Available online at www.pelagiaresearchlibrary.com

Pelagia Research Library

European Journal of Experimental Biology, 2013, 3(3):431-438

ISSN: 2248 –9215
CODEN (USA): EJEBAU

Evaluation of Khorramabad's physical changes and its green space using remote sensing data

Ahmad Beiranvand[1*], Amir EslamBonyad[1] and Javad Soosani[2]

[1]*Department of Forestry, Faculty of Natural Resources, Guilan University, Iran*
[2]*Department of Forestry, Faculty of Agriculture, Lorestan University, Iran*

ABSTRACT

A city usually changes and develops due to various factors throughout its life. Urban green space is one of the most important assets and effective factors for every city. Environmental effects are the most significant function of urban green space, which may increase the biological quality of cities. The present research intends to study Khorramabad's physical changes and its urban green space. It applies the empirical research method where aerial photos taken in 1956, 1974, and 1994 as well as the image captured by Quick Bird Satellite in 2006 were used and analyzed. First, geometric corrections of the photos were made and their orthophotos were provided. The physical changes of the city were specified by means of the aerial photos and satellite images taken in different years. Moreover, dot grid was used to calculate the urban green space during these years. Results show that city area has become 2.09 times larger in the 18-year period (1956-1974), 3.34 times larger within the 20-year period (1974-1994), and 1.86 times larger in the 12-year period (1994- 2006). The ratios of the green space area to the whole urban area in these years are 10.42, 9.67, 15 and 9.1, respectively. Statistical test results show that there is a significant difference between green space percentage in 1994 and those of other years. However, there is not a significant difference between green space percentages of 1956, 1974 and 2006. In general, Khorramabad green space is not proportional to universal standards, and the city's green space growth is slow if compared to its physical development process.

Keywords: Aerial photos, Khorramabad, dot grid, changes

---

1. Introduction

1.1. Statement of the Problem

A city is similar to a living organism. The people and their activities as well as its spirit and anatomy are like the body of this living thing. Each city usually changes and develops because of different factors. However, a good city is the one whose structure meets its people' needs due to changes with time. Every city has its own characteristics, but it is generally similar to other cities regarding its form and duties. Whatever we learn from studying a city may be useful in other studies [21].Uncontrolled population increase and the enhancing growth of urbanization have been among the main reasons for changes and development of a city, especially in developing countries, in recent years [32].Along with this high rate of urbanization, the increasing growth of development plans either consciously or unconsciously resulted in environmental, economic and social warnings in 1970s. In response to the problems and crises arisen from the above-mentioned events, new concepts and approaches were introduced, such as sustainable development, environmental equity, modern urbanization, and more recently, intelligent development [7].The declaration of sustainable development as the main slogan of the third millennium is also due to the effects exerted by cities on the biosphere and different aspects of human life. No doubt, discussion about stability and sustainable development, without considering cities and urbanization, is nonsense. In fact, urban stability and global stability are both a single concept [16]. Studies on the factors influencing cities and their orientation may serve as a suitable

guideline for better indentifying the effective factors and their rates of effectiveness [10].Drought is not only the world's costliest natural event, collectively affecting more people than any other form of natural hazard [30], but it is also one of the most difficult phenomena to define. Cities, serving as centers for human life and activities, must adopt structure and function from natural systems to guarantee their stability. Green spaces, as inseparable and necessary elements in the skeleton of cities, play an essential role in this connection; therefore, their absence may lead to serious disorders in the life of cities [20].The green space in each city is one of its most significant assets. Environmental effects are the most important function of an urban green space, enhancing the quality of city life [17]. Green spaces, known as the "green lungs" of a city, are especially important not only in providing physical and physiological health but also in ensuring the welfare of people's city life [13].When we accept that green spaces are the lungs of a city and their absence means lack of physical and mental health in cities, their importance becomes more tangible parallel with industrial development [15].It is necessary to use remote sensing data for the better management of urban development arising from urban activities [1].Aerial photos are among the oldest remote sensing data, which have ever received attention due to recording some information on the past earth. The significance of this valuable source doubles when studying the changes of land cover so that future generations will also need this basic data in spite of using advanced satellite one [27].

