International Journal of Engineering Research and Advanced Technology (IJERAT)

E-ISSN : 2454-6135

DOI: http://dx.doi.org/10.7324/IJERAT.2018.3211

Volume.4, Issue 3

March-2018

Evaluation of Trend of Land utilization and Population Growth Using Remote Sensing Data: Case Study of Yazd City, Iran

Sara Abdollahi[1], Akram Karimi[2], Hamid Reza Kabiri-Balajadeh[3], Kaveh Ostad-Ali-Askari[4*] Vijay P. Singh[5] and Saeid Eslamian[6]

[1]MSc of Environmental Science, Environmental Science Department, Yazd University, Yazd, Iran

[2]Graduate Degree in Environmental Education, Evaluation and Tendency, Karaj Environmental Faculty, Karaj, Iran.

[3]MSc of Environmental Science, Environmental Science Department, Science and Research Branch, Islamic Azad University, Tehran, Iran

[4*]Department of Civil Engineering, Isfahan (Khorasgan) Branch, Islamic Azad University, Isfahan, Iran

[5]Department of Biological and Agricultural Engineering & Zachry Department of Civil Engineering, Texas A and M University, 321 Scoates Hall, 2117 TAMU, College Station, Texas 77843-2117, U.S.A.

[6]Water Engineering Department, Isfahan University of Technology, Isfahan, Iran

ABSTRACT

Detection of changes is one of the fundamental requirements in the management and evaluation of urban areas. Various methods have been proposed to detect changes and land cover developments. The purpose of this study was to study land use changes in the Yazd area using Landsat 5 satellite imagery, TM, MSS and ETM+ images for the period of 1987-2012. For this purpose, the images were first corrected geometrically using appropriate algorithms. After determining the educational samples, two images of the vegetation of the study area were prepared using the supervised classification method. In the next step, the mapping of the changes was made by comparing the overlapping maps using the comparative method. The results indicate that land cover has changed during this time period. The main reason for these changes is population growth, changing social, economic and industrial conditions in Yazd.

Keywords: *Land use change, Satellite images, Population growth, Land cover.*

1. INTRODUCTION

Remote sensing is a key technology for assessing the extent and the amount of land cover change [8]. Land cover and its changes are important variables that have significant effects on the environment and its processes [3]. Population growth and the development of human activities have affected the earth's surface significantly in recent decades. Nowadays, due to the growing population and the tendency to urban life, the largest changes in land cover occur in urban areas [12]. Precise and timely information on the coverage and land use is required by decision makers and researchers at all levels. Currently, satellite data is highly capable of providing user maps and land cover, especially in vast geographical areas [20]. In addition to the importance of

*correspondence author: kaveh .oaa2000@gmail.com

having up-to-date information on land cover, knowledge of changes and changes during a period of time is of utmost importance for planners and managers [17]. In this regard, it is vital to use the methods of detecting changes to determine the trend of changes over time. The accurate and timely detection of the changes in the image and the heights of the earth's surface provides a basis for a better understanding of human relationships, interactions and natural phenomena for the management and better use of resources and generally speaking, it is one of the basic requirements for the management and assessment of natural resources [13 and 14].The methods for detecting their changes are divided into two categories: the first is the methods that do not provide information about the nature of the changes, and finally a picture is obtained that is in binary form and can only recognize variations from non-variations and has nothing to do with nature of variations. The separation of images is one of these methods. Other methods are those that, in addition to the magnitude of the changes, show the nature of the changes. The comparison method after classification is the most prevalent among these methods [7]. Ghorbani et al [5] investigated demographic changes and their impact on changing land use in the upper Taleghan region. In this research, GIS data, remote sensing systems and statistical methods together with Landsat satellite TM and ETM sensors were used to determine land use changes in the years 1987 and 2002. Demographic data were also compiled in these two years and the population growth rate was calculated. According to the results, the abandoned land area rate in the study region has been positive and in fact increased and other uses have a negative change rate. However, the population growth rate is negative in all villages and the population has declined. In 2012, a survey of changes in land cover in the city of Isfahan was carried out using AWiFS and MSS images in the period of 1987-2009 [11]. In this regard, the images were first corrected geometrically using appropriate algorithms. Then, by determining the educational samples, two images were classified into five classes of water, residential areas, bay lands, vegetation cover and roads using neural network multi-layered perceptron network. In the next step, the classification of map of changes was obtained by ranking the classified maps using the comparison method. The results show that during this time period, 76/14516 hectares of land cover have been changed. The main reason for these changes is the result of an inclination of approximately 62 percent of the population and the changing social, economic and industrial conditions in Isfahan. Sanjari et al. [15] investigated the land use / land use changes consistency in the last three decades using remote sensing techniques in the Zarand area of Kerman province. In this research, MMS images of 1977, ETM + 1987 and TM of 2001 and 2006 were used. The land use / land cover mapping was prepared using monitored classification method and finally, five types of users were identified in the area. The results indicate the change of land in the form of conversion of open land and uncultivated land to garden lands and residential and industrial areas. Latfowitz et al. [9], using Landsat imagery, investigate land use change as a result of mining development in part of Canada, claiming that knowing the reasons for the change in the coverage mode made it possible to distinguish between natural and human-induced coexistence and it should be noted that such research requires corrections such as atmospheric corrections, surface anisotropy correction, and the problem of covering pollutants in remote sensing and cloud.

