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An analysis of population distribution and urban public services in the new city of Sahand, Iran

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Abstract

Today, the expansion of cities and the increase in population in different areas of the city has caused the urban population to disperse; Therefore, the mission of spatial justice in cities is essential in order to distribute urban facilities and services fairly, taking into account the needs of citizens; So, if the city managers cannot distribute the facilities and public services in a fair and desirable way in different areas of the city, they will create grounds for citizens' dissatisfaction with access to services. The purpose of this research is to investigate the relationship between population distribution and spatial distribution of urban services in the phases of the city. The information needed for the research has been prepared by document-library and field methods. the fuzzy method was used to scale the indicators (population, water, electricity, and green space) and then the mentioned indicators were analyzed in the ArcGIS 10.8.1 software environment with the Gates Ardeji statistics and Moran's spatial autocorrelation methods. Also, the results of hot and cold spots show that the amount of water and electricity consumption and other investigated criteria are higher in phases two, three, one and four, respectively. Therefore, attention to planning regarding the fair distribution of urban services not only includes the realization of spatial justice for the city, but also can prevent the occurrence of gaps and inequality of services between phases.

1. Introduction

The rapid growth of the urban population in the past few decades is one of the most important aspects of global change [1] and the lack of financial, technical and infrastructure facilities to create public and social uses of the city has created a heterogeneity and imbalance in the distribution of various facilities in the city [2]. The rapid growth of the population has provided the introduction to the extensive urban growth and development and has also created vast changes in land use from the local to the global scale [3]. As the population of the cities has increased, but the services that respond to their various needs are not properly responding to the citizens [4]. Therefore, one of the important issues in urban planning is the balanced and proportional development of urban public services according to the population of cities; Therefore, the role of urban planners and their efforts in the direction of fair distribution of urban public services, in order to meet the needs of the society and social groups, is essential [5]. The concept of spatial justice has been raised since the 1980s in the United States of America as one of the challenges of equality, which considers spatial justice in the city synonymous with the fair distribution of resources and services among different areas of the city and equal access of citizens to services [6]. Therefore, with the expansion of the population of cities and urban constructions, the excessive use of land has caused the limitation of urban spaces [7]. On the other hand, the realization of social justice in cities will lead to citizens' satisfaction with their way of life and will contribute greatly to their political stability and national authority [8].

Paying attention to urban services and easy access to them is one of the basic strategies of social establishment in cities, which leads to the realization and establishment of social justice in cities. In order to achieve this realization, these facilities and services must be provided in the city in such a way that it benefits all social classes and groups of the society. In this regard, urban uses and services are among the effective and useful factors that respond to the needs of the population, increase the public benefit and pay attention to the merits and

competences of people, and can establish the dimensions of spatial, social, and economic justice by establishing them more justly [9].

According to the previous statements, it can be stated in another way that both the uneven distribution of the population and the uneven distribution of urban services have caused a series of disturbances and spatial disorder in the cities. In most cities of Iran, urban development plans are being implemented by the public sector and municipalities as a public and non-governmental organization; Therefore, each of the different areas of the city requires different services according to its population and the needs of the citizens. These services should be distributed according to the population of the cities [10]. In urban development, these needs include all existing uses, including educational, health, medical, green space, sports, parking, residential, urban infrastructures, etc., which are actually services that meet the basic needs in the urban space [11]. The new city of Sahand (Tabriz) is an example of new cities that was created in order to absorb the overflow of the population of Tabriz metropolis and has a high population density compared to other areas [12]. This new city has 5 phases, which will be investigated and analyzed in the present research on the relationship between population distribution and spatial distribution of urban public services. Therefore, the purpose of this study is to investigate the relationship between population distribution and spatial distribution of public services in the new city of Sahand.

2. Material and Method

2.1. Criteria selection

The indicators of population distribution and spatial distribution of urban public services studied in this research are: population (population of 2016 and 2021), water (annual production and consumption of water in the new city of Sahand in 2021), electricity (total number of subscribers (domestic, public, agricultural, industrial, other uses, street lighting) and energy consumption in 2021) and green spaces (the area of parks and green spaces according to each phase and the number of parks in the city). These 4 indicators (population, water, electricity and green space) were first descaled by the fuzzy method, then for the analysis of the spatial distribution of the population and public services, the hot and cold spot method and Moran's spatial autocorrelation were used in Arc GIS 10.8.1 software environment. In the following, the indicators used were measured and a consolidated index was obtained using the Morris zoning technique, and it was determined which of the phases of the new city of Sahand has services and facilities and which one lacks services and facilities.

2.2. Data extraction and analysis

The information needed for the research by referring directly to urban institutions such as Sahand New City Municipality, Sahand New City Development Company, Water and Sewerage Department, East Azerbaijan Electricity Distribution Company, etc. has been collected and also the method of documentary, library and field study has been used. And the statistical population of the present study is the residents of the new city of Sahand; due to the fact that the statistical blocks in 2021 are not ready from the data of the statistical blocks of the previous years (2011-2016), the population of 2021 has been fulfilled.

2.3. Research models

De-scaling is one of the important steps in multi-criteria decision making and is used to make the decision matrix non-dimensional [13]. There is a stochastic process called Moran's process, which describes the changes in the system assuming that the population is constant. Typically, biological systems in which two types of species are competing for expansion in the system are analyzed by this process. It is assumed that each species does not make any mistakes during the reproduction process and only produces its own similar species. In each time step, one person is randomly selected for reproduction and one person for death, and thus the size of the total population remains constant [14] and Hot spot analysis calculates the Gettys-RDJ statistic for all complications in the data. In order for a complication to be considered a hot spot and to be statistically significant, both it and the complications that are in its neighborhood must have high values. The local sum of a complication and its neighbors is relatively compared with the sum of all complications. When the local total is much and unexpectedly higher than the expected local total and the difference is so large that it cannot be considered as a result of an accident [13] (Table 1).

3. Study Area

The new city of Sahand is a newly established city in the province of East Azarbaijan, which is located 24 kilometers southwest of Tabriz, in the east of the Tabriz-Azarshahr communication axis and in the southern slopes, in order to control the excessive growth of the city of Tabriz and respond to the overflow of the population of this city. The Sahand mountain range was built. This city was established in 1989 by the Ministry of Housing and Urban Development and using the law on the establishment of new cities in the central part of Esko city in East Azerbaijan

province [16]. In terms of urban planning, this city has 5 phases now but phase 5 is still in the preliminary research and construction has not started in this phase yet (Figure 1).

Table 1. Equation of models used in research.

Model	Equation	Source
Fuzzy de-scaling	$nij = \frac{aij - Minaj}{Maxa\,j - Mina\,j}$ $nij = \frac{Maxa\,j - aij}{Maxa\,j - Mina\,j}$	[13]
Moran	$I = \frac{n}{so}\frac{\sum_{i=1}^{n}\sum_{j=1}^{n}\omega ij(xi - \bar{x})(xj - \bar{x})}{\sum_{i=1}^{n}(xi - \bar{x})}$	[15]
Hot and cold spots	$G_i^* = \frac{\sum_{j=1}^{n} w_{i,j}x_j - \bar{X}w_{i,j}}{s\sqrt{\frac{[n\sum_{j=1}^{n} w_{i,j}^2 - (\sum_{j=1}^{n} w_{i,j})]}{n-1}}}$	[13]