1.2. Significance of the Problem

Studies on the physical development of cities and its influencing factors are one of the ways that helps us to have a more realistic prediction. As stated earlier, each city has its own characteristics. However, such studies many be effective for decision-making in many respects, showing realities in the discussions on urban development. It is necessary to have a successful and efficient planning in urban green space and forestry not only to spend budget and use financial resources, but also to recognize the conditions, requirements, and potentials of the region with respect to its vegetation [31].Thus, if we are interested in helping people to enjoy a better life in an urban world, it becomes immediately essential to study these environments and urban green space.

1.3. Goals and Objectives

The main goal of this research is to study Khorramabad's physical changes and urban green space using remote sensing data. Also, its objective is to provide the procedural map of the spatial changes in Khorramabad.

1.4. Research Background

Scohottke*et al.* [29] and Dykes [11], pointing to the increase of population and ecological problems in urban areas, emphasize the need for an advanced remote sensing technology to obtain detailed precise data on land use for urban management and planning. Using remote sensing data and GIS, many domestic and foreign researchers have studied urban application changes and land cover in cities, some of whom include Rabiei *et al.*[24] studying Isfahan, Jahadi[18] dealing with Rasht, Fattahi[12] studying Qom, Borges *et al.*[8] dealing with São Paulo in Brazil, Krundu*et al.*[19] studying eastern Mau in China, as well as Slover studying Washington in the United States. Panahi[22]and Andarz *et al*. [3] introduce dot grid on aerial photos as a suitable method for estimating canopy cover percentage in urban forestry. Goel Cohen [9] has estimated the minimum standard green space to be 10 to 15m^2 per person according to each country's climate, having introduced this standard as 20 percent of the whole urban area according to another criterion.

1.5. Questions and Hypotheses

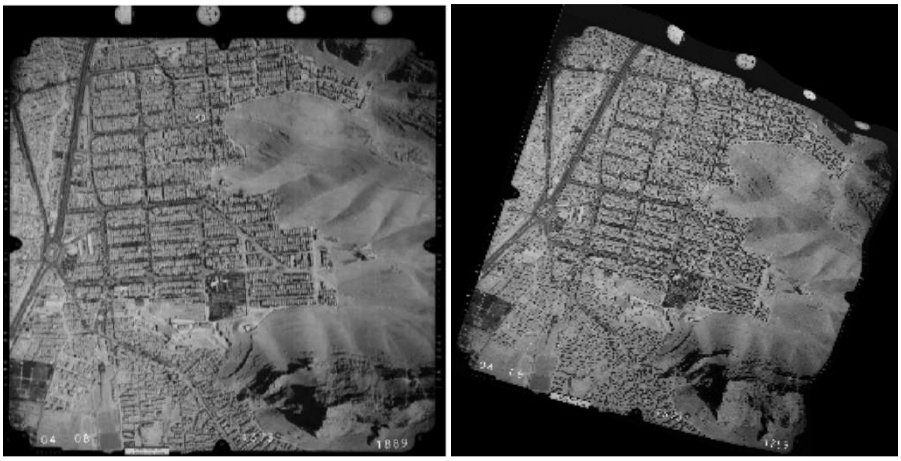
1.5.1. It is possible to prepare a model for spatial changes of Khorramabad using remote sensing data.

1.5.2. Changes in Khorramabad's green space become significant with time.

1.6. Methodology

1.6.1. Obtaining Data from Aerial Photos and Satellite Image

Required geometric corrections, such as displacement due to height difference and non-horizontal negative plate, were conducted by means of PCI 9.1 Software and using the data including camera type, focal distance, marginal points of photos, height digital model, ground control points and common double points between photos and surveying obtained from the aerial photos of the region. The orthophoto of the region was also prepared for the aerial photos at this Software environment [23] (*See* Fig. 1)



(**a**) (**b**)

Fig. 1.Orthophoto picture (a), and non-orthophoto picture (b)

