

Rethinking the Horizontal Expansion of the Central Core in Small Cities, Case study: Torqabeh City, Iran

Mostafa Amirfakhrian^{1*}

1 Department of Geography, Ferdowsi University, Mashhad

** Corresponding Author, Email: amirfakhrian@um.ac.ir*

Received: Aug 25, 2020

Accepted: Dec 8, 2021

Key words: Torqabeh City, Spatial diffusion, Spatial analysis, Urban horizontal expansion, Central core.

Abstract: Although the horizontal expansion of cities is mentioned in the literature as one of the reasons for the decline and instability of the central core, this study intends to show, by using spatial analysis models, such as Getis-Ord Gi and Grouping Analysis, and the spatial diffusion approach, that this conclusion differs in small cities. The study area is Torqabeh City, located in the northeast of Iran with a population of 20,998. Since 2006 the city has experienced rapid physical expansion with an annual growth rate of 5.27%. The research variables were population number, number of women, elderly, young, employed, unemployed and illiterate. The analysis was performed on 1,476 urban blocks across 1996, 2006 and 2016. The results indicated that before 2006, the central core as a "hot spot" was the origin of all population groups and was distinct from other urban areas. However, after 2006, population groups with the dominant pattern of "contagious diffusion" left the central core and settled around it. The outcomes of these changes did not show signs of decline and instability of the central core of Torqabeh in response to rapid physical expansion. This may be due to the failure of the new areas to play the role of a destination for the spatial diffusion of population groups and the lack of change in the position of the central core from a "hot spot" to a "cold spot". On the other hand, the diffusion of population groups from the central core to the peripheral areas, connected to the core in Torqabeh City, caused these areas to be similar to the central core and indicated the different condition of this city when compared to central core changes in big cities.

1. INTRODUCTION

Nowadays, the deterioration and instability of the central core of cities are some of the most important issues in urban planning. This is due to the population migration from the central core as a result of physical characteristics not keeping up with the latest developments, ideological ([Gentile, Tammaru, & van Kempen, 2012](#)) and cultural ([Grant & Gregory, 2016](#)) changes, the process of touristification and commercialization ([Hoffman & Musil, 1999](#); [Musil, 1993](#)) and economic reasons. Meanwhile, urban physical and horizontal expansion is mentioned as other effective factors ([Fol & Cunningham-Sabot, 2010](#); [Hyuntae & Myungje, 2015](#)). The theoretical basis of this issue is rooted in theories related to smart growth and new urbanism, the elements (smart growth) of which are strong and direct

development towards the existing communities and prevention of urban horizontal expansion ([MDP, 2015](#)).

In the current situation, many cities' efforts are focusing on strengthening the position of a central core and preserving its indigenous inhabitants ([Bromley, Tallon, & Roberts, 2007](#)). However, satisfaction with living in the core is accounting for a small percentage of the population ([Temelová & Dvořáková, 2012](#)). Hence, the population structure in this area is constantly changing. Some studies indicate that despite the displacements within the texture of the urban core, the settlement pattern of different population groups in the central core of cities still follows a cluster pattern. The most important factors in this regard are residence history and access to transportation options ([Bromley et al., 2007](#); [Sakamoto, Iida, & Yokohari, 2018](#)), the provision of welfare facilities ([Brueckner, Thisse, & Zenou, 1999](#)), and practical and tangible attractions of life ([Tallon & Bromley, 2004](#)) in urban centres compared to other areas.

The importance of being aware of these changes is due to informing planners of future developments and helping to meet the needs associated with a variety of uses. Also, the changes in the social structure of the urban space may require new discourses to interact with. On the other hand, these new structures mirror a certain lifestyle and affect the orientation of future actions. Such changes in urban areas range from a short term ([Qi et al., 2015](#)) to a medium-term ([Rahnama, Amirfakhrian, & Shirzad, 2014](#)) or a long-term ([Grant & Gregory, 2016](#)) change. Now an underlying question is how to measure these changes and displacements. A review of previous studies shows that using census information over different periods and comparing them (by a variety of graphs, tables and using statistical methods such as correlation and regression models) is common. However, in geographical studies, displacements can be examined in the form of spatial diffusion patterns ([Rosenberg, 2019](#)).

Such displacements, which take place for various reasons, play an important role in the formation or change of urban socio-spatial structure. The spatial diffusion pattern enables us to identify the way demographic changes occur in cities, especially of the central core. Spatial diffusion is a process by which people's behaviours or landscape attributes, and what has already occurred in a place, are changed.

In Iran, the issue of population displacement in cities shows that before 1920, the central core had a special dynamism and rigidity with a structure and function tailored to the resident's needs ([Zenozi, 2000](#)), and established a logical link between physical elements in the spatial organization of the city, while accepting special functions and playing a role on a human scale ([Tavakoli Nia & Mohammadi, 2010](#)). In recent decades, these areas, due to various reasons, have lost some percentage of their population ([Sajadi & Mohammadi, 2011](#)) and now their demographic changes are a main concern in urban studies in Iran. According to some studies, about 60% of the population living in these areas tend to move ([Mustafa Zadeh, 1998](#); [Pourahmad et al., 2011](#)).

Studies conducted in Iran indicate that among the factors mentioned, including environmental degradation and texture exhaustion ([Pourahmad et al., 2011](#)), physical deficiencies ([Rahnama, 1996](#); [Tavassoli, 1989](#)), degradation of social indicators ([Reshadatjoo & Toloie, 2013](#)), the position of economic indicators especially income ([Basiri, Mousavi, & Husseinzadeh Dalir, 2017](#); [Zanganeh, Samieipour, & Hosseini, 2012](#)), the way of dealing with these textures ([Habibi, 1988](#)) and the impossibility of female attendance ([Rahimi et al., 2018](#)), physical and horizontal development is also an

important factor of demographic changes in the central core ([Poorahmad & Shamaeipour, 2001](#); [Soleimani et al., 2013](#); [Soleimani, Zanganeh, & Sheikhi, 2017](#); [Vares, Zangiabadi, & Shaterian, 2014](#); [Zangi Abadi, Nastaran, & Kamali Baghbrahi, 2016](#)). These studies show that at the same time the horizontal development of a city occurs, the population disperses from the central core.

Numerous studies have been conducted on the effect of horizontal expansion on changes in the central core of cities. There are two common points in these studies (especially in Iran):

1. These studies are dedicated to big cities and cities with a population of more than 200,000 people.
2. These studies use classic statistical methods such as correlation to examine these changes.

There are not, however, enough studies on small cities, and it may be assumed that the effect of horizontal expansion in the central core of small cities is the same as in big cities, while this is not exactly clear. In addition, the common method in these studies (classic statistical methods) do not show the spatial evolution and the scale of displacement from the central core.

Therefore, identifying the pattern of central core demographic changes as a result of the horizontal expansion in small cities using spatial statistical methods are the contribution of this article.

Torqabeh is a city near the metropolis of Mashhad in the northeast of Iran with a population of 20,998 in 2016. It has long been considered a tourist city due to its natural and historical assets ([Farnahad, 2009](#)). According to the latest information, it attracts 18,414,900 tourists every year. Available data show that since 2006 the city has experienced rapid physical expansion (annual growth rate of 5.27%, while it was 1.49% previously). The census data also shows a decrease in population and various population groups in the central core from 43.5% in 2006 to 28.2% in 2016. Therefore, at first glance, the population is leaving the core along with the increase in urban horizontal growth. Using spatial diffusion patterns and spatial analysis models, the present study aims at identifying (1) Whether the decrease in the population of Torqabeh at the same time as the horizontal expansion of the city is a sign of instability and the decline of the central core; (2) As a result of physical expansion, how the central core position changes compared to other areas; (3) What the governing pattern of the population displacement from the central core is; and (4) How successful the newly added areas are in attracting different population groups.

