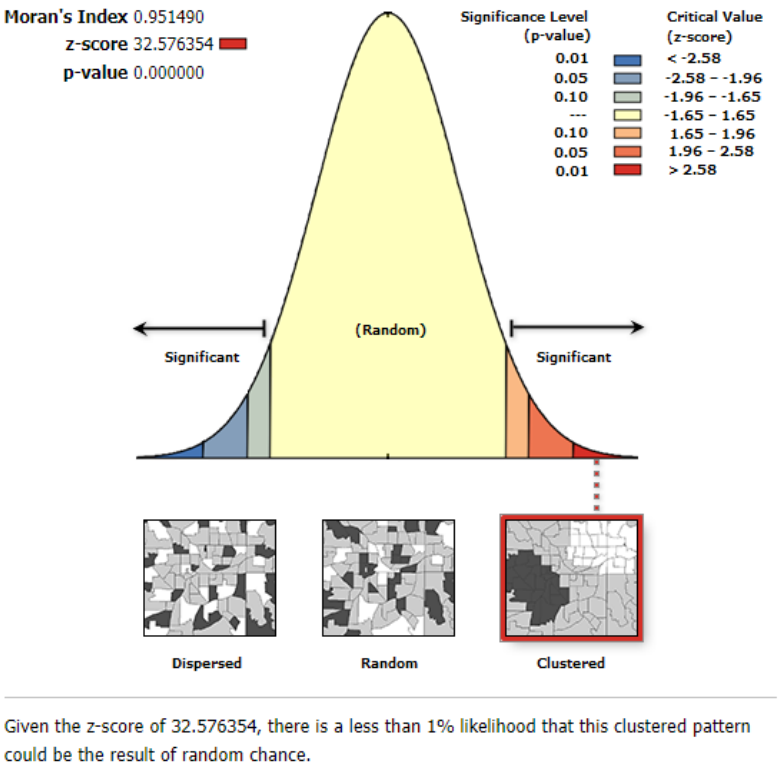


Figure 1: Moran population distribution index

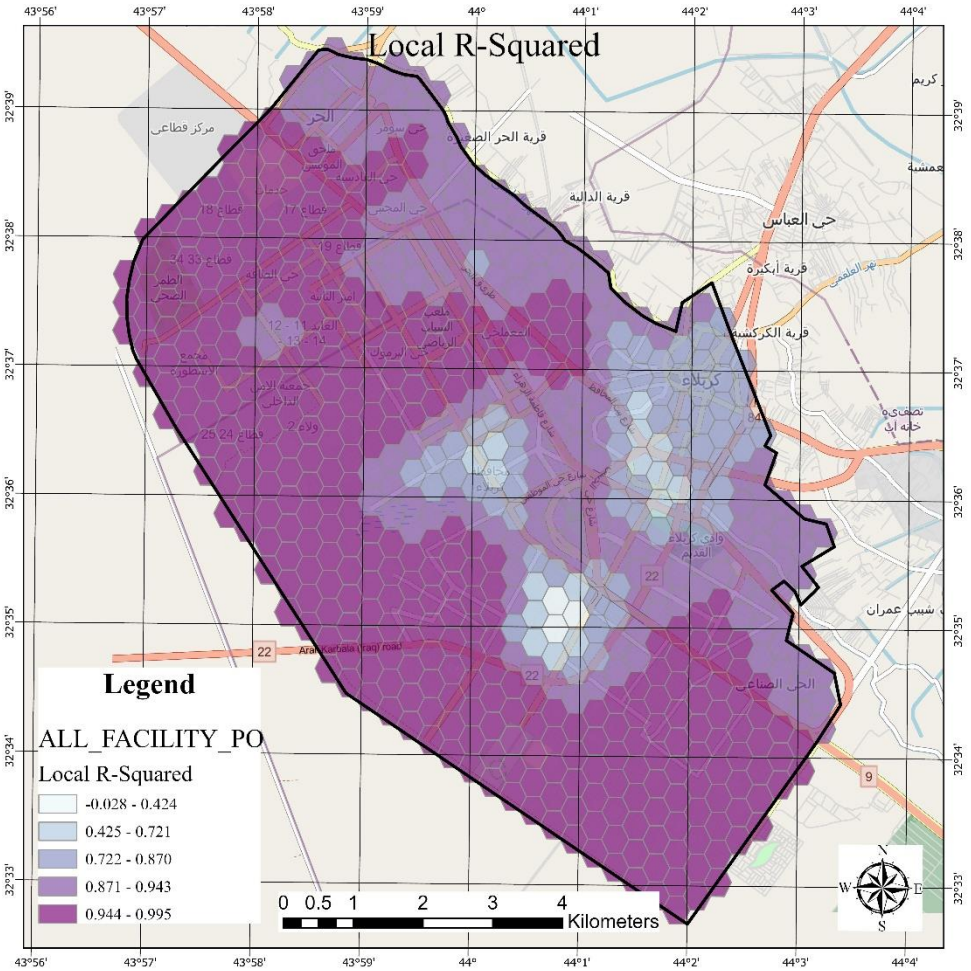
Analysis of population distribution structure and distribution of urban services