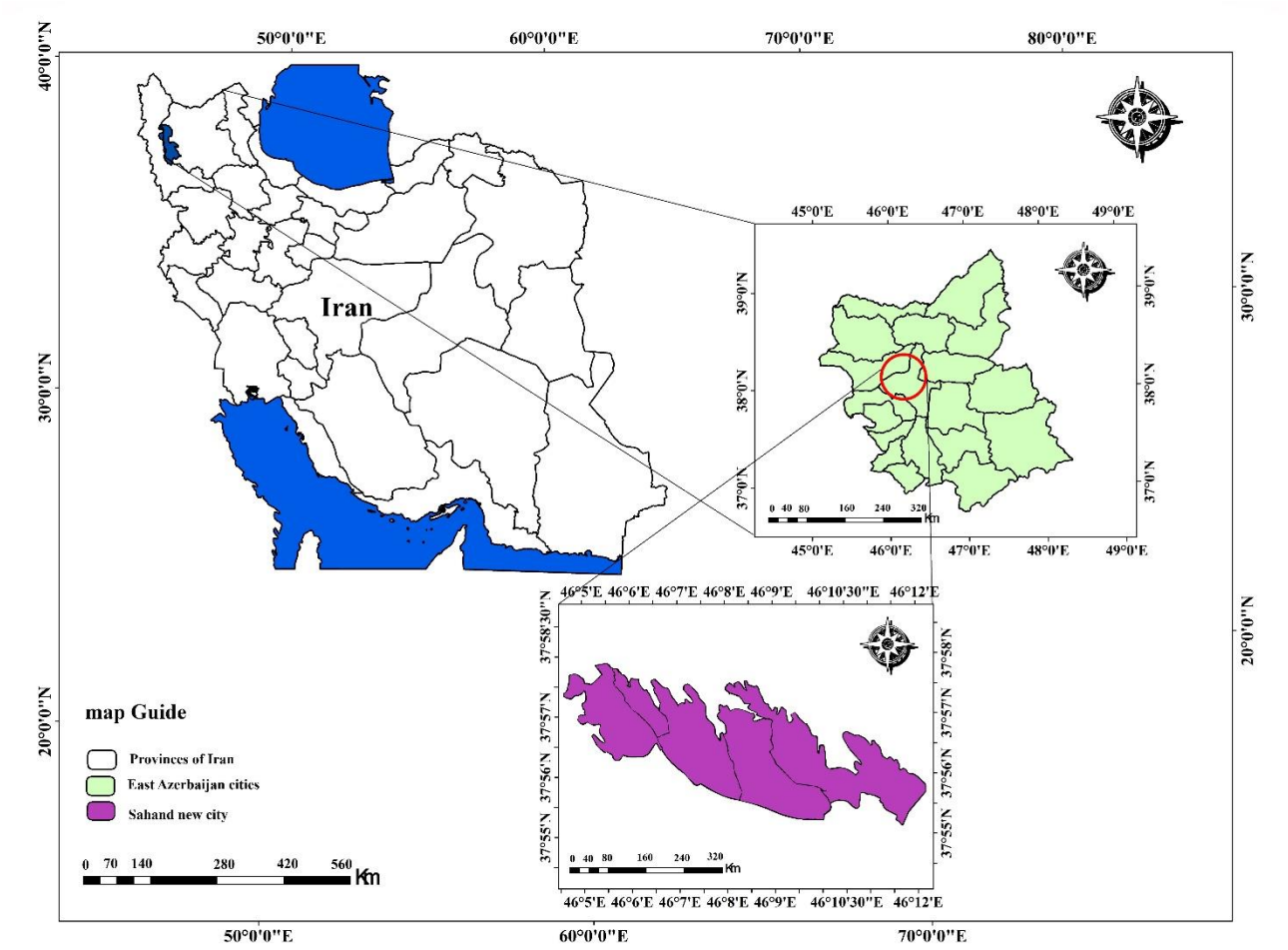


Figure 1. Map of the geographical location of the study area.

4. Sahand New City Landuse

Urban land use planning is actually a set of activities that organizes the human environment according to the demands and needs of the urban society. According to the master plan of the new city of Sahand, the land allocated to the new city of Sahand is about 12,650 hectares, but until today only 7,050 hectares of it have been fully established and built. The main justification provided for the development of the city and the addition of a new phase is to provide services to the current residents. Land use map of the city of Sahand, out of 7050 hectares of established space, most of the area is under residential use and green space, and another part of the city is owned by Sahand University of Technology, and the rest of the space has commercial, medical and educational use. The current research has shown the distribution of proposed land uses in the studied city (Figure 2).

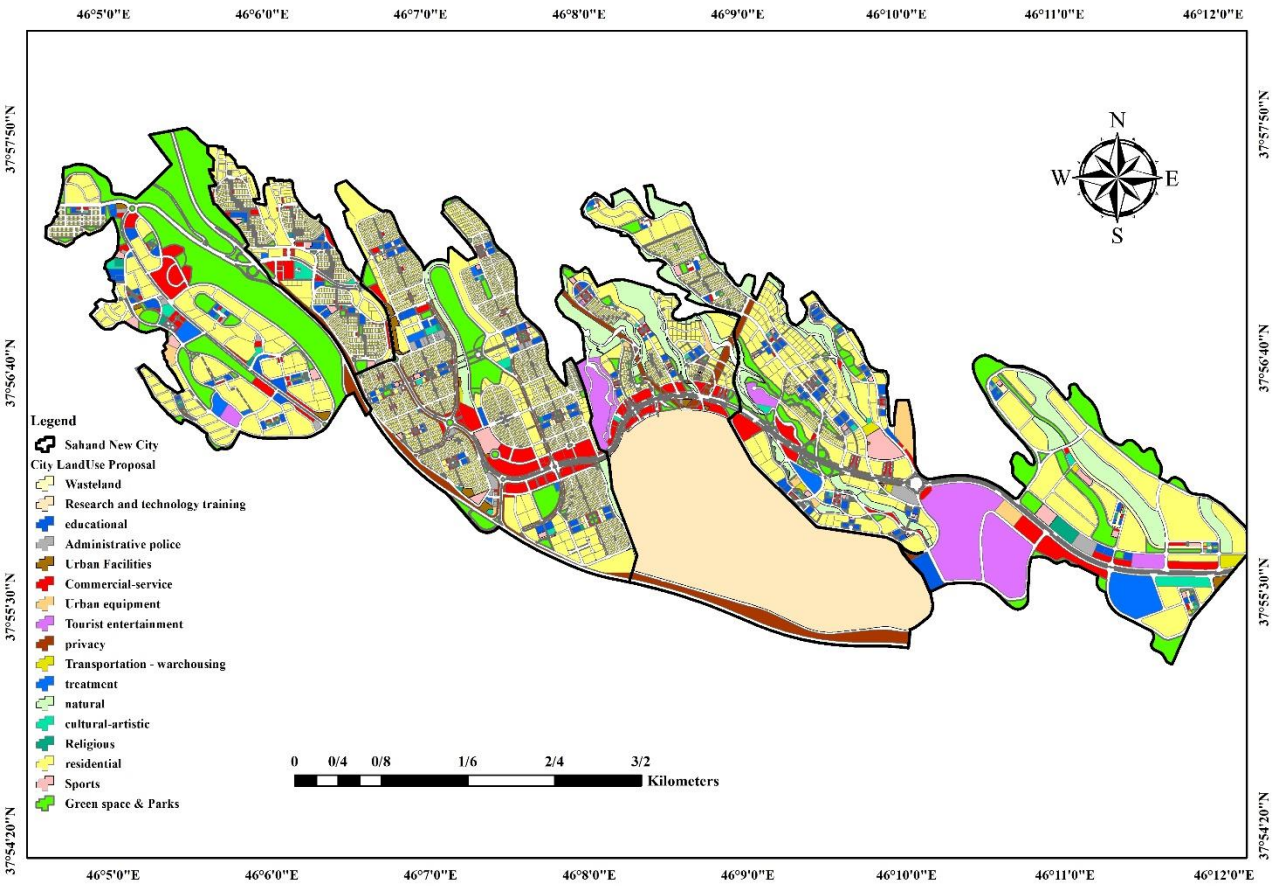


Figure 2. The proposed land use distribution map in the city.