2. MATERIALS AND METHODS

This study aimed at analysing the trend of demographic changes in the central core of Torqabeh City during two periods: 1) before 2006 (slow physical expansion); and 2) after 2006 (rapid physical expansion) based on the existing theoretical bases and literature on spatial diffusion patterns (contagious, extension, hierarchy and relocation) and intelligent growth, and using statistical tools and techniques such as Getis-Ord Gi and Grouping Analysis. Getis-Ord Gi identifies statistically significant hot spots and cold spots using a set of weighted features. This tool identifies statistically significant spatial clusters of high values (hot spots) and low values (cold spots). It creates a new Output Feature Class with a z-score, p-value, and confidence level bin (G_i_Bin) for each feature in the Input Feature Class

([ESRI, Hot Spot Analysis \(Getis-Ord Gi*\), 2019b](#)). While Grouping Analysis performs a classification procedure that tries to find natural clusters in data. Given the number of groups to create, it will look for a solution where all the features within each group are as similar as possible, and all the groups themselves are as different as possible. Feature similarity is based on the set of attributes that you specify for the Analysis Fields parameter and may optionally incorporate spatial properties or space-time properties ([ESRI, Grouping Analysis, 2019a](#))

We used a pseudo-F-statistic diagram to determine spatial clusters. The research variables included population size, numbers of women, elderly, young, employed, unemployed and illiterate, which were obtained from 1996, 2006 and 2016 census data. The analysis unit was urban blocks of Torqabeh, which included 1,476 blocks in 2016. These variables were selected because the information about them was available spatially in the statistical periods studied. Using Arc-GIS software, the census information of individual variables was linked to the urban block layer. Using the spatial analysis tool Getis-Ord Gi hot and cold spots denoted the dispersal of population groups separately over three time periods. Due to the natural situation of the city, parts of the land within the city is allocated to rivers, gardens and mountains which are called cold spots in this study.

The results of the analysis revealed the changes in the dispersal pattern of each population group in the city of Torqabeh. By comparing the patterns governing each population group during the respective time period, the spatial diffusion trend of each group, in particular after rapid physical changes, becomes clear. [Table 1](#) shows how the different types of spatial diffusion patterns are identified using the spatial analysis tool Getis-Ord Gi.

Table 1. The way of identifying spatial diffusion patterns by the spatial analysis tool Getis-Ord Gi in Torqabeh city during the periods 1996-2006 and 2006-2016

Change type	Diffusion pattern
Increased area of hot/cold spots around the central core	Expansion
Formation of hot/cold spots side by side from the central core in one or more directions	Contagious
Formation of hot/cold spots in each period in different places	Relocation
The formation of hot/cold spots in each period in different places with the preserved origin	Hierarchical

Then, using spatial clustering models such as Grouping Analysis, similarities and differences between the central core and other areas can be seen during demographic changes, as well as the position of population groups in different areas of the city. By analysing the results, a clear picture of the spatial diffusion and changes in population groups in the city of Torqabeh and its central core is obtained.

In addition to identifying the types of diffusion patterns ([Table 1](#)), the present study determines their intensity by combining spatial diffusion patterns and spatial analysis models, and this is an innovative aspect of this study compared to other studies that only use population changes of the central core and changes in the city size.

2.1 Study Area

The city of Torqabeh in the northeast of Iran, at 59 degrees and 22 minutes longitude and 36 degrees and 18 minutes latitude, has an elevation

of 1,284 meters above sea level and is located near the metropolis of Mashhad (Bazoobandi, 2007). According to the 2016 Census, its population was 20,998, the urban area was 1,545 hectares and its built area was 721 hectares. The central core of the city, with a history of about 800 years, has an area of 90.4 hectares and a population of 5,935 (28.26% of the population, 5.85% of the urban area and 12% of the built area). The city consists of 21 neighbourhoods, the three neighbourhoods of Eidgah, Qala-i-Naw and Pachenar are known as its central core.

Investigating the physical expansion trend of the city reveals its slow growth before 2006. Since then, a sudden rapid growth in the physical texture of the city occurred which reached 721 hectares within 10 years with an annual growth rate of 5.27%. The population of the city increased from 15,144 in 2006 to 20,998 in 2016 with an annual growth rate of 3.3% (Figure 1 and Table 2).

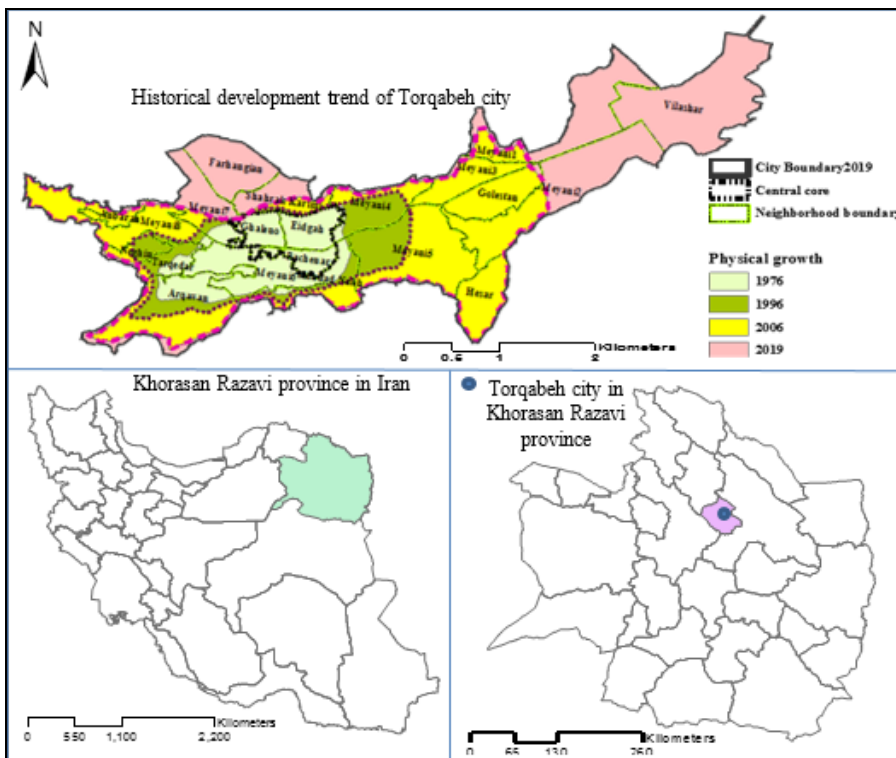


Figure 1. The position of Torqabeh City in Iran and its historical development trend

Table 2. Population growth and the framework of Torqabeh City 1976-2016

Year	Area(ha)	Population (number)	Period	Annual growth rate (%)	
				Physical	population
1976	236.5	8473	1976-1996	0.9	0.8
1996	371.7	9982	1996-2006	1.49	4.2
2006	431.3	15144	2006-2016	5.27	3.3
2016	720.9	20998	1996-2016	3.36	3.7

2.2 Spatial Diffusion Theory

Spatial diffusion was first raised by Hagerstrand in his book "Innovation Diffusion as a Spatial Process" in 1953 in Sweden (Haggett, 1996) and now is considered as one of the ways of analysing displacements (people, goods, styles, etc.) in urban areas. However, it can also be traced to the theories of

Chicago school researchers. Ernest Burgess (1886-1966), for example, suggested that in the physical development of a city, the process of dispersing land uses takes place, and consequently, individuals and groups disperse (Poorahmad and Shamaeipour, 2001). Homer Hoyt (1933) believed that economic and social differences in demographic and physical structure caused the segmental shape of the city (Farid, 2012). According to Calvin Schmid, social changes in urban texture occur due to their development (Shokui, 1994). Peter Haggett did not consider this "diffusion" as a mere shift, but rather as a valuable key to know how information is exchanged between regions (Haggett, 1996).