For geometric correction and geocode of photos, 11 ground control points in each photo and 11 common double points between photos and surveying were used in definite areas of such reliefs as road junctions and/or marker lines. After conducting geometric corrections and preparing the orthophotomosaic of the aerial photos, urban borders were determined in an Arc GIS environment through visual interpretation [2] up to the points where the city did not lose its discontinuity, in a way that residential areas were compact and continuous, and the dispersed suburban areas were not studied. After locating city borders in each period, its area and place-time development was studied by means of Arc GIS. To estimate the green space area in different periods, regular dot grid with land dimensions of 10×10m was used in PCI Geomatic Software environment [26]. In this study, all the points located on tree crowns and in the existing green spaces of different areas are counted. However, if a point is located exactly on the regional borderline, it is counted as half a point. Moreover, if the larger part of a point is located inside the city border, it is counted; otherwise, it is excluded [34]. Green space ratio was obtained by P_i=$\frac{n}{N}$, standard error by$Sp_i = \pm\sqrt{\frac{P_i(1-P_i)}{N}}$, reliability by $E = \pm Spi \times t$, and inventory error percent or reliability up to 95% probability by$\%E = \pm\frac{E}{pi} \times 100$, where P_i: green space ratio; n: number of points located in urban green space; N: total number of points over the city; Sp_i: standard error; and E: reliability. The value of t depends on the number of samples or points that must be counted, and is commonly considered as 1.96 in the equations according to the sample size. In order to change the population of 1991 to that of 1994, and the population of 1996 to that of 1974, the equation $P_n = P(1+r)^t$ was used, where P_n: population in the nth year; P: population in the basic year; r: growth coefficient and$t$: number of years [6]. Moreover, t-test statistic is defined by the expression

where$\hat{P}_{i1}$: relative frequency of the phenomenon in the first time; $\hat{P}_{i2}$: relative frequency of the phenomenon in the second time; n_1: number of points in the (sample) dot grid of the phenomenon in the first-time, and n_2: number of points in the (sample) dot grid of the phenomenon in the second-time. If the calculated $\hat{t}$ is greater than that in Table 1, there is a significant difference between the ratios of the phenomenon in both periods, and the null hypothesis (H_0: $\hat{P}_{i1} = \hat{P}_{i2}$) is rejected [33].

1.7. The Region under Study

The region under study is Khorramabad, capital city of Lorestan Province in Iran, situated at 250,500 to 257,000 meters eastern longitude and 3,714,000 to 3,713,000 meters northern latitude in universal transverse Mercator (UTM). It is 2,526.3 hectares in area and 1,171 meters above sea level.Khorramabad is limited from north to Kiow hill being 1290 m ASL, from northeast to the slopes of Mt. Kamarsiah (or Makhmalkouh) being 1802 m ASL, from southeast to Mt. Shirkeshan being 1765 m ASL and Mt. Poshteh Hosseinabad being 1550 m ASL. It is also connected from west to the branches of Mt. Sefidkouh advancing to the suburban areas and surrounding the city (Fig. 2)

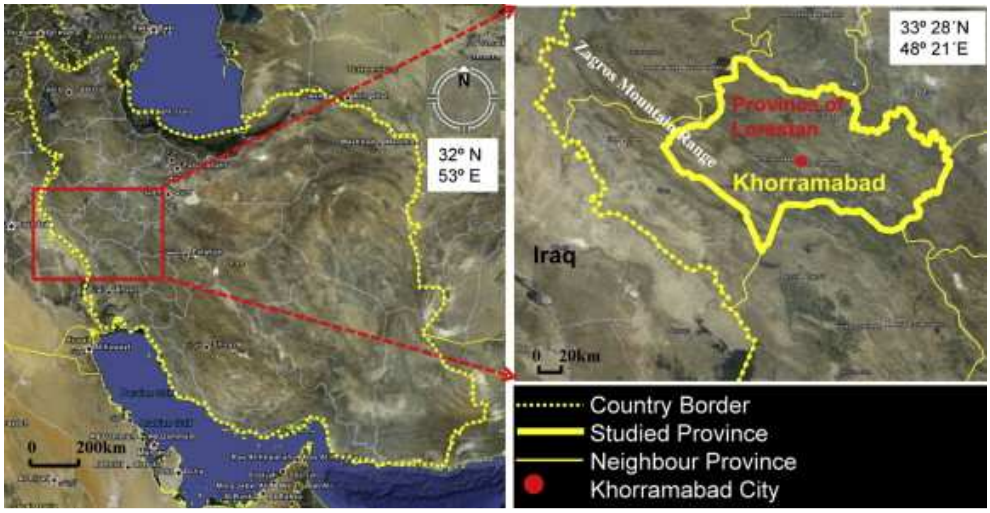


Fig. 2.Geographical position of the area under study

MATERIALS AND METHODS

The present study has used two aerial photos taken in 1956 and three aerial photos of 1974 on a scale of 1:10000, and fifteen aerial photos taken in 1994 on a scale of 1:8000, as well as a color image of the region captured by Quick Bird Satellite with a ground resolution power of 0.61 meter in corrected form (without displacement, geometric, and radiometric errors) and without different spectral bands (i.e., single band). A height digital model prepared by means of topographic maps with a scale of 1:25000, was used for geometric and displacement error correction. Also, the aerial photos provided by Iranian Surveying Organization on a scale of 1:25000 were used to visually evaluate geometric correctness. Regional population data, considering the censuses conducted in 1956, 1976, 1986, 1991, 1996 and 2006, was received from the Statistical Center of Iran.