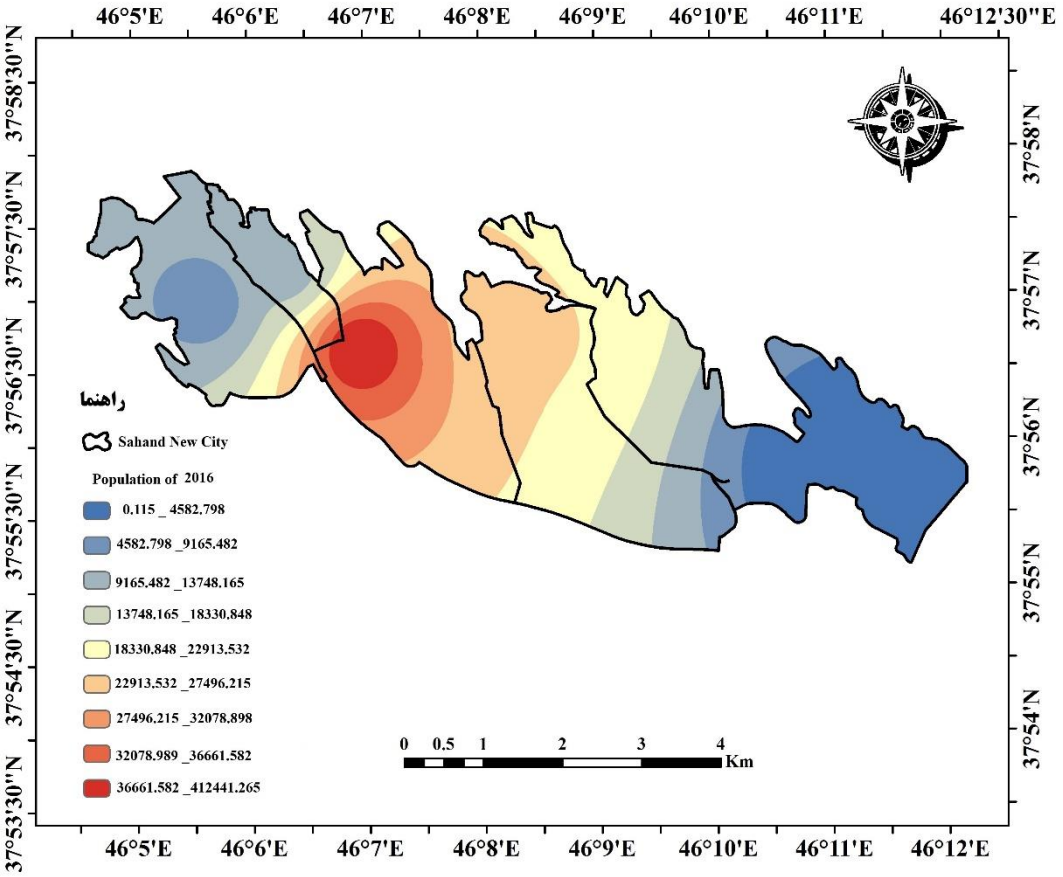
5. Results

According to the results of the 2016 general and housing census, the new city of Sahand had a population of 8,244 and the city of Tabriz as the mother city had a population of 1,558,693. The increase in housing prices in the city of Tabriz and the appropriateness of its prices in the new city of Sahand, especially for the low- and middle-income classes compared to the metropolis of Tabriz, also the policy of building Mehr housing in the new city of Sahand has greatly increased the population of the studied city. According to the estimates made in 2021, the population of the new city of Sahand has reached more than 275 thousand people [12]. It should be noted that out of the total of 5 phases designed for this city, phase 5 has not been used yet and is uninhabited. Considering this, phase five is defined as zero in the calculations and only phases one, two, three and four of Sahand have been analyzed in the hot and cold spots analysis.

5.1. Population index

The expansion of the physical dimensions of the cities, the development of the city and the informal settlement of the new urban strata in the suburbs of the big cities of the country and the increase in the price of land and housing in the area of the cities as well as the metropolis of Tabriz have practically made the provision of housing for the low-income or middle-income strata very difficult and even impossible [16]. This has led to an increase in the population of the new city of Sahand, so that according to the population estimate in 2021, it has reached 275,472 people from 82,494 people [12]. The results of hot and cold spots for the population index in the mentioned years show that the second phase of Sahand has the largest population, which is marked with red color (hot spot indicator) and the fourth phase with low population in both years with blue color (cold spot indicator) has been specified (Figure 3). According to the analyzes carried out, if in the coming years the population capacity in phase two exceeds the allowed limit, we will face a crisis.

Spatial autocorrelation analysis (Moran) has been used for the spatial distribution of the population. Moran's value is equal to 0.17, which shows the spatial distribution of the population of the new city of Sahand, which is distributed in phases two, three, one and four, respectively (Figure 4).



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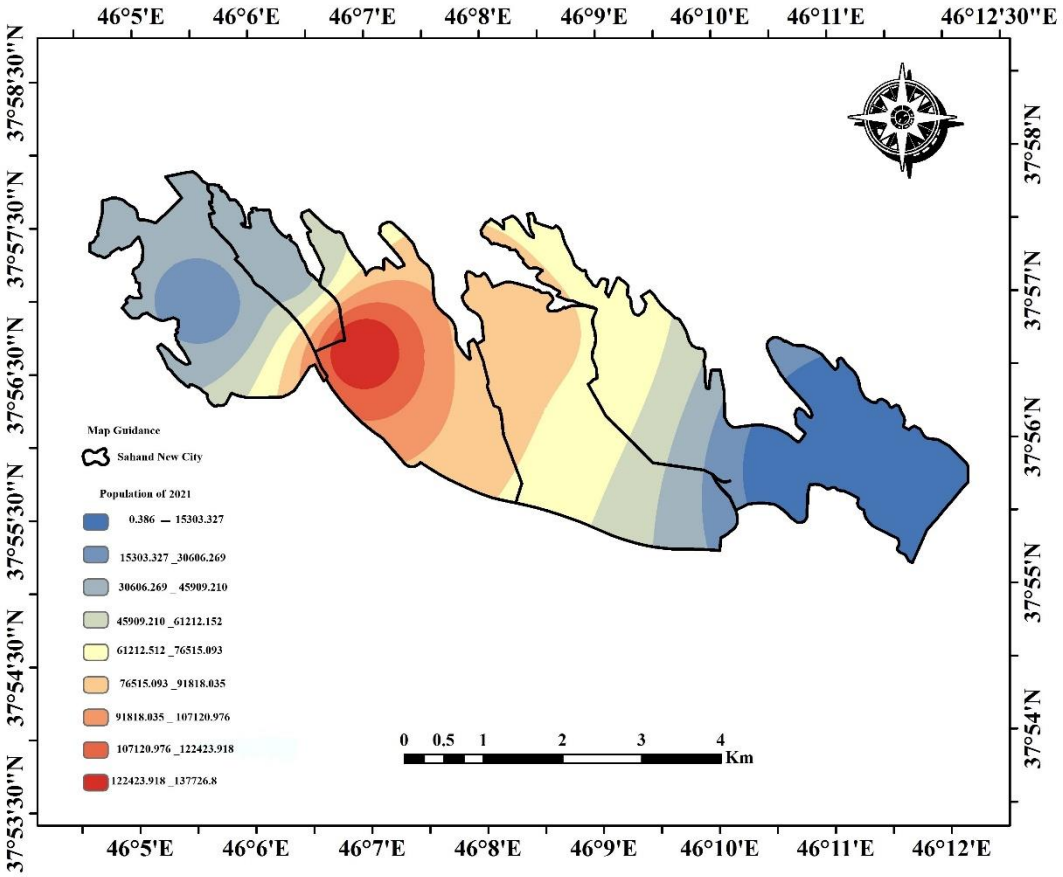

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Figure 3. A) Population in 2021, b) Population in 2016 of New Sahand City.

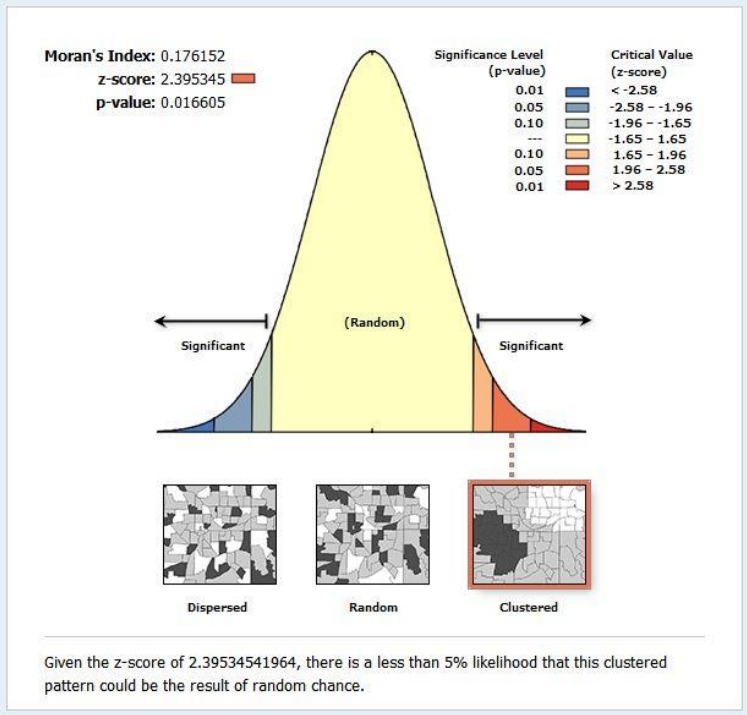


Figure 4. Sahand spatial distribution pattern based on population index.