In general, spatial diffusion is classified into four patterns (Cliff et al., 1981): a) Expansion diffusion: leakage from the source to the surrounding areas so its range is expanded. That is, between two time periods, new areas are added. b) Relocation diffusion: leakage from the source and is accompanied by displacement, such as migration from rural to urban areas. c) Contagious diffusion: a type of diffusion that is spatially interconnected; and d) Hierarchical diffusion: the prevalence of fashion types that occur without being affected by the places between the source and destination (Figure 2).

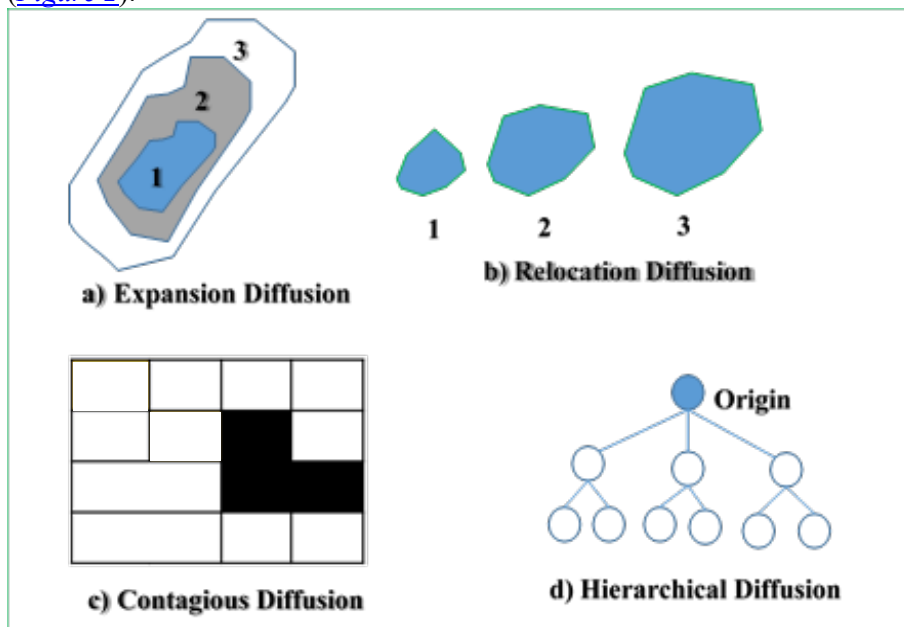


Figure 2. Spatial diffusion patterns (1, 2, 3 are stages of diffusion)

3. FINDINGS

3.1 Study of demographic changes in Torqabeh City and its central core

According to the census data of 1996, 2006 and 2016 and by comparing them, it is clear that in the city of Torqabeh, the absolute number of all population groups except the illiterate increased (Figure 3 left), while the number of some population groups such as the illiterate, the employed and the young in the central core decreased after 2006 (Figure 3 right).

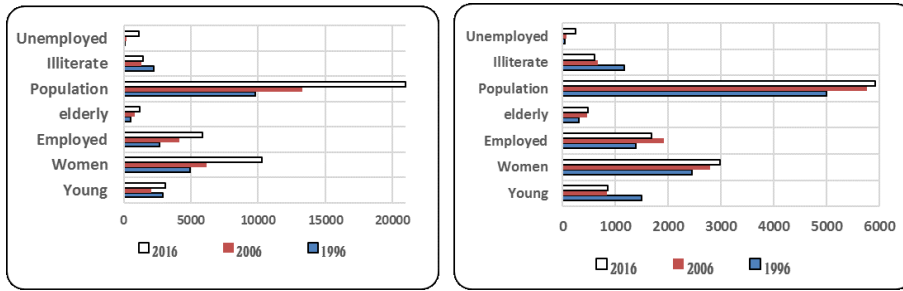


Figure 3. Variations in the population groups in Torqabeh City (left) and the central core (right) in 1996, 2006 and 2016

Comparing the position of the respective groups in the central core with the city of Torqabeh reveals that in 1996, about 50% of the different groups were living in this area. This was also observed in 2006 with a slight difference in some groups. In 2016, all the indicators decreased (Figure 4) suggesting a decline in the position and share of the central core compared to previous years.



Figure 4. The ratios of population groups living in the central core of Torqabeh 1996-2006-2016

A comparison of Figures 3 and 4 indicates an increase in the absolute number of population groups (except the young and the employed) in the central core and a decrease in its share compared to the city of Torqabeh. Therefore, if the evaluation criteria are considered the share and the number of population, it can be inferred that at the same time as the rapid physical expansion of the city, the position of the central core decreases and the early signs of decline in the central core of the city are observed.

3.2 Study of spatial changes of population groups in the city of Torqabeh

In order to provide a more accurate picture of demographic changes in the city of Torqabeh and its central core, the variations of hot and cold spots in each population group during three periods, before 1996, 2006 and 2016,

were evaluated separately using spatial analysis models such as Hot Spot Analysis (Getis-Ord G_i^*). The model shows whether the changes are statistically significant (at the level of 99% and 95% confidence), in what range they are visible, and which pattern they show. These changes are analysed based on [Table 1](#).

3.2.1 Spatial changes in population

In 1996, the central core of Torqabeh showed a significant difference from other areas of the city in terms of population. In that year, the central core was the only hot spot of the city's population, and there was an evenly distributed population elsewhere. In 2006 the central core of the city still had a significant difference with other areas. During this period, the Golestan neighbourhood was formed as a new "hot spot" in the east of the central core. In 2016, demographic changes in the central core showed an appreciable trend, with the hot spots continuously forming outside the central core and in the eastern areas. By comparing population dispersal patterns in the three periods studied, it is revealed that the spatial diffusion pattern in the period 1996-2006 is expansion and hierarchical, and in the period 2006-2016 it is contagious, suggesting the population diffusion from the city centre to the east ([Figure 5](#)).

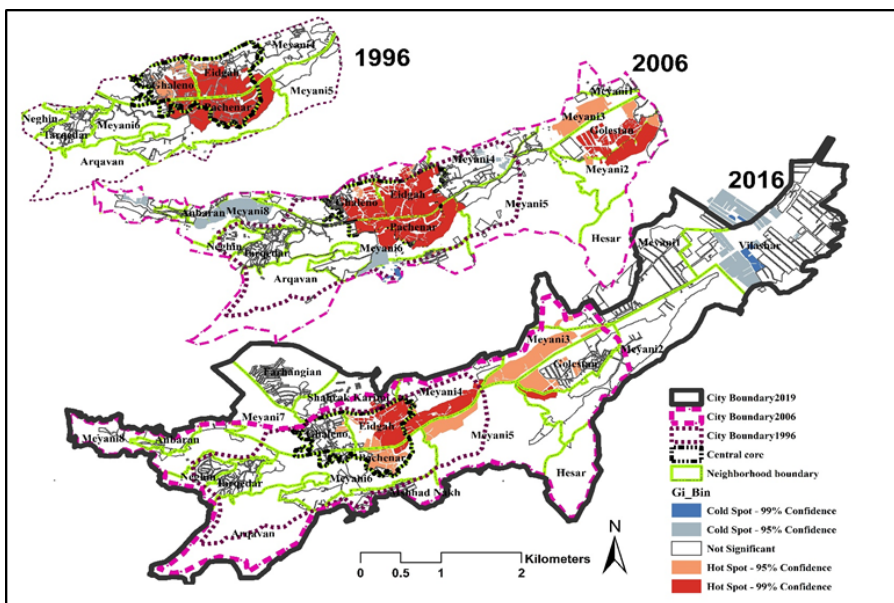


Figure 5. Spatial changes in the population dispersal of Torqabeh City (1996-2006-2016)