In order to measure the spatial structure of population location in the city of Karbala, its relationship with the distribution of service has been measured. The first output of the implementation of the geographic weight regression model on the dependent variable and the independent variables is the general information about the model. The most important values in this output are the adjusted values R2 and R2 (Adjusted R2) which indicates the goodness. The closer these values are to 1, the better the independent variables used are able to explain the changes in the dependent variable. The adjusted values of 2R and R2 obtained in this study are 0.81446 and 0.804373, respectively, which indicates the acceptable accuracy of the variables of the present study in modeling the spatial structure of population distribution in the city of Karbala. Also, the higher the adjusted R2 (as a good fit index) and the subsequent decrease in the sum of the remaining squares, the lower the error and the greater the accuracy in estimating the dependent variable in the geographic weight regression model. Other outputs appear as fields in the output properties table, for most of which the desired maps can also be prepared.

Table 1: Geographical weight regression of spatial structure of population and services

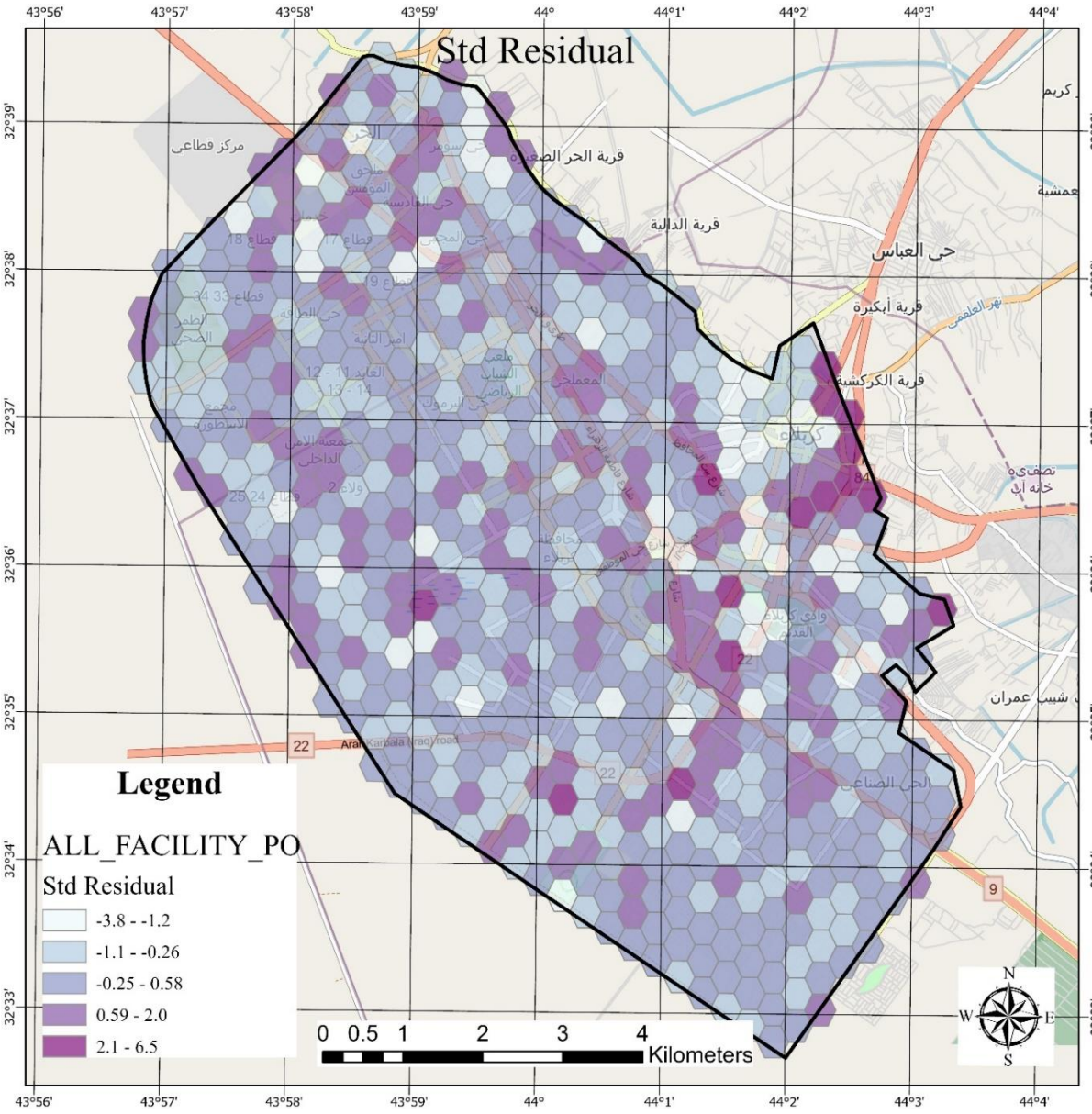
رديف	پارامترها	VARIABLE	DEFINITION
1	Bandwidth	3508.762	
2	ResidualSquares	9896.852	
3	EffectiveNumber	33.24759	
4	Sigma	4.086127	
5	AICc	3561.493	
6	R2	0.814466	
7	R2Adjusted	0.804373	
8	Dependent Field	0	pop
9	Explanatory Field	1	Religious
10	Explanatory Field	2	Sports
11	Explanatory Field	3	Cultural
12	Explanatory Field	4	Daily service
13	Explanatory Field	5	fun
14	Explanatory Field	6	Equipment facilities
15	Explanatory Field	7	Park
16	Explanatory Field	8	Health
17	Explanatory Field	9	Educational

In analyzing the results of the geographic weight regression method, the concept of local determination or the same coefficient Local R2 is very important. The local weighted value R2 is fitted between the observed values and the values. This statistic shows how accurately the model has been able to estimate and how far the observed values are from the estimates. These values are between zero and one variable, and very low values indicate a strong lack of predictability of geographic weight regression and may provide an indication of important variables that are missing in the regression model. The following map is for the R2 values of the regression model. As you can see high R2 values on the western outskirts of Karbala; The map occurs with high coefficients of the model and shows a good estimate of the model in estimating the dependent variable and the predictive explanatory variable.