The results of this zoning for the phases of Sahand, except for the fifth phase in which no construction has been done (with zero number in the very low category), the population of the fourth phase is more than 11 thousand people in the low floor with red color and the second phase with The population of more than 37 thousand people in the very large area which is classified with bold green color in 5 levels, while the second phase of Sahand has the largest population compared to the other three phases (Figure 5). The population of this city fluctuates between 3,000-2,000 people, which usually increases at the end of September due to the opening of schools and universities. The economic foundation of the city is based on industrial employment and university services. It should be noted that Sahand University of Technology has a population of about 1470 people and this number is not counted in the population statistics of this city.

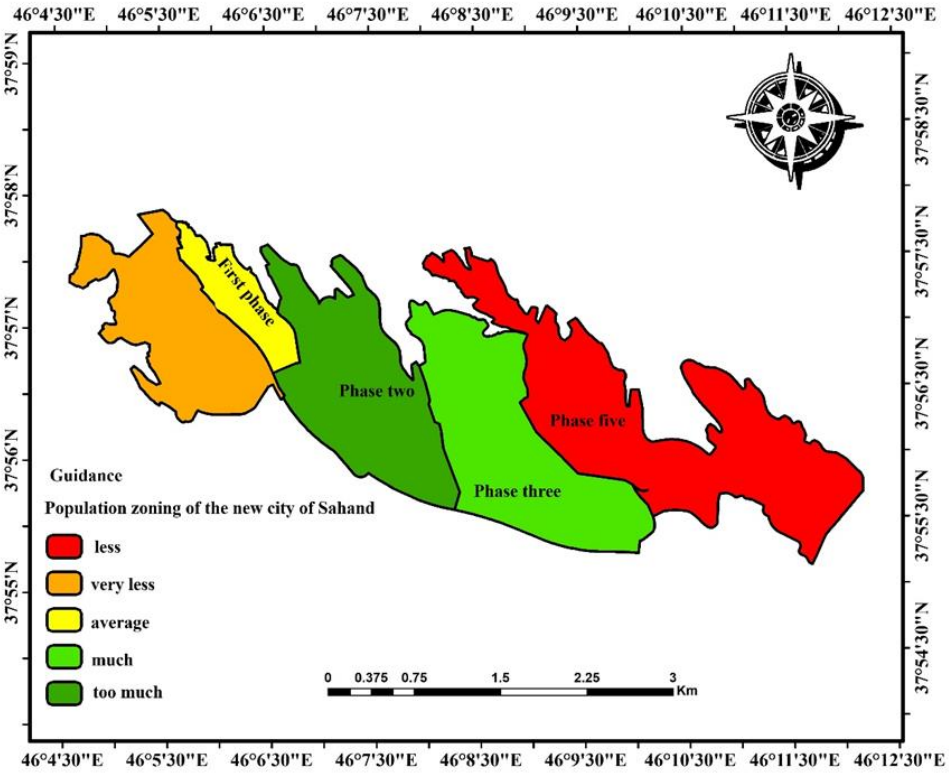
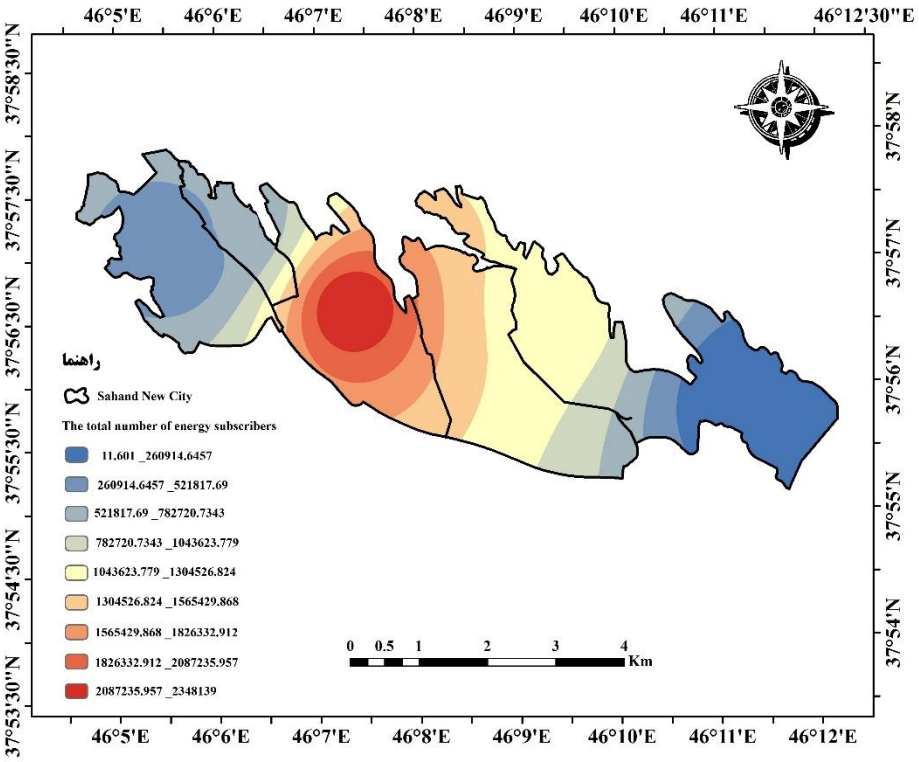


Figure 5. Population zoning in the new city of Sahand.

5.2. Electricity index

Cities are the main consumers of energy in the world, and at the same time as population growth and economic growth, we also see a lot of energy consumption. Energy saving can make cities flexible to protect people and environment. Electricity consumption is one of the most important things that can be used by citizens. The map of cold and hot spots of the total number of subscribers and energy consumption for 2021 has also been prepared. The results show that the number of subscribers in phase one and four is located in the cold spot with blue color (low value indicator), while the number of subscribers in phase two and three is more (Figure 6).



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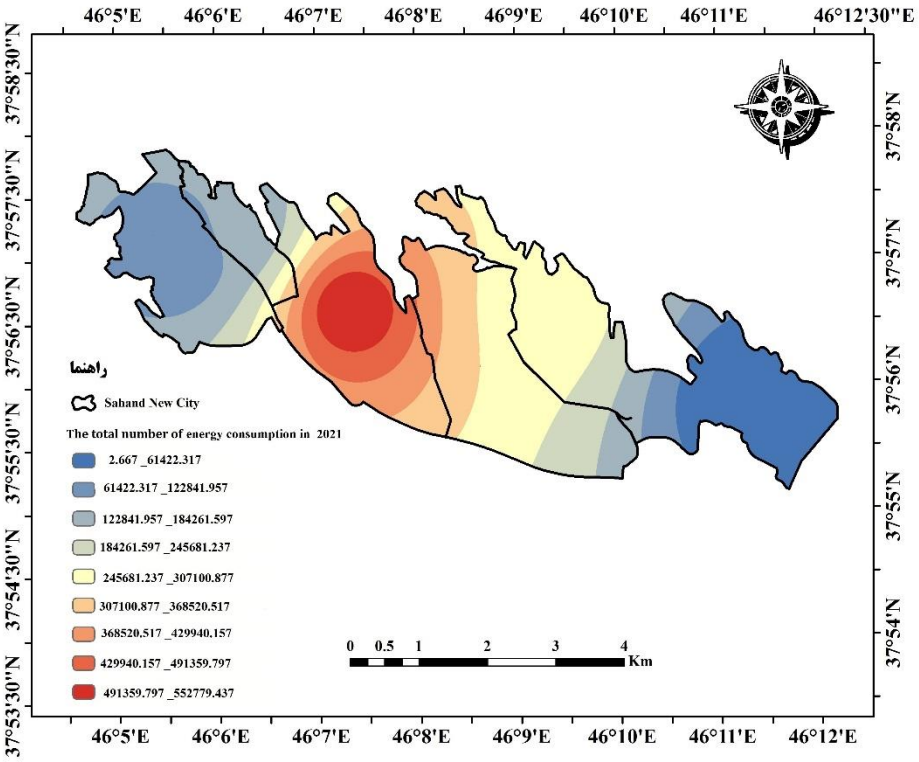

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Figure 6. A) total number of subscribers, B) total number of energy consumption in 2021.

