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Spatial Development of Karaj Metropolis based on Ecologic City

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Abstract:

Uncontrolled spatial development in many great cities of the world has operated the ecological resources intensively. Karaj also experienced the urban development and evolution much quicker than normal process and within a short time. This city that had a population of 14526 people in 1956, with an area of 2 square km, has been converted in 2011 to a metropolis with a population of 1614626 peoples and an area of 180 square km. Summary of results indicates that Karaj with irregular special expansion has changed its nature from urban garden with agriculture performance to an inharmonious metropolis with service performance. The macro national and regional policies such as decentralization from Tehran, approval of maintenance and organizing plans and Tehran urban complex, transfer of land and dwelling, and Karaj integrated plan have been the most important factors effective on special development of Karaj Metropolis. Destruction of high quality agricultural lands, gardens and green spaces, all kinds of environmental pollutions, increase of garbage, waste and wastewater production, increase of energy consumption etc. are the results of this special development. At end, results of this research indicated that accelerated and irregular special development not provided the opportunity of ecologic resources maintenance, to Karaj.

Keywords: Spatial development, ecological city, ecologic resources, eco-city theory, Karaj Metropolis.

1. Introduction

Uncontrolled spatial development in many big cities of the world has operated the ecological resources intensively. The cities are the most important user of ecologic resources and the greatest producer of environmental pollutions. Therefore, achievement to a sustainable world is not possible without having ecological cities. Nowadays, the concept of spatial development of cities is not imaginable without regarding to the capacity of ecologic resources. The importance of ecologic resources in urban development is so highly that is assumed as one of the indicators of societies development. Ecologic resources such as water, soil, vegetation, animal species etc. are the biological basis of cities. Therefore, to achieve the ecological city, guarding and maintaining the said indicators is unavoidable. Therefore, investigation of the effects of special development of cities on ecologic resources is very necessary due to limitation of these resources, increasing growth of cities and continuous changes of urban structure. Establishment of ecological cities is one of essential strategies for controlling the uncontrolled growth of cities toward conservation of ecologic resources. Therefore, various theories and viewpoints in the world have been raised for realization of ecological city. The sustainable urban development, sustainable city, eco-city, safe city, green city, intelligent urban growth etc. are taking step towards realization of ecological city. These theories emphasize on collective participation, social justice, compact societies, restoration of damaged urban environments,

public transportation development, energy saving etc., for realization of ecological city. Inharmonious special development, destruction of lands and inattention to the capacity of ecologic resources are assumed as concerns of the said theories.

Karaj, the capital of Alborz Province, with an area more than 180 square km in 2010 was separated from Tehran Province. According to the census of 2011, this city has a population of 1614626 peoples, and after Tehran and Mashhad, is the third populous city in Iran. Besides, Karaj after Tehran is assumed as the most immigrant-accepting city of Iran, and with an annual growth of 3.14% among Iranian metropolises has the highest population growth (Iranian Statistics Center, 2011). Therefore, based on the commercial, administrative, educational and service functions of Karaj Metropolis and accelerating growth of its population, the present study aims to investigate the spatial development of Karaj Metropolis based on ecological city to answer the following questions:

- What are the grounds and processes effective on quick and inharmonious spatial development trend of Karaj Metropolis within 1956 to 2011?
- Have been the ecologic resources conserved in the spatial development trend of Karaj Metropolis?

2. Introduction of Studied Area

Karaj Metropolis with a population of 1614626 peoples and 180 square km in area, is capital of Alborz Province. This city has been located in west bank of Karaj River and within south slopes of Alborz Mountains, between north latitudes 35 degree and 41 minute to 35 degree and 53 minute and east longitudes 50 degree and 51 minute to 51 degree and 2 minute. The average height of Karaj is 1325 meter above sea level and is located within 35 km to northwest of Tehran.

3. Theoretical Fundamentals of Study

Continuity of urban poverty, inaccessibility to the dwelling and appropriate urban services, alienations of citizens from each other, marginalization and informal settlements, weakness of urban transport systems, environmental pollutions etc. are assumed as results of uncontrolled spatial development. These issues resulted in raising various theories and viewpoints for their adjustment. One of these raised viewpoints is ecological city. Ecological city takes step towards realization of urban sustainability. Urban sustainability is also realized when a group of social, economic and environmental sustainability is created. In fact, ecological city upon reducing the environmental pollution, reducing the volume of urban wastes, protection of recycles, management of unrecyclable wastes, conservation of open lands, conservation of green zones, establishment of urban green zones, health supply etc. will realize the environmental sustainability.