3.2.2 Spatial variations in the number of elderly (over 65 years) and young population

Elderly population: In 1996, the central core of Torqabeh city showed a significant difference with other areas in terms of the elderly population distribution as the only hot spot was the elderly population. The same was observed in 2006 with a slight difference. However, in 2016, in addition to the central core, hot spots were formed as scattered in different parts of the city, especially in the east and northeast of the city. These areas should be considered as new residential areas for the elderly. Considering the variation trend in the period 1996-2006, no certain pattern is observed. However, the

dominant pattern in the period 2006-2016 can be considered hierarchical as hot spots are scattered in other parts of the city (*Figure 6b*).

Young population: The central core was the only hot spot of the young population in 1996 and 2006. In this period, the wavelength of spatial diffusion is limited and is of relocation and hierarchical type that forms within the central core. In the period 2006-2016, the wavelength of spatial diffusion increases and the same pattern as the previous decade is observed and hot spots are formed outside the central core (*Figure 6a*).

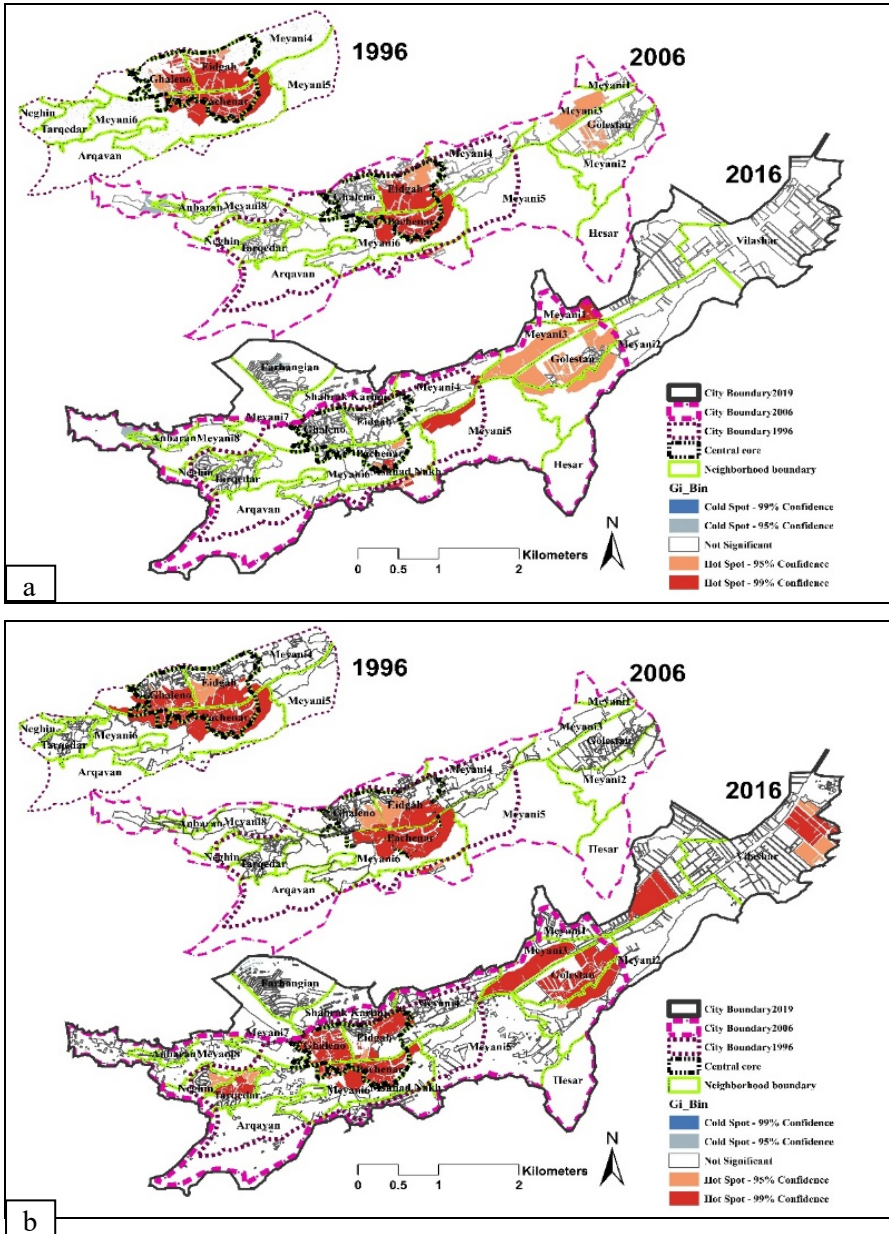


Figure 6. Spatial variations of the young (a) and elderly (b) population in the city of Torqabeh 1996-2006-2016

3.2.3 Spatial variations in the female population

Spatial variations in the female population also show that by 2006 the central core was the only hot spot, and therefore showed a significant difference with other areas of the city. However, since then the female

population displacement from the central core to the eastern parts caused the formation of hot spots continuously (Figure 7).

3.2.4 The spatial variations of the illiterate population

The spatial variations of the illiterate population also indicate that the spatial diffusion in the period 1996-2006 is within the central core, and the hot spots in the core change from one neighbourhood to another. In the period 2006-2016, the variations indicate the diffusion of hot spots in a hierarchical (discrete) pattern in the east and a contagious pattern around the central core (Figure 7).