The calculation results of Moran average index of total electricity consumption in New Sahand city show the cluster distribution of this index in the city level. Its Moran coefficient was equal to 0.15, the lowest amount of consumption was in phase four and phase one, and the highest amount was in phase two and three (Figure 7).

According to the Morris classification map, due to the greater number of subscribers in phase three and two, the amount of electricity consumption in these phases is also higher, which are located in very high and high category, while the amount of consumption in phase one is at an average level. The fourth phase is less consuming than the previous three phases, which is shown in light green (Figure 8). Increased electricity consumption leads to higher energy costs for residents and businesses. This issue can reduce people's ability to buy and invest and thus aggravate the economic recession. In addition to excessive use of electricity, it may endanger natural resources and cause environmental pollution. Therefore, the correct control and management of electricity consumption in cities is very important to reduce the negative effects on the economy and the environment.

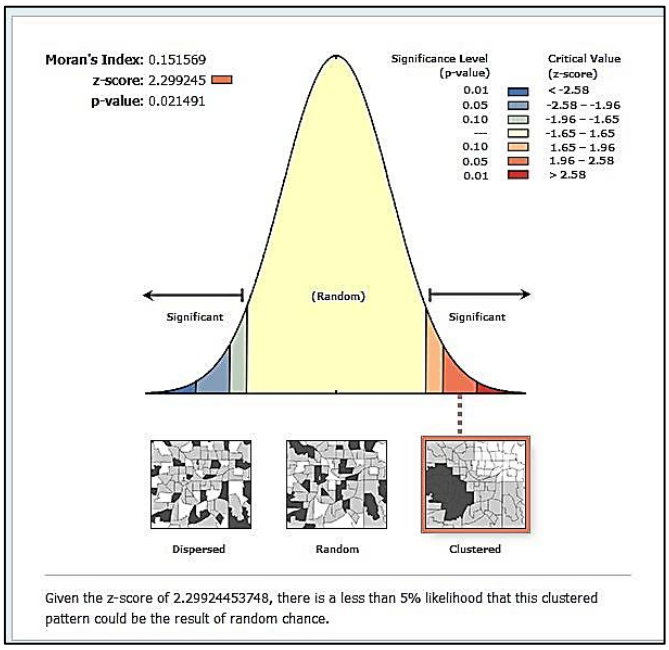


Figure 7. Sahand spatial distribution pattern based on energy consumption index.

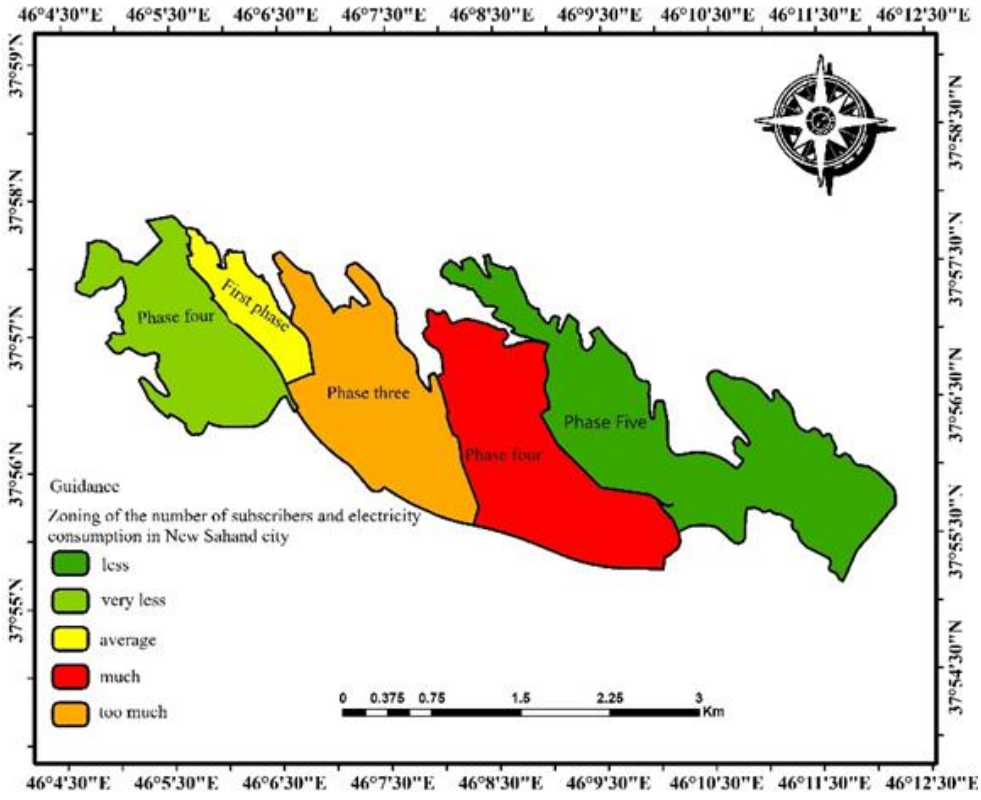
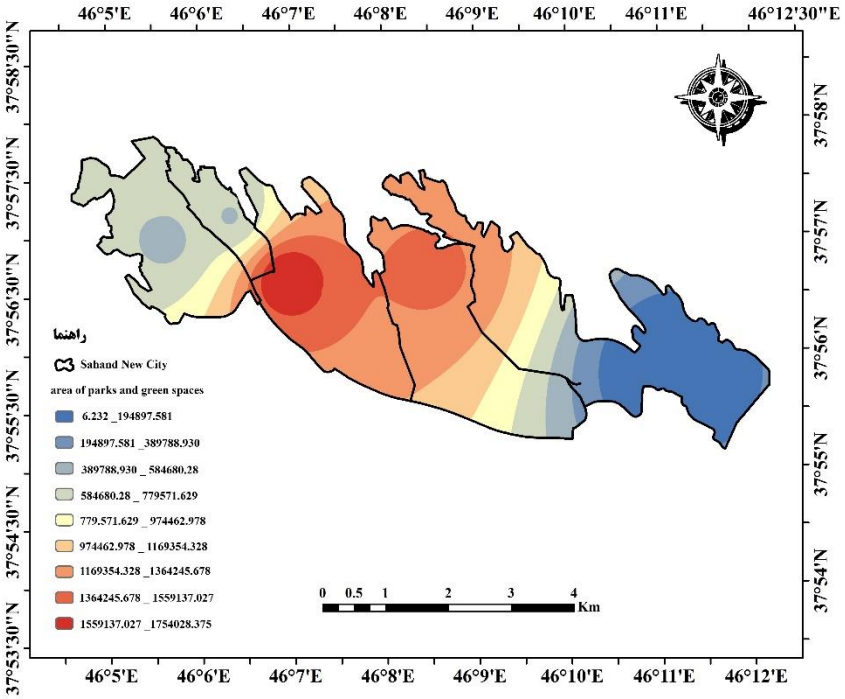


Figure 8. Zoning of Sahand urban electric energy.

5.3. Green space index

Appropriate green space in cities is one of the effective factors in reducing these effects, and especially in the case of dust and air pollution, green space is like a forest, the breathing lungs of cities. The most important effect of green space in cities is temperature adjustment, relative humidity increase, air softness and dust absorption. Therefore, if the green space is necessary as a part of the fabric of cities and also a part of urban services, it cannot be separated from the needs of urban society. Therefore, the green space should be quantitatively and qualitatively proportional to the physical volume of the city, buildings, streets and roads and the needs of the society in terms of psychological, leisure time and health needs according to the ecological conditions of the city and the trend. Its future expansion should be built, so that it can be environmentally efficient and sustainable as an active green space [17]. According to the land use map of the new city of Sahand, about 370 hectares have been allocated to urban parks and green spaces (Figure 9).