In addition, upon development of diverse dwellings for all, establishment of local employment, balanced density, conservation of culture, tradition and values, creation of local identity and attachment, social participation development, establishment of balance between population and resources etc. causes realization of social sustainability and also realizes the economic sustainability by optimal distribution of resources, economic productivity, restoration of damaged lands, public transportation development, energy saving, more efficient use of land, internal development, mixed land uses etc. (Brehany and Ralph, 1994 and Clark, 1992).

4. Spatial Development Trend of Karaj Metropolis

As before 1956, Karaj similar to other cities of Iran was an urban with agricultural function. Population of this city based on the first census in 1956 was equal to 14526 peoples and 2 square km in area. 1956 may be deemed as beginning of sensible demographic developments of Karaj, so that in the census of 1966, population of this city was increased to 52415 peoples. The normal growth of population together with immigrant-accepting are assumed as the most important urban development factors of this period. Within 1966 to 1976, a population about 132482 peoples was added to the city, and population of Karaj was reached to 184897 with a growth rate of 3.5%. The state policies for expansion of urban and industrial hubs and leading the villages and agricultural sector to the margins are assumed as the most important agent of immigrations within this period. After revolution in 1979, Karaj was also affected by the results of making revolutionary decisions. This city due to adjacency to the central core of revolution and natural capabilities and bed-makings within Pahlavi Era such as establishment of plants and industrial and residential estates therein, more than ever was changed to one of major immigrants absorbing areas who had been departed from different regions to the capital. Most of this immigrant population due to different reasons had immigrated within that period, such as asking share from revolution (achieving land and dwelling free of charge). Upon beginning Iran & Iraq War, immigrations trend was accelerated, so that in 1986, more than 21.2% of immigrants entered into Karaj came from war-torn provinces such as Khuzestan, Kurdistan and Kermanshah (Firouzbakht, 2001). Within 1976 to 1986, Gohardasht and Mehrshahr Estates were merged to Karaj and city's population was reached from 184897 peoples in 1976 to 453925 peoples in 1986. Expensiveness of land and dwelling in Tehran and increase of macroeconomic investments and promotion of service sector in Karaj and in general appropriateness of this city for residence are assumed as the most important factors of immigration to this city within this decade. At the beginning of 1990s, government's attention to the surrounding areas and investment in these areas reduced the immigrations trend for a while, but inadequacy of investments and drought in these regions again departed the immigrants toward the capital and its surrounding areas, particularly Karaj. Following execution of plants and industries establishment prohibition policies within Tehran, a considerable part of industrial activities was transferred to the around of Tehran, particularly its west in Karaj-Ghazvin axis, and created many career fields in this region. The normal result of this trend of continuity of immigration to Karaj was establishment of residential estates around the city and beginning of vertical expansion of city simultaneous to its horizontal expansion, so that area of Karaj within this period was reached to 110 square km. In the census of 1996, population of Karaj was equal to 940968 that in comparison to a decade ago, 487043 peoples were added to the population of this city. Increase of population of this city during this decade in addition to being under impact of previous factors and loadings, is also arising from new loadings in this city, such as establishment of Islamic Azad University, establishment of new plants

around this city particularly after approval and execution of industrial establishment prohibition act within capital, promotion of constructions, low price of land and dwelling etc. At the recent of 1990s, startup of Tehran-Karaj subway line caused transfer of population overload of Tehran to Karaj (Ibid). Population of Karaj in census of 2006 was equal to 1386030 peoples, that comparing to 1996, 445062 peoples were added to the population of city. Out of total population added to the city within this period, 17.6% thereof is the result of normal growth of city and 82.4% thereof the result of immigration from different regions to this city. Currently, Karaj Metropolis passes through its development steps, and Jahanshahr, Gohardasht, Azimieh, Khalajabad, Golshahr, Mehrshahr, Dehghanvilla, Mehrvilla, Fardis, Vahdat, Kianmehr, Hesarak and other estates that sometime had been formed around Karaj, are currently supposed as internal neighborhoods of city. As observed, Karaj has passed the urban development and evolution trend quicker than its normal trend and within a very short time. In fact, growth and development of this city has begun consistently and under impact of accelerated development of Tehran, and within next decades, was culminated by decentralization of Tehran.