3. Research Results

3.1. Khorramabad's Area in the Years under Study

Khorramabad area in 1956, 1974, 1994 and 2006 was estimated to be 193.77, 406.07, 1356.74 and 2526.3 hectares, respectively. Results show that city area has become 2.09 times larger in the 18-year period (1956-1974), 3.34 times larger within the 20-year period (1974-1994), and 1.86 times larger in the 12-year period (1994-2006).

3.2. Khorramabad's Spatial Development Process in the Years under Study

The spatial development process of Khorramabad during the years under study is presented in figure 3. It shows that the city develops in a north-southerly direction.

3.3. Khorramabad's Per Capita Green Space in the Years under Study

The results of estimating the green space percentage in Khorramabad by means of aerial photos and a satellite image are presented in Table 1.

Table1. Changes in Khorramabad's green space percentage in different periods

Year	$\%P_i$	SP_i	E	$\%E$
1956	10.42	±0.199	±0.39	3.7
1974	9.67	±0.14	±0.27	2.7
1994	15	±0.096	±0.19	1.2
2006	9.1	±0.057	±0.11	1.2

Results show that Khorramabad's green space percentage in 1956, 1974, 1994 and 2006 was 10.42±0.199, 9.67±0.14, 15.42 ± 0.096 and 9.1±0.057, respectively ($p<0.05$).