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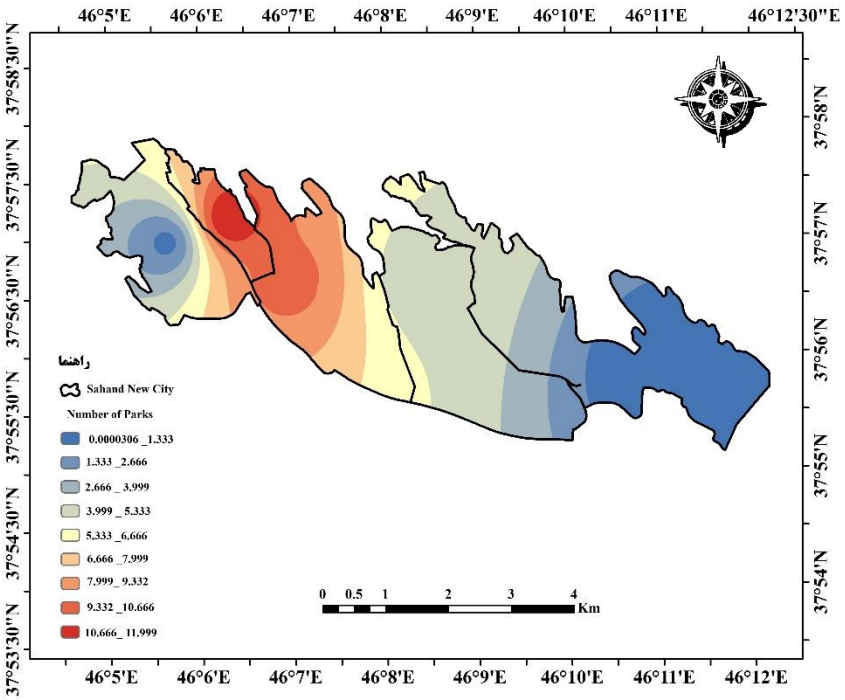


(b)

Figure 9. A) the area of the park and green space, B) the number of parks in the city.

The results of Moran's calculation of green space index are equal to 0.03, which indicates the scattered distribution of this use in the new city of Sahand. Also, the concentration of park use is in a part of the city, and as a result, more enjoyment in a certain area and less enjoyment in other areas and their deprivation of this facility (Figure 10).

The results of Morris zoning showed that the average number of parks and area in phase two is more than other phases, which is highlighted in bold green color and phase one in favorable condition is marked in yellow color (Figure 11). Green spaces in cities play an important role in economy and education. Creating green spaces in cities can help improve the quality of life of citizens. These spaces can be used as recreational, sports and educational places for young people and children. Also, green spaces can help improve the air in the city and play a role in reducing air pollution. On the other hand, creating green spaces can help the economic development of the city and attract tourists.

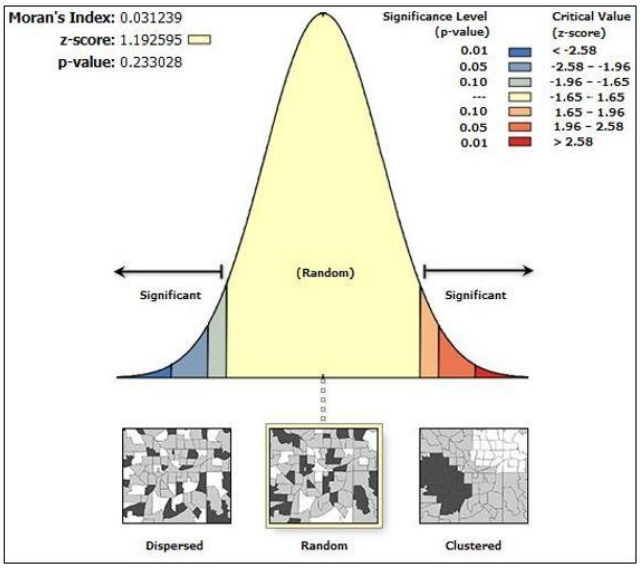


Figure 10. Sahand spatial distribution pattern for green space index.

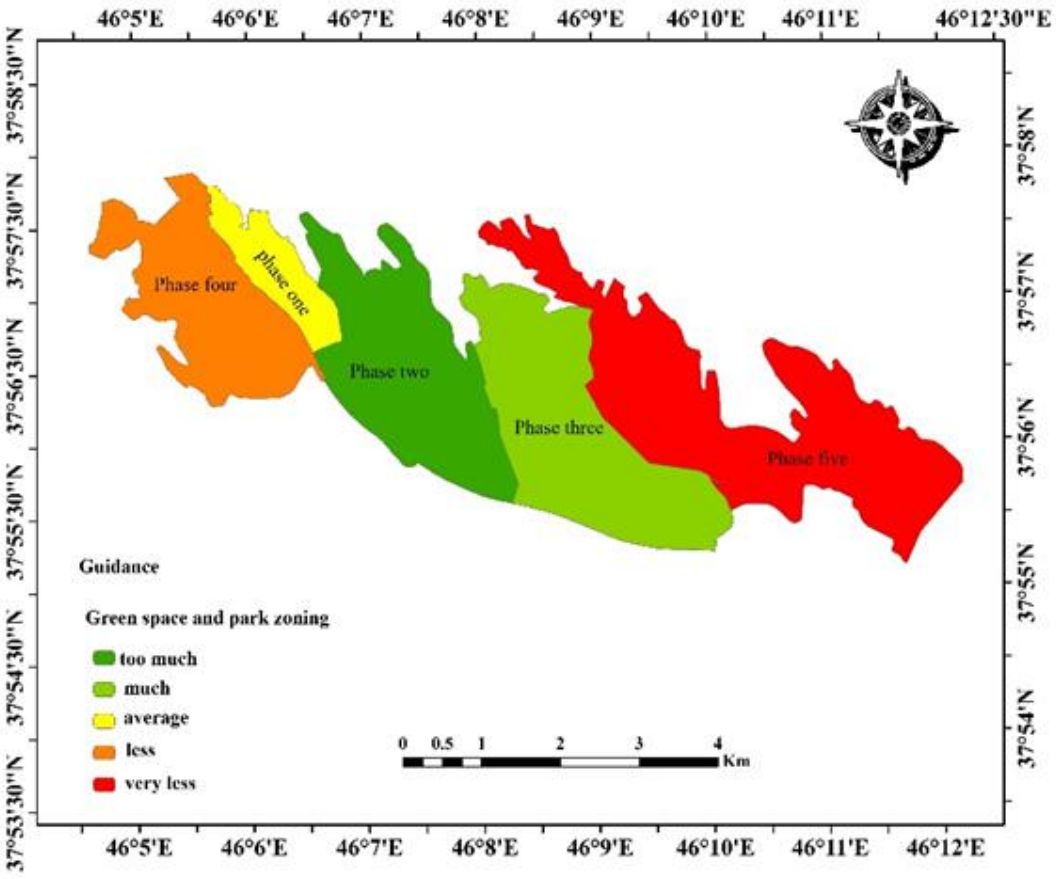
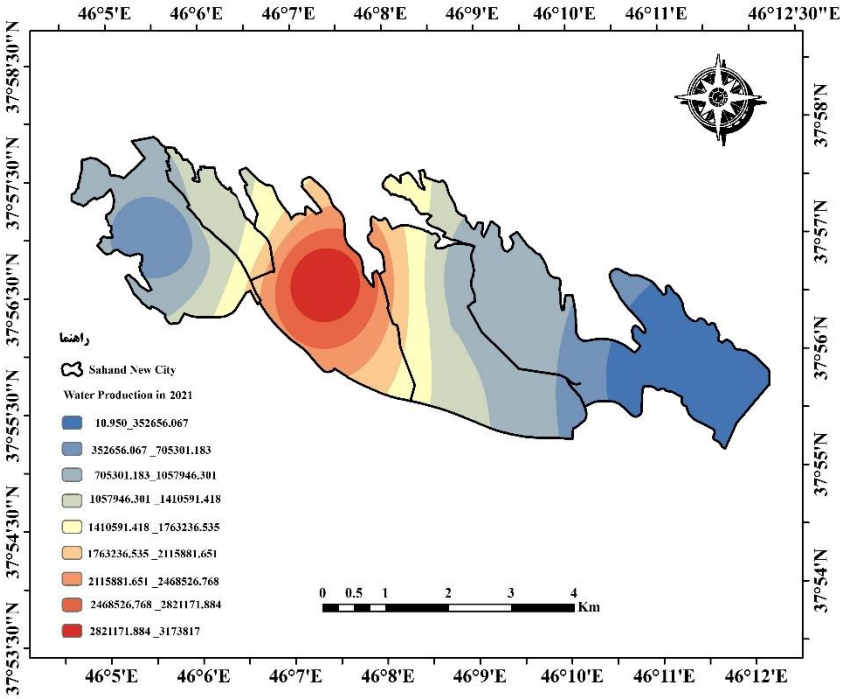


Figure 11. Green space zoning in Jadid Sahand City.