5. Assessment of Accelerated Spatial Development of Karaj Metropolis

In this research, Holdern Model was used to assess the accelerated spatial development of Karaj Metropolis. Holdern model indicates that which part of spatial development of city is arising from population growth and which part is due to urban sprawl phenomenon (Hekmatnia and Mousavi, 2006). The model structure is as follows:

$$\ln \left(\frac{P_f}{P_p} \right) + \ln \left(\frac{PR_f}{PR_p} \right) = \ln \left(\frac{A_f}{A_p} \right)$$

P_f : Population at the end of period

P_p : Population at the beginning of period

PR_f : Gross per capita at the end of period

PR_p : Gross per capita at the beginning of period

A_f : City area at the end of period (hectare)

A_p : City area at the beginning of period (hectare)

\ln : Normal logarithm

With respect to Karaj Metropolis, variables of Holdern model within 1956 to 2011 are replaced as below:

$$\ln \left(\frac{1614621}{14526} \right) + \ln \left(\frac{111.5}{137.7} \right) = \ln \left(\frac{18000}{200} \right)$$

$$\ln (111.1538) + \ln (0.8097) = \ln (90)$$

$$2 + 0 = 2$$

$$\left(\frac{2}{2} \right) + \left(\frac{0}{2} \right) = \left(\frac{2}{2} \right)$$

$$1 + 0 = 1$$

Summary of results indicates that spatial development of Karaj Metropolis is completely due to population growth (1 due to population growth, 0 due to urban sprawl) which resulted in increase of gross population density and reduction of gross per capita of urban land. In fact, the obtained results indicate that the area of Karaj Metropolis for its current population is not enough at all. Since Karaj after Tehran is the most immigrant-accepting city of Iran, and with an annual growth 3.14% among Iranian metropolises has the highest population growth, results obtained from Holdern model seems to be completely logical.

6. The Most Important Factors Effective on Spatial Development of Karaj Metropolis

The most important factors effective on spatial development of Karaj Metropolis include the policy of decentralization of Tehran, approval of conservation and organizing plans and urban complex of Tehran, policy of land and dwelling transfer and Karaj integrated plan.

At the beginning of 1960s, in order to avoid the accelerated and expansive growth of Tehran, various plans were designed for political, administrative and industrial decentralization of capital. One of the said plans was prohibition of industrial unit's construction within Tehran. Execution of this plan, besides scattering the industries within wider regions, resulted in formation of polarization space and various industrial axes. Therefore, since that time, establishment of satellite towns were considered for settlement of employees of industrial sector, and Mehrshahr, Gohardasht, Golshahr, Fardis and Hesarak Estates, and residential complexes around Karaj were constructed. These estates within next periods also with the policy of population overflow absorption policy had an important effect on decentralization of Tehran, and resulted in irregular spatial development of Karaj.

In the Tehran conservation and organizing plan, Tehran and Karaj were assumed as a twin urban complex. In this plan, multi-coring and development of twin city of Tehran, means Karaj, was emphasized to find a role as same as Tehran in the megalopolitan level, and balances it. In the Tehran urban complex plan, also the purpose was transferring the functions disproportional to the central code of Tehran to Karaj urban complex and establishing relatively self-sufficient centers. Due to execution of these policies, a great part of population was led toward urban region of Karaj.

The policy of land and dwelling transfer from one hand and low price of land in Karaj comparing to Tehran, on the other side, caused immigration of a large number of population of Tehran to Karaj, and promotion of constructional activities out of legal area of city. Karaj integrated plan also caused integration of three Karaj, Mehrshahr and Gohardasht municipal areas, as well as joining Fardis and Mianjaddeh zones to the urban area. In addition, in Karaj integrated plan, more than 20sqkm of dried lands had been estimated within approved area of city, to achieve a national identity by leading civil activities in megalopolitan scale. As observed, macro national and regional policies have had very important role in spatial development of Karaj Metropolis.

7. Study of the Effect of Spatial Development of Karaj Metropolis on Ecologic Resources

In this study, the effect of spatial development of Karaj on the ecologic resources such as water resources, gardens, farming lands and green spaces, environmental pollutions etc. are analyzed.