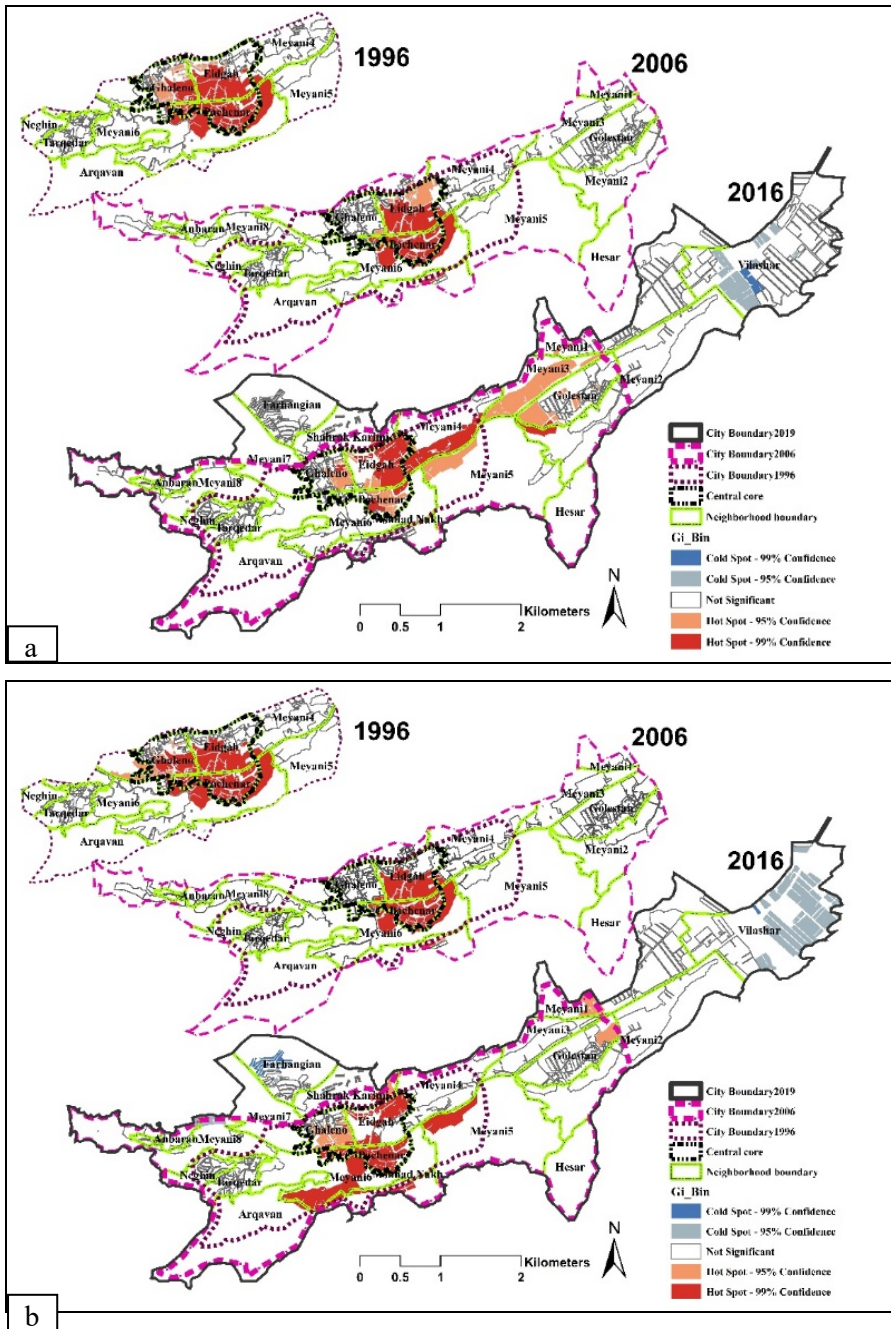


Figure 7. Spatial variations of the female (a) and illiterate (b) population in Torqabeh City 1996-2006-2016

3.2.5 Spatial variations of the employed and unemployed population

Spatial variations of the unemployed population: The results indicate the spatial diffusion of hot spots from the central core to the surrounding areas occurred in a relocation pattern in the period 1996-2006. The same can also be seen in the period 2006-2016 (Figure 8a).

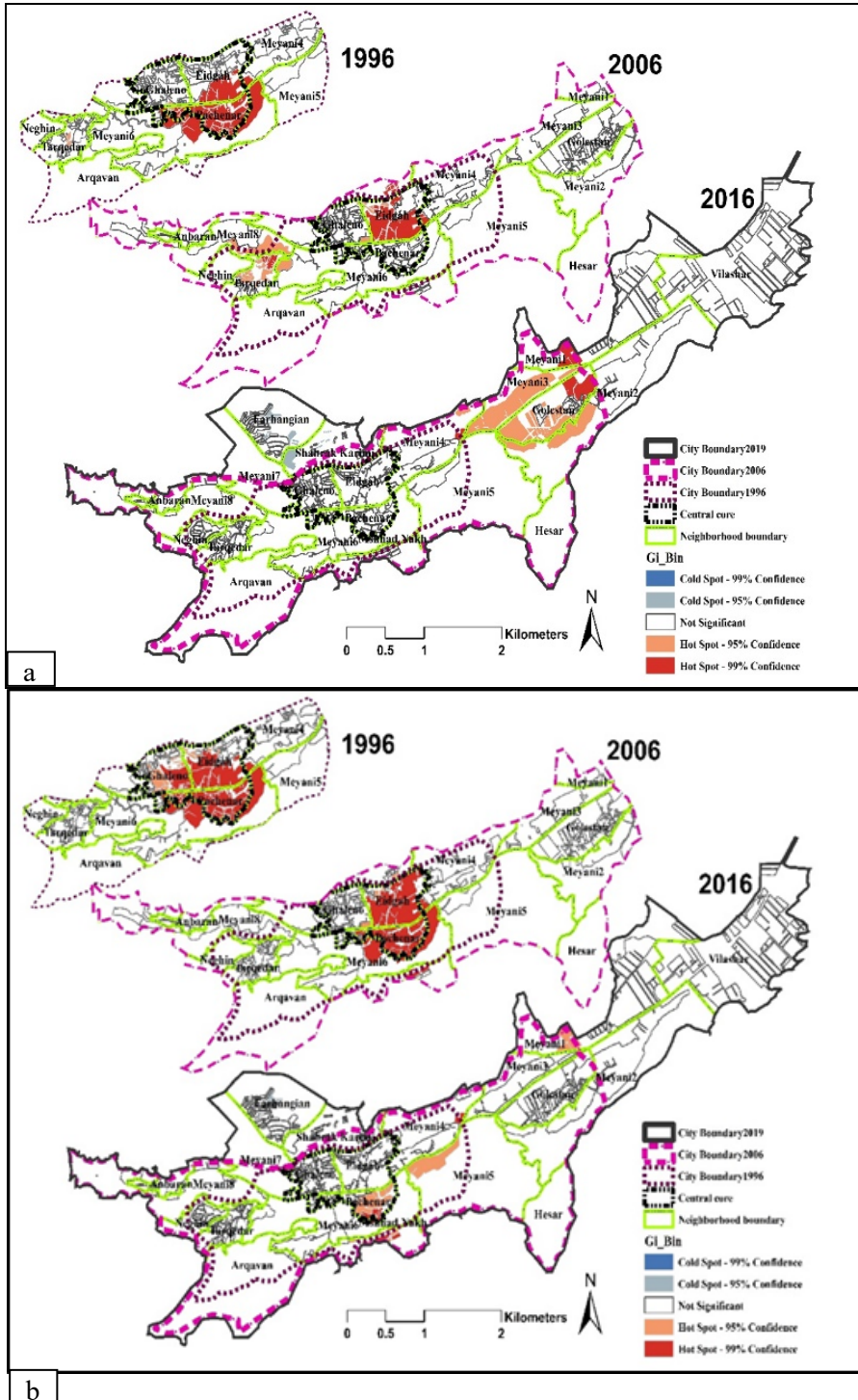


Figure 8. Spatial variations of the unemployed (a) and employed (b) population in Torqabeh City 1996-2006-2016

The spatial variations of the employed population indicate the displacement of hot spots in the central core in a relocation pattern in the

periods 1996-2006 and 2006-2016. The only difference is that in the period 1996-2006 the displacement was within the central core; however, in the period 2006-2016, it was outside the central core. Hence, the central core is losing its position, so that the employed population of the city of Torqabeh is being evenly distributed throughout the city, and the hot spots formed in previous periods are declining (*Figure 8b*).

Table 3 shows the dominant spatial diffusion pattern of population groups in the city of Torqabeh.

Table 3. Dominant spatial diffusion pattern of population groups in Torqabeh City, 1996-2006 and 2006-2016.