5.4. Water index

After examining the green space index, the analysis of the water index of the new city of Sahand has been done. Currently, the total production of water in 8 months of Sahand year (2021) is equal to 5642565 cubic meters. The results of the monthly water production of the year in question showed that the expansion and urban development of the new city of Sahand in the second and third phases have many effects on the water balance and the circulation system of the water resources of the urban ecosystem and interferes with the interaction of the input and output of the production of water resources. So that the increasing demand of Sahand is in the direction of receiving resources and increasing the amount of monthly water production through treatment plants and underground water. While the total consumption of water in 8 months of 2021 is equal to 4443220 cubic meters, the lowest amount of consumption and production related to the fourth phase and the highest consumption is allocated to the second phase (Figure 12).



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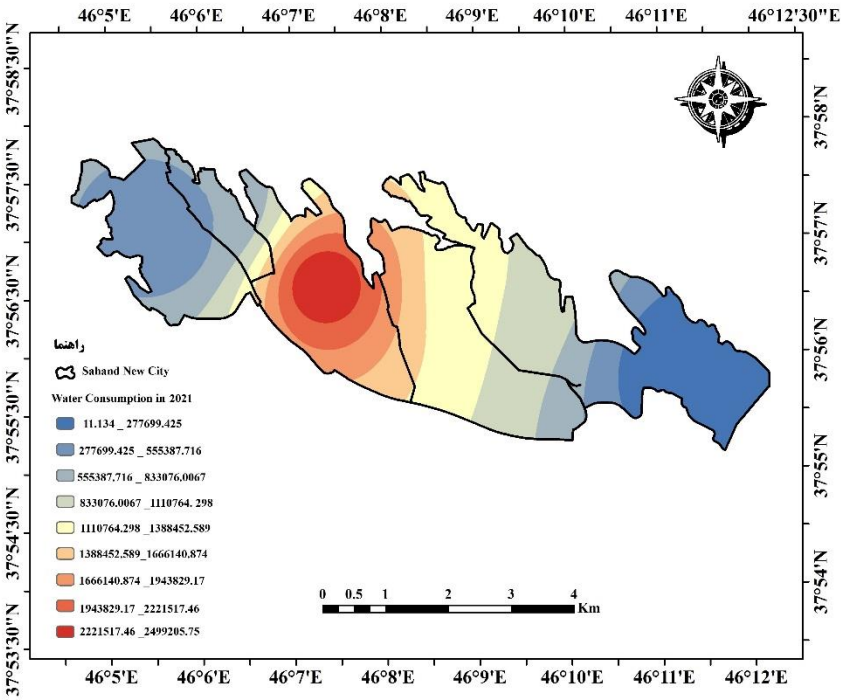

(b)

Figure 12. A) Water production in 2021, B) Water consumption in 2021.

The results of Moran's spatial autocorrelation analysis for water index (production and consumption) showed that Moran's value is equal to 0.15. Considering that the Z calculated for the water index has a positive and large numerical value (2.29), the spatial distribution of this index follows a strong cluster pattern with a high confidence of 97% like the previous index (Figure 13).

In this map, the area with a lot of water is marked with red and orange colors. Due to the high population of phases two and three, the water consumption of these two phases is more. While the fourth phase has the lowest water production and consumption in a very small area (Figure 14). The reduction of water resources leads to an increase in the price of water, an increase in production costs, and a decrease in employment in some industries. In addition, lack of water can reduce the quality of life of citizens, increase drought and even political and social disputes. To deal with this issue, it is necessary to implement appropriate policies for water resources management, optimal use of water, promoting the culture of saving water and developing water management technologies.

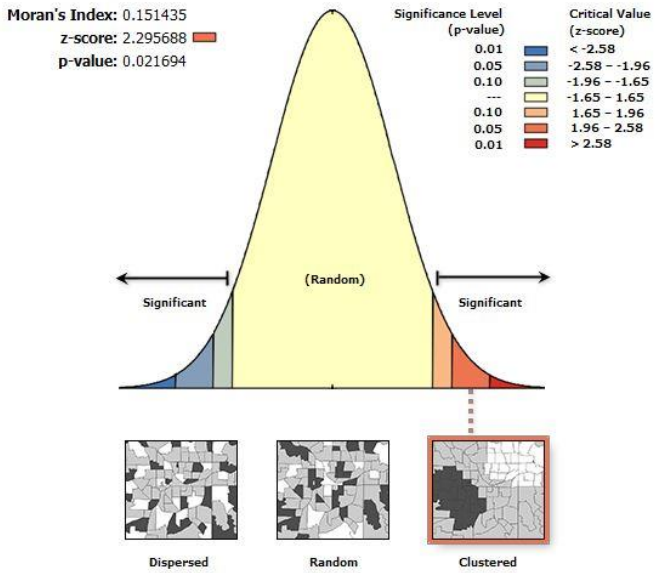

Figure 13. Sahand spatial distribution pattern based on water consumption index.

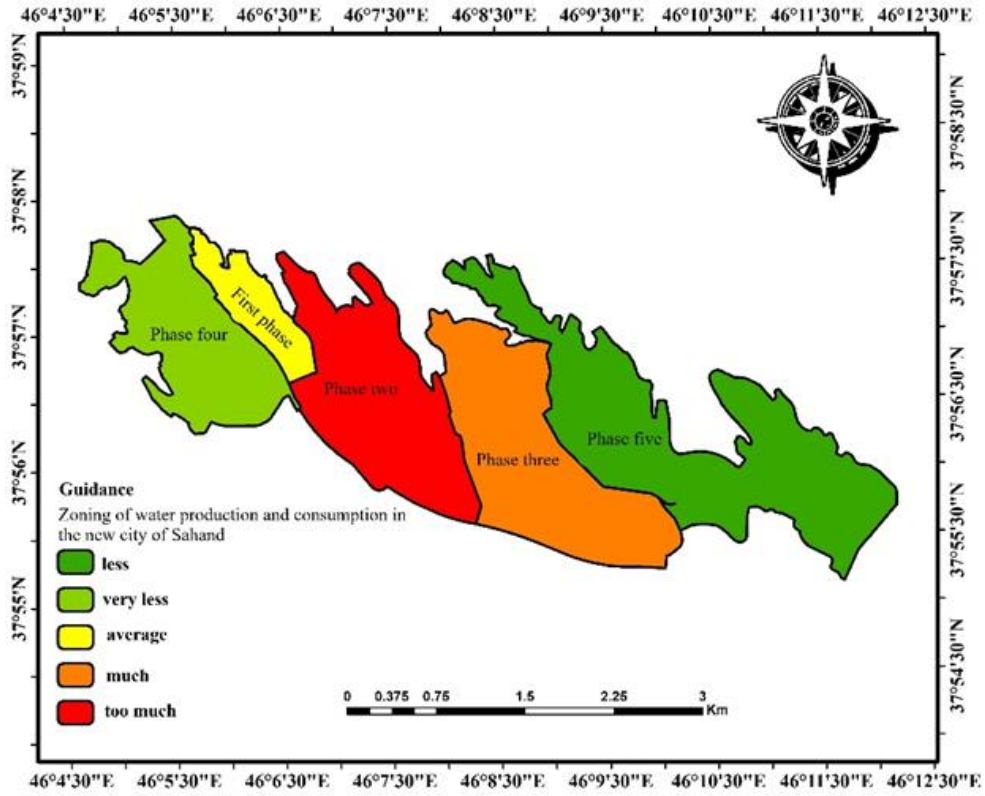

Figure 14. Sahand urban water zoning.

6. Discussion

Moran's spatial correlation is based on the first law of geography, every phenomenon is dependent on other phenomena, therefore, the closer the phenomena are, the stronger the correlation between them. Moran's autocorrelation analysis is also able to measure the spatial difference between all samples. The requirement for determining hot and cold spots is to check the existence of spatial autocorrelation, which spatial autocorrelation with Moran's index includes local Moran and global Moran. The local Moran's correlation index is used to discover the spatial distribution of hot spots and cold spots and compare them with their neighboring samples.