7.1. Water Resources

Spatial development of Karaj Metropolis together with the increasing population growth and lack of optimum use of underground water resources in different domestic, agricultural and industrial sectors has incurred irreparable damages to the aquifers of Karaj Plain. Within 1966 to 2006, the area of aquifers water has been decreased averagely 23.5 meter, so that aquifer of Karaj Plain in 2001 experienced a critical status, and has been introduced as prohibited plains since 1995. The notable point in this relation is increase of number of excavated wells from 2055 in 1966 to 4193 in 2010, and increase of water drainage from wells of Karaj Plain from 224 million m³ in 1966 to 997 million m³ in 2010 that resulted in change of aquifers' water depth from 15 meter to 96 meter (Abdolali, 2007). Furthermore, according to the data obtained from Karaj Regional Water Co., the depth of wells drilled for supply of drink water of Karaj, was 35 meter at first, and currently has been increased to 140 meter. Total aforesaid conditions demonstrate that in case of continuity of the current trend, Karaj will face serious problems in the status quo and also in the future. Thus, continuity of spatial development of Karaj will result in water resources destruction within suburb areas.

7.2. Gardens, Farming Lands and Green Spaces

In this research, satellite images have been used for change detection of land uses of Karaj Metropolis within two periods. First period is referred to 1998 and second period to 2011. In order to classify the land uses of Karaj Metropolis in these two periods, the images of assessor TM5, respectively on 29.08.1998 and 17.08.2011, have been used. The said images are related to path 165 and row 35. Histogram equalization was used for images enhancement, and nearest neighbor method for resampling. In addition, the terrains have been drawn using supervised classification method and false color composite of Karaj in both periods for reduction of error in selection of training samples.

Summary of results indicated that in 1998, 31.3 square km of Karaj Metropolis lands consisted of green spaces, 62.3 square km barren lands, and 81.2 square km constructed lands. In other word, 17.9% of Karaj Metropolis area allocated to green spaces, 35.6% to barren lands and 46.5% to constructed lands, but in 2011, green spaces and barren lands were reduced respectively to 24.2 and 55.9 square km and the constructed lands increased to 94.7 square km. In fact, in 2011, 13.8% of lands of Karaj Metropolis consisted of green spaces, 32% barren lands and 54.2% constructed lands (Table 1 and figure 1 and 2). The obtained results show that 7.1 square km of gardens, farming lands and green spaces of Karaj have been destroyed due to accelerated and unplanned spatial development and used for urban constructions.

Land use	1998		2011	
	Area (square km)	Percent	Area (square km)	Percent
Green spaces	31.3	17.9	24.2	13.8
Barren lands	62.3	35.6	55.9	32
Constructed lands	81.2	46.5	94.7	54.2
Total	174.8	100	174.8	100

Table 1: Area of land uses of Karaj (1998 and 2011)

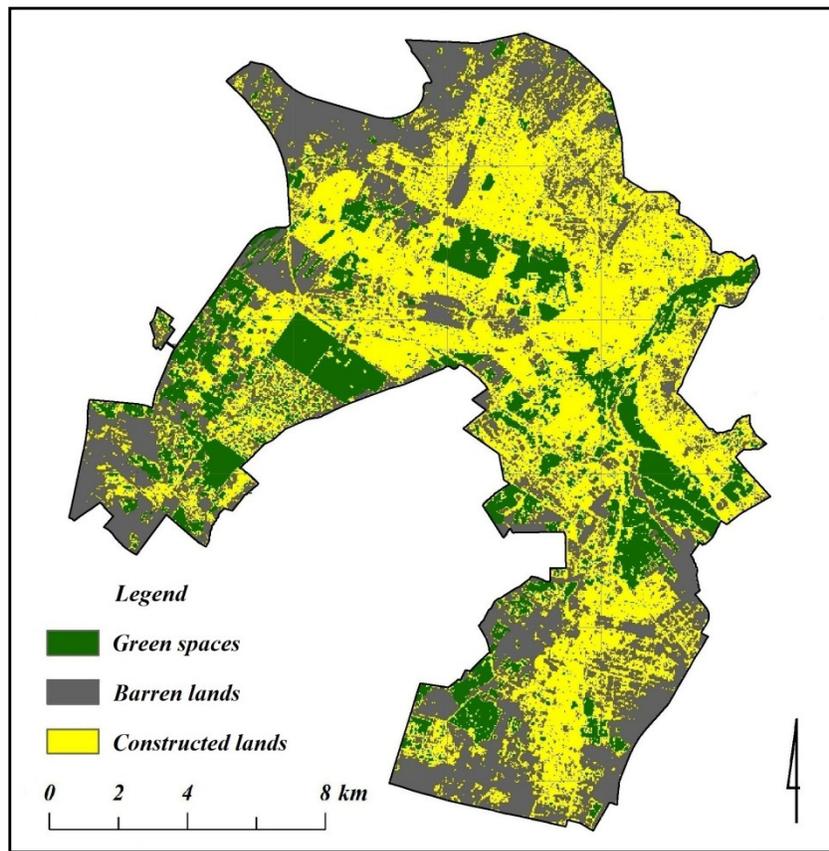


Figure 1: Karaj metropolitan land use classification (1998)