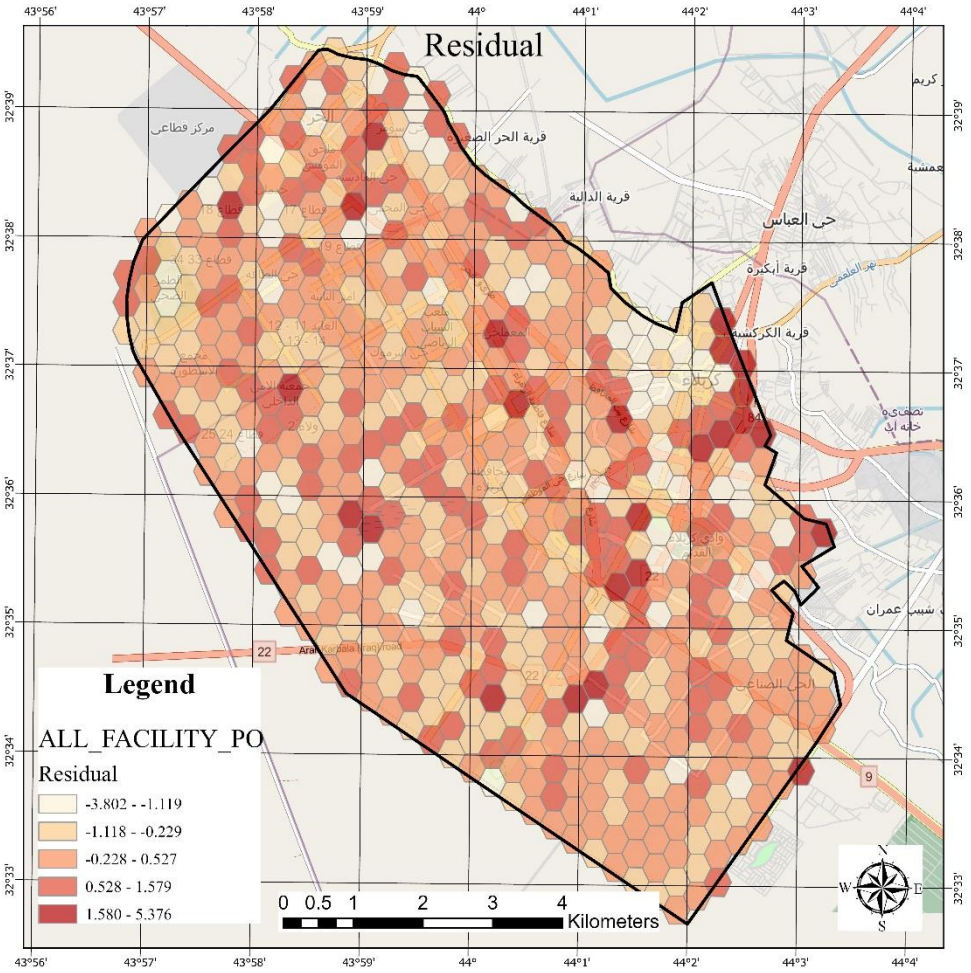
Map No. 2: Local R2

One of the inferred points for understanding and modeling geographic weight regression is that A: Where are the remaining values of the model unusually high or low? B: Do the residual values have spatial autocorrelation or not? In this study, zones with a higher number of residual values above the standard (sidRe Std <2.5) will indicate the possibility of alignment. This has only happened in 7 areas.