Diffusion Model	Period	Population	Young	Elderly	Women	Illiterate	Employed	Unemployed
Expansion	1996-2006	*						
	2006-2016							
Hierarchical	1996-2006	*	*					
	2006-2016			**		**		
Relocation	1996-2006		*		*	*	*	*
	2006-2016		**				**	**
Contagious	1996-2006							
	2006-2016	**	**		**	**		

* Indicates the presence or absence of the pattern. While ** indicates the dominant pattern

Considering the rapid physical expansion of Torqabeh City in the period 2006-2016, and the abovementioned, the following important points can be inferred from the spatial diffusion of population groups in Torqabeh City:

- The central core before 2006 is the origin of all population groups studied in the city of Torqabeh. It is supported by the hot spots of population groups in the core before this time. The dominant pattern in this period is relocation which occurs only within the boundaries of the central core.
- After 2006, the dominant pattern of spatial diffusion is contagious, formed from the inside to the outside of the central core. During this period, the diffusion wavelength increases compared with the past period.
- The population displacement from the central core and its coincidence with the physical expansion of the city after 2006 is quite evident. However, the displacement caused no cold spots to form in the central core, and it is still considered a hot spot for some population groups.
- New areas added to the urban area during this period could not be the destination of spatial diffusion waves of population groups. The destination of this diffusion is mainly around the central core.
- The results obtained indicate that there are different patterns of spatial diffusion as a result of population displacement. Therefore, applying the word "population outflow" to these developments and not paying attention to the way of population diffusion makes the understanding of different patterns difficult.

4. DISCUSSION

The preliminary assessment indicates a decline in the position of the central core due to the decrease in the share of population groups in the total population of the city during the period 2006-2016. Also, investigating spatial variations shows that by 2006, the central core is significantly different from other areas of the city in terms of population groups. However, after 2006 and with the rapid physical expansion of the city, the spatial diffusion of population groups begins from the core. Now, an underlying question is, what is the effect of the diffusion on the position of the central core as the origin of population groups, compared to other areas? And, does the area still show a different and distinct position from other areas? This evaluation is performed according to the spatial analysis model Grouping Analysis, which is based on spatial data.

4.1 The position of the central core before and after the rapid physical expansion of the city of Torqabeh

The position of the central core in slow expansion conditions (before 2006): The results of investigating this period indicate all indicators and population groups in the form of three spatial clusters. The number of clusters is selected based on a pseudo F-statistic diagram and given the best conditions. According to this classification, the central core is completely located in the second cluster, which is not similar to any of the other city textures in terms of population groups. Also, the newly added areas are mainly in the first cluster and the areas around the central core are in the third cluster ([Figure 9](#)).

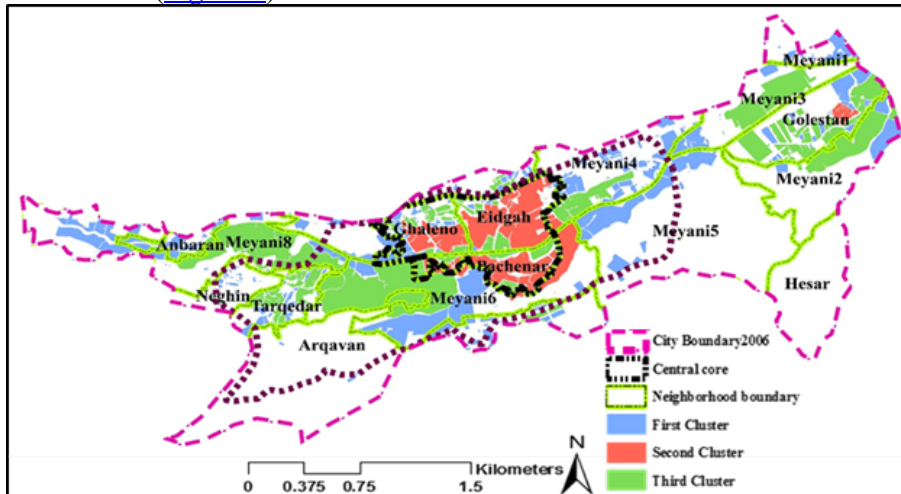


Figure 9. Clustering of Torqabeh City areas in slow physical expansion conditions (before 2006) in terms of population groups

Investigating the position of individual population groups in each cluster shows that the value calculated for all groups in the second cluster (central core) is significantly different from other clusters and areas of the city. Accordingly, the first cluster (new areas of the city) is in the lowest position ([Figure 10](#)).

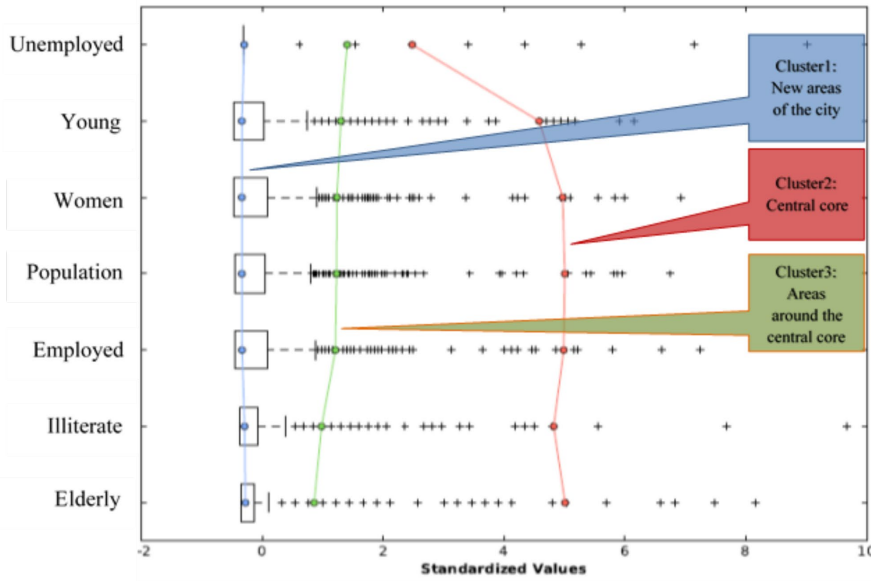


Figure 10. Comparison of the positions of population groups in the three clusters under the slow expansion conditions of Torqabeh City (before 2006)

The position of the central core in rapid physical expansion conditions (after 2006): As the spatial variations of population groups after the rapid physical expansion of Torqabeh City show, the diffusion of population groups from the central core to the surrounding is observed. The results of spatial clustering in this period also show the areas of Torqabeh City in the same three clusters. This clustering indicates that spatial diffusion causes the emergence of new population cores (similar to the central core) in the east and abreast of the central core. In this clustering, the first cluster is allocated to the newly added areas. Compared to the developments of the last decade (Figure 10), it can be said that among Torqabeh City areas, it is only the central core the demographic characteristics of which are diffused leading to the emergence of new cores similar to the central core in other areas of the city. This is not the case with other areas and their demographic characteristics (Figure 11).