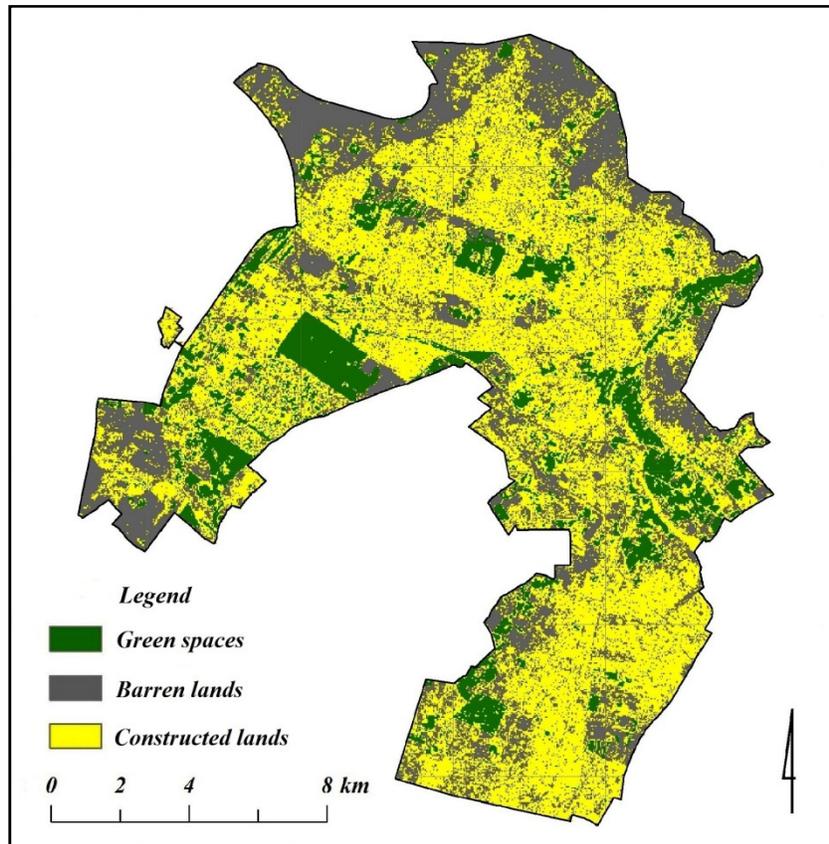


Figure 2: Karaj metropolitan land use classification (2011)

7.3. Air Pollution

Plants such as vegetable oil, shatterproof glass and sugar plants, 13 aviculture units, 15 animal husbandry units etc. have caused the air pollution of city, because the said plants due to high oldness (more than 30 years) have a great pollution. Furthermore, they don't use the air pollution control technologies and gradual enhancement of residential land uses toward the said plants, led them toward impact of air pollution of plants. The same status also is applicable on residential land use around Shahid Montazer Ghaem Power Plant. In the next place, industries and industrial estates are propounded that although are not located within the legal area of city, but affect the quality of its air. According to the report of general dept. of environmental conservation of Karaj County, Haljerd, Simindasht, Baharestan, Mahdasht and other Industrial Estates have no license (Bavand Consulting Engineers, 2006). The crows of motorized vehicles are also very effective on the air pollution of Karaj. Although Karaj has passed accelerated growth, but the communication infrastructures of city have not been formed consistent to the population growth and urban development, and the heavy crowd arising thereof may be assumed as one of the most important current problems of this city. The scattered development of city also has reduced the possibility of using public navigation. Location of Tehran-Karaj Highway within the margin of this city and Ghadim and Makhsus Roads and Ghazvin-Karaj Transit Road has doubled the crowd of motorized vehicles in this city. Averagely, 110000 interurban daily trips and entry of 105000 vehicles through different city gates demonstrate this status (Andishkar Consulting Engineers, 2012). Based on the report of general dept. of environmental conservation of Alborz Province, the number of unsafe days in Karaj has been increased from 17 days in 1986 to 187 days in 2010.