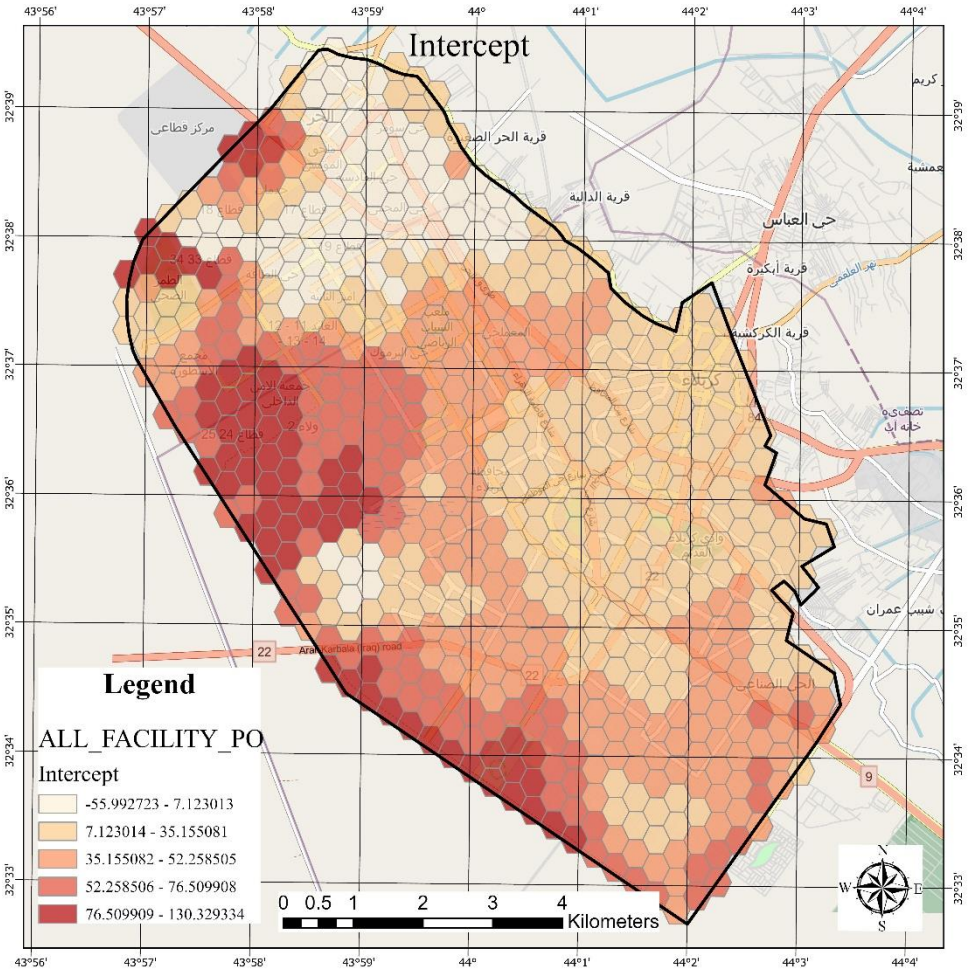
Map No. 3: Std.Residual

Due to the existence of spatial autocorrelation in the data to identify the appropriate estimate of the geographic weight regression model and the lack of spatial autocorrelation in the residual values of the forecast model, the model has prepared a map of residual values that differ from the observed and estimated values. The following figure shows the fit between the observed and estimated values at R^2=0.814466 of the estimate, this means that the model has been able to evaluate up to 81% of the existing relationship and has a high ratio of this coefficient of adequacy and appropriateness of the geographical weight regression model in the distribution of population structure. This relationship and the closeness of the observed values and the predicted values indicate the absence of not so high spatial autocorrelation in the remaining values.



Map No. 4: Residual

Maps of estimated local coefficients (Intercept) show that the effect of independent variables in the model varies significantly in the study area and has a specific direction. If the estimated local regression coefficients are positive for the independent variable, it indicates that by increasing the share of the independent variable in the range, the share of the dependent variable is increased, and if the estimated local regression coefficients are negative, it indicates that by increasing the share The independent variable will reduce the share of the dependent variable in the study area. Also, in some cases, the local coefficients are close to zero, which indicates that the studied variables do not affect the local fluctuations in the model. As shown in the map below, based on the model forecast, it has predicted the lowest rate in the western edges of the city and Al-Hur area has predicted the highest rate.



Map No. 5: Estimated local coefficients

Conclusion

The spatial structure of the population in residential areas is affected by several factors and one of the most important factors is access to urban services so that access to more services will increase the quality of life in these areas and the higher the quality of life in a higher range. The tendency to live there and as a result the population density will also increase. As one of the important issues in urban management that can provide uniform and comprehensive development of cities, it is necessary to pay attention to aspects of the spatial structure of the city in terms of distribution of population and services in urban areas, because the spatial structure The city has a cohesive system that is composed of various components and elements that the instability of each of these elements affects the entire complex and urban structure. Eliminate the proper distribution of services in urban areas, waste of time of city residents in accessing the required services, and so on. How and how much urban services are distributed, has an effective role in spatial population displacement and population changes in urban areas, and considering that one of the criteria for sustainable urban development and social justice is paying attention to balanced population distribution.

Therefore, the distribution of urban services should be done in such a way that spatial justice is established in the city. The results of the research indicate that in the city of Karbala, the distribution of population is clustered and also the distribution of services is clustered and this indicates a direct and positive relationship between the distribution of services and population density in the city of Karbala And the research hypothesis that population distribution is consistent with service distribution has also been confirmed so that service-focused areas Most of the population is mostly inhabited. Areas with fewer services are also less populated.

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