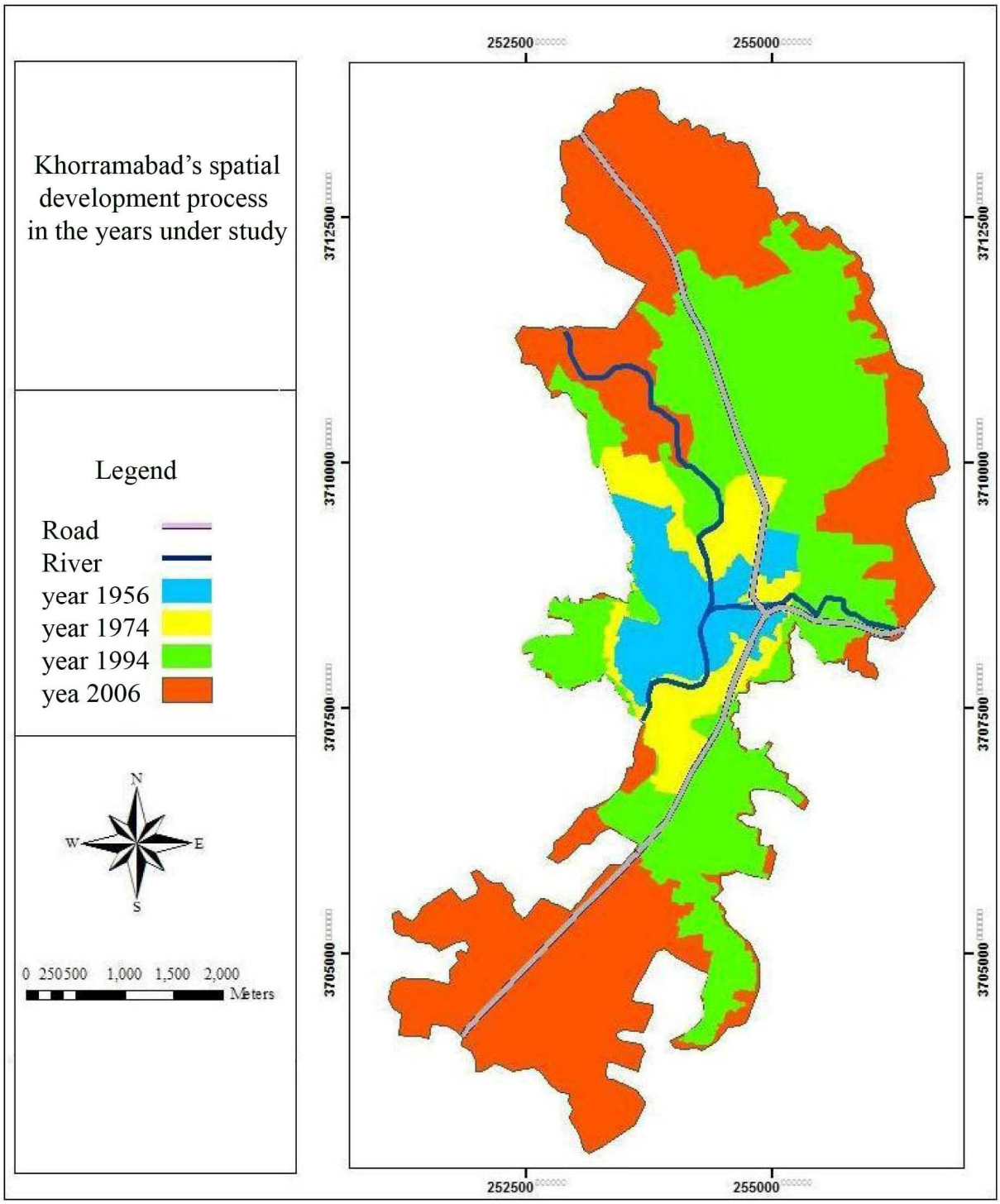


Fig. 3.Khorramabad's spatial development process in the years under study on a scale of 1:50000; source: calculations provided by the authors from processing the aerial photos and the Quick Bird Satellite image

3.4. Statistical Test Results

The results of *t*-test between green space ratios are presented in Table 2.

Table 2. Results of *t*-test between green space ratios in the years under study

Period	df $(n_1 + n_2 - 2)$	Calculated *t*	Table $t_{(0.01,\infty)}$	*P*
1956-1974	5948	0.89	1.96	ns
1956-1994	22376	6.33	1.96	* *
1956-2006	25015	1.86	1.96	ns
1974-1994	24286	9.98	1.96	* *

1974-2006	26925	0.76	1.96	ns
1994-2006	43353	5.96	1.96	* *

Results of *t*-test show that there is a significant difference between green space percentages in 1956-1994, 1974-1994 and 1994-2006 ($p< 0.01$), and the null hypothesis is rejected for these periods. However, there is not a significant difference between green space percentages in 1956-1974, 1956-2006, and 1956-2006 ($p< 0.01$), and the null hypothesis is correct for these periods.

3.5. Khorramabad's Population in the Years under Study

According to the censuses conducted in 1956, 1974, 1994 and 2006, Khorramabad's population was 38676, 93411, 263456 and 333945 people, respectively. Results show that its annual population growth rate has been 7.76% in the 18-year period (1956-1974), reached 9.1% during the 20-year period (1974-1994), and amounted to 1.75% within the 12-year period (1994-2006).