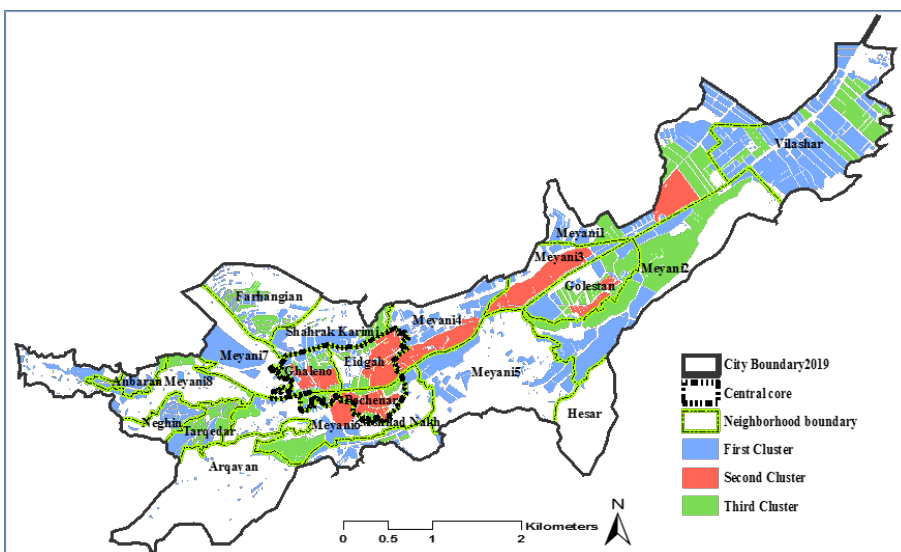


Figure 11. Clustering of Torqabeh City areas in rapid physical expansion condition (after 2006) in terms of population groups

The position of population groups in the three clusters in this period indicates that the second cluster, as in the previous period, is significantly different from other clusters. It is implied that the spatial diffusion of demographic characteristics from the central core has not caused the position of this area to be declined in terms of the establishment of population groups, and the central core could maintain its position despite the physical development of the city and the addition of new areas to the urban area. In contrast, the newly added areas in recent development do not show a suitable position in terms of population groups, in other words, these areas couldn't attract different population groups (*Figure 12*).

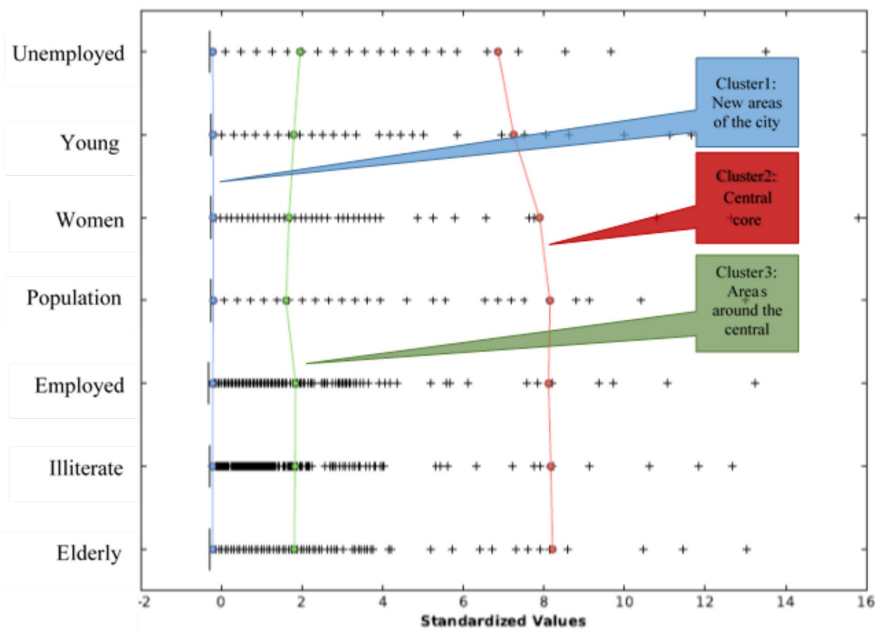


Figure 12. Comparison of the positions of population groups in the three clusters under the rapid physical expansion conditions of Torqabeh City (after 2006)

4.2 Theoretical implications

The results of this study, as other studies indicate ([Poorahmad and Shamaeipour, 2001](#); [Soleimani et al., 2013, 2017](#); [Vares et al., 2014](#); [Zangi Abadi et al., 2016](#)), imply that accompanying horizontal development, the population proportion in the central core decreases.

However, in the present study (regarding a small city), in contrast to other studies (in big cities), this is not necessarily considered as a sign of degradation of the central core. Supplementary results and spatial diffusion patterns and spatial analysis indicate that the process of population diffusion begins from the central core simultaneous to physical expansion.

Such a pattern in the case study (Torqabeh) has some properties that are distinct from the findings of other research (in big cities) as to demographic variations of the central core in physical growth conditions. These properties are:

- (1) Spatial analysis models show that spatial diffusion causes the diffusion of demographic characteristics of the central core. This diffusion implies that the surrounding textures resemble the central core (i.e., the proliferation and diffusion of the central core into other areas in the city).

- (2) Reduced population ratio of the central core in this process is common and is a part of the complementary cycle of spatial diffusion as displacement requires diffusion, and it is accompanied by an increase or decrease in population. What matters is the overall outcome of this diffusion. On the other hand, the diffusion may reduce the density and congestion of the central core and improve the quality of life and prevent the decline of this area. This can be considered as the reaction of the central core to the increase in density and overcrowding.
- (3) Population diffusion from the central core is significant as it mainly involves the peripheral areas connected to the central core, so it makes these areas similar to the central core. On the other hand, it shows the spatial continuity and internal cohesion of population groups.
- (4) The population departure from the central core and urban decline as a result of physical growth of the city can be considered true if a) the spatial diffusion of the population from the central core to new areas is due to physical growth, and b) the central core as a hot spot of population groups loses this position and becomes statistically, significantly indifferent regarding its hot or cold spots. Both of these are rejected in the study area.
- (5) The role of population displacement and diffusion from the central core in improving the quality of life in this area can be a main topic for future studies.

5. CONCLUSION

In Torqabeh City, for a period of 10 years and after horizontal expansion, the dissimilarity of demographic changes in its central core with big cities was observed. A better understanding of this model and the identification of its frameworks requires further case studies. Awareness of these changes can help to prepare measures and applications to improve the conditions of the central core in these cities.

However, less attention has been paid to this issue in the scientific literature, and the conditions of the central core in big cities were generalized in the form of an accepted pattern for all cities. This study revealed that there are new contexts of research in small cities.

In the end, it should be noted that what is evident in the city of Torqabeh in a period of 10 years after its physical growth is that the central core position has not declined. However, a more accurate assessment may require the passage of time. But what challenges past studies in this regard is the focus on the early population decline of the central core at the same time as physical growth, which seems to be common and a part of the diffusion process. Meanwhile, paying attention to other factors, especially the interventionist role of governments in the form of physical actions and plans, can resolve the existing ambiguities in this regard.

REFERENCES

- Basiri, M., Mousavi, M. I. R. S., & Husseinzadeh Dalir, K. (2017). "Evaluation and Prioritization of Intervention in Neighborhoods of Central District of Tabriz". *Geography (Regional Planning)*, 7(4), 115–131.
- Bazoobandi, M. (2007). *Tourism Geography of Torqabeh Shandiz*, Zolal, Mashhad.