7.4. Water Pollution

According to the report of general dept. of environmental conservation of Alborz Province, 2.5 million liters of wastewater daily is produced in Karaj Metropolis, whilst total settlement and activity centers such as residential zones, educational and research center and administrative centers etc. have no gathering and installation network related to wastewater filtration, and wastewater disposal is made in two unsanitary ways; through absorbent wells that gradually cause pollution of underground waters, and drainage of domestic and agricultural wastewater in Karaj River. Industrial units rarely use the required measures for wastewater filtration and prevention of pollution of surface and undersurface waters.

7.5. Sound Pollution

The highest sound pollution in the cities is arising from urban transportation and a part of which is the share of industries affiliated to urban transportation. Centralization of service centers at Karaj and shortage or non-existence thereof in its covering cities increased the number of trips from around cities to this city. Currently, the problem of motorized vehicles crowd and sound pollution arising therefrom is assumed as one of problems of Karaj Metropolis. Averagely, 110000 interurban trips are made daily, and 105000 vehicles enter from various gates into Karaj. According to the report of environmental broadcast of Karaj County, the noise level in Karaj Metropolis in residential and residential-commercial regions respectively equal to 65 and 70 decibels from 07:00 Am to 10:00 Pm is higher than noise level in the country (respectively 50 and 60 decibels). In fact, the crowd of motorized vehicles particularly heavy vehicles upon crossing through population centers, construction of residential units around the highways and rail lines without compliance with approved boundary, location of plants, power plants, auto repair shops, forging, turning shops, industrial and agricultural machineries, diesel motors etc., within residential areas, are assumed as the most major sound pollution resources in Karaj Metropolis.

7.6. Production of Garbage and Wastewater

According to the report of general dept. of environmental conservation of Alborz Province in Karaj Metropolis and its satellite towns, 100 tons of garbage is produced daily, of which only 250 tons are recycled and the rest is buried. Furthermore, 6 tons of hospital waste is daily gathered from Karaj, that due to lack of integrated management from one side, and increase of city garbage affected by increasing enhancement of population on the other side, will make problems for the citizens, so that Karaj within last decades consistent to population growth and expansion of city, also encountered the growth of urban wastes.

8. Conclusion

The uncontrolled spatial development in many great cities of the world has operated the ecologic resources, intensively. Karaj also experienced the urban development and evolution much quicker than normal process and within a short time. This city that had a population of 14526 people in 1956, with an area of 2 square km, has been converted in 2011 to a metropolis with a population of 1614626 peoples and an area of 180 square km. Summary of results indicates that Karaj with irregular special expansion has changed its nature from urban garden with agriculture performance to an inharmonious metropolis with service performance. The macro national and regional policies such as decentralization from Tehran, approval of maintenance and organizing plans and Tehran urban complex, transfer of land and dwelling, and Karaj integrated plan have been the most important factors effective on special development of Karaj Metropolis. Destruction of high quality agricultural lands, gardens and green spaces, all kinds of environmental pollutions, increase of garbage, waste and wastewater production, increase of energy consumption etc. are the results of this special development. At end, study of ecologic criteria such as water resources, gardens, farming lands, green spaces, and environmental pollutions indicated that accelerated and irregular special development not provided the opportunity of ecologic resources maintenance, to Karaj.

9. Discussion

Development of social, economic and political system of third world countries and governance of domination over their destiny always had inappropriate effects in various aspects of the life of these countries, and particularly and more than other sectors, on the cities and its development. This status caused in many cases, the cities of developing countries to be developed out of their local capacities and capabilities. Spatial development of Karaj in the same conditions is perceivable. If the imposed role of Tehran Metropolis on its surrounding spaces is analyzed and investigated carefully, the accelerated and irregular expansion grounds and processes of Karaj Metropolis will be recognized well. Therefore, as long as the translocal forces and factors result in special expansion of cities within very short time, these special developments also will be unplanned and along with destruction of ecologic resources in various aspects. In this process, the cities may not reserve their ecologic and territorial resources. Growth and expansion of Karaj Metropolis is also subject to this process, and as long as these forces and processes affect it, conservation of its ecologic resources is not possible.

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