RESULTS AND DISCUSSION

4.1. Khorramabad's Development Process

Results indicate that the physical changes in Khorramabad have followed an increasing trend, having become relatively dramatic in recent years. The area of the city has increased from 193.77 hectares in 1956 to 406.07 hectares in 1972. In other words, an area of 11.79 hectares has been annually added to the city on the average. Over population is the important reason for the rise in its area. The annual population growth rate in Khorramabad reaches 7.86% within the 18-year period. This rate is more than that of population natural growth, showing that Khorramabad has faced immigration during the above-mentioned years. In 1964, the western army with a population of 20,000 troops was centralized in Khorramabad[25]. Comparison of mean annual population growth between Khorramabad city and Khorramabad town (4.92), Lorestan Province (4.18), and Iran (3.96) also confirms immigration into the city [5]. In the second period, the area of the city has increased from 406.07 hectares in 1974 to 1356.74 hectares in 1994. Therefore, an area of 47.53 hectares, on the average, has been added to the city. Overpopulation serves as a reason for the rise in the area of Khorramabad during this period. Its population natural growth is 3.8% in 1986, and 1.6% in 1996.Comparison of mean annual population growth between Khorramabad and Lorestan Province (3.51) and Iran (4.03) reveals that the city is faced with immigration (Statistical Center of Iran). Another main factor in the anatomical development of Khorramabad is the presence of suburban rural areas with flat lands suitable for urban construction. Due to its development, many rural areas in the suburb of Khorramabad have changed into rural towns and connected to the urban texture [4]. In the third period, the area of the city has increased from 1356.74 hectares in 1994 to 2526.3 hectares in 2006. In other words, an area of 97.46 hectares has been annually added to the city on the average. One of the reasons for the rise in its area is overpopulation. In this period, the population of Khorramabad has increased from 263,465 people in 1994 to 333,945 people in 2006. This figure shows an annual growth of 1.75% within the 12-year period, indicating that pervious uncontrolled high rates have been modified and reached population natural growth in recent years. In this period, mean annual growth rate is 0.88 for Lorestan Province and 1.67 for Iran [4]. Another reason for the development of Khorramabad is likely to be people's interest in villas. Moreover, people's interests, attitudes, and social segregation may increase the area of a city. Davoudpour and Ardalan[10] also state that socio-cultural factors may lead to the development of cities. Town development plans, along with cession of lands to people, have also influenced the development process in recent decades; therefore, many towns have been added to the city over this period. Generally, the spatial development of Khorramabad has increased 13.03 times over half a century. In other words, it has annually developed for 46.65 hectares on the average. The increase of urban area is well reflected in the studies by many researchers, including Jahdi[18], Fattahi[12], Borges *et al*. [8], Krundu*et al*. [19] as well as Slover. The development process in Khorramabad is influenced by its nature, so that it has selected most flat lands along the river for construction within 1956-1974. The more we advance towards the east and the west of the city, the less utility the lands have due to natural reliefs, rock lands, thinner soil, etc.In 1974-1994, Khorramabad reached its maximum development in eastern and western directions. Wherever a valley is slightly broader with milder side slops and inhabitable, the city has developed in that direction. Wherever the valley becomes narrower, the city also narrows down and develops towards the north and the south. Other than natural barriers, some parts of eastern and western directions are afforested in this period, inhibiting the development of the urban area. In 1994-2006, due to the special situation of the city's natural site and limitation of its anatomical development in eastern and western directions, it has mainly developed in northerly and southerly directions, mostly subject to Khorramabad-Ahvaz and Khorramabad-Kermanshah communication routes. Salman-Mahini[28] states that road systems are among the most significant factors influencing the development of cities. Generally, rocky heights and the hills around the city are considered as important barriers of its physical development. As observed in the photo taken in 2006, Khorramabad is limited to rocky heights and dune-bedded hills in eastern, southeastern, northeastern, northern, and western directions.

4.2. The Process of Green Space Changes

In the studies conducted on urban green space, single trees along city streets and roads were measured with dot grid. This is a fairly good quality of the biometric technique of the dot grid on remote sensing data, including aerial photos and satellite images. Results of comparing the green space area to the whole urban area show that 10.42 percent in 1956, 9.67 percent in 1974, 15 percent in 1994, and 9.1 percent in 2006 was covered with various urban green spaces. According to the standard set by Goel Cohen [9], green space percentages are evaluated as unsuitable in all four periods. Results of the statistical test indicate that there is a significant difference between the percentage of green space in 1956-1994 and 1974-1994, so that the green space area in 1994 is larger than both of the previous periods. It is due to the forestation formed as a green belt around Khorramabad during 1974-1994. Also, results of the studies by Hashemi*et al.*[14] and Jahdi[18] confirm a rise in artificial green spaces. Moreover, test results suggest that there is a significant difference between the percentages of green space in 1994-2006. However, green space area in 2006 is less than 1994, indicating that is has not developed parallel with the urban area. Studies by Fattahi[12], Borges *et al*. [8], Krundu*et al*. [19]all show results similar to those of the present research. Also, test results reveal that there is not a significant difference between the percentage of green space in 1956-1974, 1956-2006 and 1956-2006 and the null hypotheses is rejected. These results can be useful and applicable for the urban planners who usually have a poverty of information.

General Results

1.Khorramabad, like other Iranian cities, has a growing trend in its area. This research listed some of its main reasons as (a) overpopulation, (b) immigration into the city, (c) addition of rural areas to the city, and (d) cession of lands to people, and town development plans.**2.** The area of Khorramabad has spatially developed towards south and north directions, having faced with physical barriers like Mt. Sefidkouh and Mt. Poshteh Hosseinabad in western and eastern directions.**3.** Per capita urban green space in Khorramabad is much less than universal standards. **4.** Green space growth in Khorramabad has a slow pace proportional to the increasing and fast trend of its development.

It is suggested that remote sensing data and aerial photos be used to study the physical changes of urban green space. Moreover, it is advised that similar research be conducted on other Iranian cities. It is also recommended that dot grid method, having the ability of measuring single trees, be applied for estimating the green space area.