- Bromley, R. D. F., Tallon, A. R., & Roberts, A. J. (2007). "New Populations in the British City Centre: Evidence of Social Change from the Census and Household Surveys". *Geoforum*, 38(1), 138–154. doi: <https://doi.org/10.1016/j.geoforum.2006.07.008>.
- Brueckner, J. K., Thisse, J.-F., & Zenou, Y. (1999). "Why Is Central Paris Rich and Downtown Detroit Poor?: An Amenity-Based Theory". *European Economic Review*, 43(1), 91–107. doi: [https://doi.org/10.1016/S0014-2921\(98\)00019-1](https://doi.org/10.1016/S0014-2921(98)00019-1).
- Cliff, A. D., Ord, J. K., Haggett, P., & Versey, G. R. (1981). *Spatial Diffusion: An Historical Geography of Epidemics in an Island Community*. Cambridge: Cambridge University Press.
- ESRI. (2019a). "Grouping Analysis". *ArcGIS Desktop*. Retrieved from <https://desktop.arcgis.com/en/arcmap/10.5/tools/spatial-statistics-toolbox/grouping-analysis.htm>.
- ESRI. (2019b). "Hot Spot Analysis (Getis-Ord Gi*)". *ArcGIS Desktop*. Retrieved from <https://desktop.arcgis.com/en/arcmap/10.3/tools/spatial-statistics-toolbox/hot-spot-analysis.htm>.
- Farid, Y. (2012). *Geography and Urbanism*. Tabriz: University of Tabriz.
- Farnahad, M. (2009). *Strategic Plan for the Development of Torqabeh City*. Mashhad: Housing and Urban Development Organization of Khorasan Razavi.
- Fol, S., & Cunningham-Sabot, E. (2010). "Urban Decline and Shrinking Cities: A Critical Assessment of Approaches to Urban Shrinkage". *Annales de Géographie*, 674 (4), 359–383. doi: <https://doi.org/10.3917/ag.674.0359>.
- Gentile, M., Tamaru, T., & van Kempen, R. (2012). "Heteropolitanization: Social and Spatial Change in Central and East European Cities". *Cities*, 29(5), 291–299. doi: <https://doi.org/10.1016/j.cities.2012.05.005>.
- Grant, J. L., & Gregory, W. (2016). "Who Lives Downtown? Neighbourhood Change in Central Halifax, 1951–2011". *International Planning Studies*, 21(2), 176–190. doi: <https://doi.org/10.1080/13563475.2015.1115340>.
- Habibi, S. (1988). *Revival of the Old Texture of Kerman City*. Tehran: University of Tehran.
- Haggett, P. (1996). *Geography A Modern Synthesis*. Tehran: Samt.
- Hoffman, L., & Musil, J. (1999). "Culture Meets Commerce: Tourism in Postcommunist Prague". In Judd, D. R. and Fainstein, S. S. (Eds.), *The Tourist City*. New Haven & London: Yale University Press.
- Hyuntae, E., & Myungje, W. (2015). "The Impacts of Urban Sprawl on the Decline of Inner City and Implications for Urban Regeneration: Focused on the Capital Region of South Korea". *Journal of Korea Planners Association*, 50, 73–89.
- MDP, S. M. (2015). "What Is Smart Growth?". Retrieved from <https://smartgrowth.org>.
- Musil, J. (1993). "Changing Urban Systems in Post-Communist Societies in Central Europe: Analysis and Prediction". *Urban Studies*, 30(6), 899–905. doi: <https://doi.org/10.1080/00420989320080841>.
- Mustafa Zadeh, G. (1998). "Ecological and Social Developments in Miandoab City". Tarbiat Modares University.
- Poorahmad, A., & Shamaeipour, A. (2001). "Physical Development of Yazd City and Its Impact on the Population Structure of the Old City". *Social Sciences Letter*, 18, 3–32.
- Pourahmad, A., Farhudy, R., Habibi, K., & Keshavarz, M. (2011). "Analysis The Role of Residential Environment Quality in Spatial Movement of Intra-Urban Population (Case Study: The Old Texture of Khorramabad)". *Geographical Research Quarterly*, 42(75), 17–36.
- Qi, W., Liu, S., Gao, X., & Zhao, M. (2015). "Modeling the Spatial Distribution of Urban Population during the Daytime and at Night Based on Land Use: A Case Study in Beijing, China". *Journal of Geographical Sciences*, 25(6), 756–768. doi: <https://doi.org/10.1007/s11442-015-1200-0>.
- Rahimi, A., Vaez, M., Mohamadi, H., & Bakooyi, M. (2018). "Evaluation of Gender Justice in Urban Public Spaces (A Case Study: Tabriz City Center)". *Women and Society*, 9(35), 219–244.
- Rahnama, M. (1996). "Rehabilitation of Old Texture and Urban Development, Study Area: Residential Textures of Mashhad City Center". Tarbiat Modares University.
- Rahnama, M., Amirfakhrian, M., & Shirzad, Z. (2014). "The Position of the Neighborhood in the Islamic City and the Study of the Causes of Its Instability in the Central Core of Mashhad City, Case Study: Sarshoor". *Sixth National Conference on Urban Planning and Management*, Mashhad Municipality, Mashhad, pp. 1-26.
- Reshadatjoo, H., & Toloei, P. (2013). "Investigate the Cause's Physical Changes in Central Tehran and Strategies for the Mitigation of Urban Management (Region Six)". *Urban Management Studies*, 5(3), 13–26.

- Rosenberg, M. (2019). *Common Geography Terms: Diffusion: How Things Spread From Place to Place*. Retrieved from <https://www.thoughtco.com/diffusion-definition-geography-1434703>.
- Sajadi, Z. H., & Mohammadi, K. (2011). "Social-Spatial Analysis in Urban Exhausted Textures Case Study of Sardasht Central Texture". *Research and Urban Planning*, 2(6), 55–70.
- Sakamoto, K., Iida, A., & Yokohari, M. (2018). "Spatial Patterns of Population Turnover in a Japanese Regional City for Urban Regeneration against Population Decline: Is Compact City Policy Effective?". *Cities*, 81, 230–241. doi: <https://doi.org/10.1016/j.cities.2018.04.012>.
- Shokui, H. (1994). *New Perspectives on Urban Geography*. Tehran: Samt.
- Soleimani, M., Tavallaei, S., Zanganeh, A., & Talkhabi, H. R. (2013). "Background and Processes of Decline in The Inner of Arak City". *Urban Management Studies*, 5(13), 23–34.
- Soleimani, M., Zanganeh, A., & Sheikhi, M. (2017). "Spatial Analysis of Changes of Population Density Pattern Under Renewal Actions in Tehran (1996-2011)". *Geography*, 15(53), 7–20.
- Tallon, A. R., & Bromley, R. D. F. (2004). "Exploring the Attractions of City Centre Living: Evidence and Policy Implications in British Cities". *Geoforum*, 35(6), 771–787. doi: <https://doi.org/10.1016/j.geoforum.2004.05.004>.
- Tavakoli Nia, J., & Mohammadi, A. (2010). "Functional Physical Erosion in the Central Texture of Cities, Strategic Goals and Principles of Improvement, Renovation and Reconstruction, Case Study: Central Texture of Zanjan". *Researches in Earth Sciences*, 1, 35–54.
- Tavassoli, M. (1989). *Urban Design in the Old Texture of Yazd*. Tehran: Urban Planning and Architecture Studies and Research Center.
- Temelová, J., & Dvořáková, N. (2012). "Residential Satisfaction of Elderly in the City Centre: The Case of Revitalizing Neighbourhoods in Prague". *Cities*, 29(5), 310–317. doi: <https://doi.org/10.1016/j.cities.2011.11.015>.
- Vares, H., Zangiabadi, A., & Shaterian, M. (2014). "An Analysis on the Social and Economical Construction of the Old Texture of Kashan City". *Environmental Based Territorial Planning*, 6(23), 1–26.
- Zanganeh, Y., Samiepour, D., & Hosseini, S. (2012). "Investigating the Trends and Motivations of Urban Migrations (Case Study: Sabzevar)". *Arid Regions Geographics Studies*, 7, 43–61.
- Zangi Abadi, A., Nastaran, M., & Kamali Baghrahahi, E. (2016). "Trend Analysis and State of Physical – Structural Development of Kerman City (Emergence Up to Now)". *Journal of Urban Social Geography*, 2(4), 23–42.
- Zenozi, F. (2000). "Basic Problems of Improvement and Renovation of Historical and Old Centers of Cities". *Architecture and Urbanism*, 36, 58–59.