If the Moran value is close to a positive number of one, the data has spatial autocorrelation and has a cluster pattern, and if the Moran index value is close to a negative number of one, then the data are discrete and scattered. Therefore, this model is one of the best methods for evaluating public uses and services, which has shown us how to distribute them at the city level in the current research.

7. Conclusion

Providing desirable and suitable services is a suitable platform for social, economic and cultural activities and provides the fields of welfare and satisfaction of citizens. The well-being and satisfaction of any society depends on making sure that all its members feel that they have a share in it. Along with the goal of development and progress in the planning process, it is necessary to have balance and coordination between the desired areas in enjoying the benefits of development. The investments made will not only lead to development, but will also deepen the existing inequalities and cause a lumpy growth that is not in harmony with the environmental powers and capacities. Justice is a concept that has never been free of human concern. In urban planning, what can help to achieve more urban justice is paying attention to spatial justice and plans that distribute population concentration and services equitably in different areas. Paying attention to the importance of distributing service users in urban areas and providing needed facilities and services is an important factor in improving the standard of living, social justice, and sustainability of urban life.

This article has shown that in recent years the population distribution in the new city of Sahand will be disturbed and this can be a warning sign for the disintegration of spatial justice. Because spatial justice is not justice if it cannot establish social, distributive and allocative justice. Undoubtedly, one of the main factors in disrupting the population balance in the phases of the city is paying attention to the usage of urban services. According to the defined standards in the field of indicators (population, water, electricity and green spaces), the present research has analyzed the distribution of population and the spatial distribution of public services in the new city of Sahand, as well as the method of hot-cold spots and self-analysis. Moran's spatial correlation has been used for the spatial distribution of the mentioned indicators for the existing four phases of the new city of Sahand. The research results show that the Moran value of population, water, electricity and green space are 0.17, 0.15, 0.15 and 0.03 respectively and the spatial distribution trend of the first three indicators follows a cluster pattern, while due to the low Moran value, the index of green space is scattered. The measurement of the used indicators and the creation of a consolidated index using the Morris zoning technique show that the amount of water and electricity consumption and other investigated criteria are higher in phases two, three, one and four, respectively, according to the results of zoning. be (the fifth phase is defined as zero due to the lack of development in the analysis).

According to the analysis of the hot and cold spots of the population index in 2016 and 2021, the results show that the second phase of Sahand has the largest population and the fourth phase with a low population in both years is marked with blue color (cold spot indicator), according to the analysis carried out, if in the coming years the population capacity in phase two exceeds the allowed limit, we will face a crisis And the analyzes of hot and cold spots of monthly water production in 8 months of the year (2021) showed that the expansion and urban development of the new city of Sahand in phase two and three has many effects on the water balance and the circulation system of water resources of the urban ecosystem, while the least The amount of consumption is related to the fourth phase and the second phase has the highest consumption. Also, the number of electricity consumers in the first phase is in the cold spot, and in the third phase, it is balanced compared to the second phase and the area of green spaces, parks and the number of parks in the city show that the area of green surfaces in phases three and four are located in the cold spot, and the number of parks in phase two and one is more. This research also shows that one of the influencing factors on migrations and displacements within the city is the distribution of urban services. If the distribution of urban services is not in accordance with the needs of the phases, distributed uses and urban spaces used by the citizens, it can increase the population density in the other phase, which will not only benefit the citizens but also cause some of the Citizens also do not enjoy the distribution of proper urban services. Therefore, attention to planning regarding the fair distribution of urban services not only includes the realization of spatial justice for the city, but also can prevent the occurrence of gaps and inequality of services between phases. Population growth in a city can have far-reaching effects on urban services, economy, and education. Population growth may lead to greater demand for social services, public transportation, housing, and urban infrastructure. This can put a lot of pressure on city budgets and public resources. Also, population

growth can create new job opportunities, but at the same time it may cause more competition for urban resources and services. In the field of education, the increase in population requires proper planning to increase the capacity of schools and universities in order to provide education for all people.

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Author contributions

Shiva Sattarzadeh Salehi: Methodology, Software, Writing-Original draft preparation, Writing-Reviewing and Editing, Investigation, Data curation, **Firouz Jafari:** Conceptualization, Validation, Visualization, Writing-Reviewing and Editing

Conflicts of interest

The authors declare no conflicts of interest.

References

1. Xu, C., Liu, M., An, S., Chen, J. M., & Yan, P. (2007). Assessing the impact of urbanization on regional net primary productivity in Jiangyin County, China. Journal of Environmental Management, 85(3), 597-606. https://doi.org/10.1016/j.jenvman.2006.08.015
2. El Ghorab, H. K., & Shalaby, H. A. (2016). Eco and Green cities as new approaches for planning and developing cities in Egypt. Alexandria Engineering Journal, 55(1), 495-503. https://doi.org/10.1016/j.aej.2015.12.018
3. Yu, X. J., & Ng, C. N. (2007). Spatial and temporal dynamics of urban sprawl along two urban–rural transects: A case study of Guangzhou, China. Landscape and urban planning, 79(1), 96-109. https://doi.org/10.1016/j.landurbplan.2006.03.008
4. Rana, M. S. (2009). Status of water use sanitation and hygienic condition of urban slums: A study on Rupsha Ferighat slum, Khulna. Desalination, 246(1-3), 322-328. https://doi.org/10.1016/j.desal.2008.04.052
5. Server, H; Lalepour, M. and Sarbaz Goli, S. (2015). Evaluation and spatial analysis of population distribution and distribution of services in urban areas of Tabriz. Geography The scientific-research and international quarterly of the Iranian Association, 14(51), 324-305.
6. Rustaei, S., Hâkimi, H., & Alizadeh, S. (2019). Measuring the spatial justice of quantitative and qualitative indicators of housing in urban areas (Urmia). Human Geography Researches, 52(3), 1029-1009.
7. Khedmatzadeh, A., Mousavi, M. N., & Mohammadi Torkamani, H. (2021). An Analysis on Land Use Process Changes and Forecasting in Urmia City Using SVM Model and Neural Networks. Iranian Journal of Remote Sensing & GIS, 12(4), 53-72. https://doi.org/10.52547/gisj.12.4.53
8. Amanpour, S., Hosseini Shahparian, N. & Maleki, S. (2016). Investigation and analysis of the distribution of urban services with the approach of spatial justice in Ahvaz metropolis (using integration technique). Regional Planning Quarterly, (25)7, 55-68.
9. Bazzi, K., Sayad Salar, Y., & Moammare, E. (2019). Monitoring and tracking inequality in the services and facilities of urban space justice (Case study: Gorgan city). Journal of Urban Social Geography, 6(1), 29-42.
10. Mousavi, M., Omidvarfar, S., Hoseinzadeh, R., & Bayramzadeh, N. (2022). Analysis of spatial justice in the distribution of service uses in urban areas (Case study: 5 regions-Urmia). Journal of Geography and Environmental Studies, 11(43), 162-177.
11. Maleki, S., & Rezae Ashaqvandi, S. (2023). Analysis of Indicators of Social Justice and Access to Urban Services (Case Study: Region 1, Kermanshah City). Geography and Urban Space Development, 9(4), 75-91. https://doi.org/10.22067/jgusd.2022.71582.1078
12. Jafari, F., Asghari Zamani, A., & Sattarzadeh Salehi, S. (2022). Evaluation of the New City of Sahand Using the Urban Carrying Capacity Assessment System. Spatial Planning, 12(3), 83-108. https://doi.org/10.22108/SPPL.2023.133424.1651
13. Asgharpour, M. (2016). Multi-criteria decision making. Advances in MCDM Models, Algorithms, Theory, and Applications.
14. Mozhdeh, T. B. (2013). Study of quasi-stability in evolutionary dynamics on scaleless network using Moran's process, [Master's Thesis, Isfahan University of Technology]

15. Askari, A. (2011). Spatial statistics analysis with ArcGIS. Tehran: Publications of the Municipal Information and Communication Technology Organization.
16. Sap (2008). Sahand New City Comprehensive Revision Plan, Sabze Andish Paish Consulting Engineers (SAP), New Cities Construction Company, Tabriz.
17. Majnounian, H. (1995). Discussions about parks, green spaces and promenades. Department of Parks and Green Spaces of Tehran City-Iran Press: Tehran, Iran.
18. Salehi, S. S., & Jafari, F. (2023). Spatial distribution of public services and facilities in the Sahand new city of Iran. Intercontinental Geoinformation Days, 7, 168-171.