REFERENCES

[1] Aghaei-Meibodi, A. **2004.**Unpublished M.Scdissertation, Faculty of Engineering, Tehran University, 104 p.
[2]Alavipanah, S.K. **2003.**Remote sensing application in earth sciences (soil sciences).Tehran: Tehran University press.
[3] Andarz, Z. *et al.***2009.***Ecology Quarterly* 35, No. 50, pp. 55-62.
[4] Anonymous, **2006.**Statistical Center of Iran.
[5] Anonymous, 1991. *Journal of Socio-cultural studies on Lorestan*, 3, 1, 115 p.
[6] Ardakani, M.R. **2009.**Ecology. Tehran: Tehran University Press.
[7] Barton, H. **2003.**Shaping neighborhoods: A guide for health, sustainability andvitality, Spon Press, London and New York.
[8] Borges, M.H., et al. **1993.**Scantia Agricola, 50:3, 365-371.
[9]Cohen, G., **1992.**Evaluation of Tehran's green space management and recognition of presented at the Green Space Seminar in Iran."
[10] Davoudpour Z. & D. Ardalan, **2008.***Journal of Urban Identity*, No. 3.
[11] Dykes, L. **2005.***Remote Sensing of Environment*, 68, 206 – 216.
[12] Fattahi, M. M., **2009.***Iranian Pasture and Desert Quarterly*,Vol. 16, No. 2, pp. 234-253.
[13] Grahn, P.*et al*. **2003.***UrbanForestry and Urban Greening*, Vol. 2 (2003), pp 1- 18.
[14] Hashemi, S.F. *et al.***2009.***Journal of Environmental Science*, 6, No. 3, pp. 73-86.
[15] Hibberd, B. G. 2005. *Journal of Agriculture and Forestry*, Vol. 12.
[16] Hosseinzadeh- Dalir, K. **2009.***Journal of Urban and Regional Studies*, 1st year, No. 2, pp. 1-18.
[17] Houshyarkhah, B. & S. A. Hosseini, **2006.**Access roads and urban roads in urban forestry using GIS and RS (case study: Sari, Iran).
[18] Jahdi, R. **2008.**Unpublished M.Sc dissertation, Dept. of Natural Resources and Forest Economics, Faculty of Natural Resources, Tehran University.
[19] Krundu,D.M. **2000.**Edgerton University.P.O.BOX 536, Njoro, Kyna.
[20] Majnounian, H. **1995.**Tehran's Parks and Green Space Organization. Tehran: Tehran University Press.
[21] Mazini, M., **2006.** Essay on Urban Development. Tehran University Press.
[22] Panahi, P. **2001.**Unpublished M.Sc dissertation, Dept. of Natural Resources and Forest Economics, Faculty of Natural Resources, Tehran University.

[23] PCI Geomatica 9.1 User's Guide, **2002.** Ontario, Canada.
[24] Rabiei, H.R. *et al*. **2005.***Humanities Instructor Quarterly*, 9, No. 4.
[25]Rashidian, H. **2002.**Khorramabad on the Stage of Human Geography.Aflak Publishing House.
[26] Sadeghi, I. **2005.**Unpublished M.Sc dissertation, Islamic Azad University, Science and Research Campus, 89 p.
[27] Salehi, A. *et al*.**2008.***Land Degradation and Development*, 19: 542 553.
[28] Salman-Mahini, A. & M. Gholamalifard, **2005.***Environment Quarterly.*
[29] Scohottker, B. *et al*. **2003.** Proceeding of the SPIE, International Symposium on Remote Sensing, 8-12 September 2003 , Barcelona , Spain.
[30] Safari Shad, M., DashtiMarvili, M, AllahbakhshianFarsani, P. **2013.***International journal of Advanced Biological and Biomedical Research.* 1, 5: 477-481.
[31] Teimouri, S. **2008.***Iranian Spruce Fir Forest Scientific-Research Quarterly* Vol. 6, No. 2, pp. 292-303.
[32] Zangiabadi, A. **2005.***Green Message Quarterly* [in Persian], No. 49, pp. 10-13.
[33] Zobeiri, M. **2002.**Forest biometrics. Tehran: Tehran University Press, 1st ed., pp. 350-351.
[34] Zobeiri, M. **2005***.* Tehran University Press, 2nd ed., pp. 204-208.