Landsat TM images from 1985, 1993 and 2005, as well as topographic and agricultural maps with a scale of 1: 25000, were used in this research. Considering the rapid growth of the city and changes in land cover types, the need to study the changes in land cover and proper planning to preserve existing resources is receiving more significance. The results indicated that the method of analysis of the vector provides the best efficiency for analyzing land use change.

2. MATERIALS AND METHODS

2.1 The study region:

The study region in this research is Yazd, which is located between geographical distances of 52 degrees'longitude and 55 minutes to 56 degrees' longitude and 37 minutes east and 29 degrees' latitude and 52 minutes to 33 degrees' latitude and 27 minutes north and its area is about 2397 square kilometers [Figure 1]

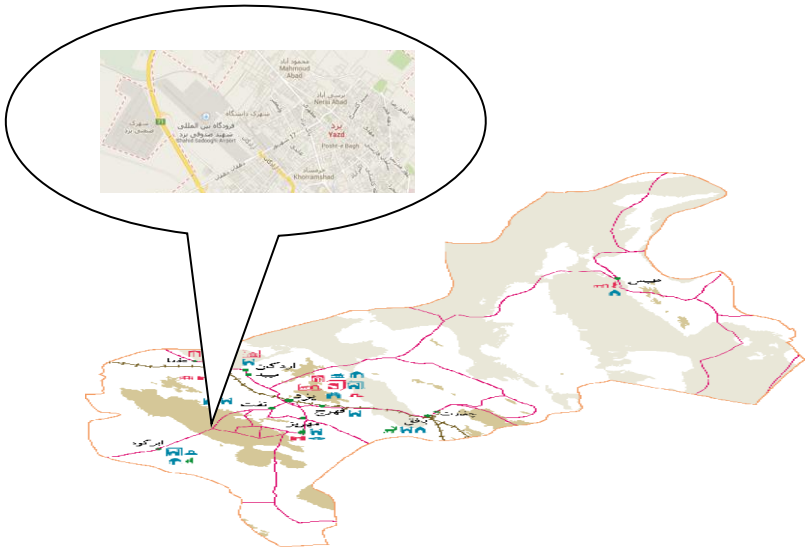

Figure 1. View of Yazd province and location of the studied region

2.2 Used data:

In this research, MMS images of the year 1977 and ETM belong to the year 1987 and TM sensor of years 2001 and 2006 were used. A managed classification method was used to prepare the land use / coverage map.

Satellite imagery is a reference ground, and geometric correction is performed on them and they are free of any radiometric errors and cloud cover. The overlaying of the city maps and satellite imagery of the earth provided accurate data accuracy and geometric correction was ensured [Fig. 3].

2.3 Research method:

Images were created with the ERDAS v (2014) software, a multi-band image. Then, the study area was separated from the entire image [Fig. 2]. For image processing and monitoring of changes, a combination of 1 to 7 Landsat 5 TM sensor bands was used. For classification of images according to the number of uses, 20 educational samples were selected in 3 classifications with vegetation, without vegetation and residential areas. The location of the educational samples was determined randomly on the image obtained from the combination of TM bands and finally these educational points, along with the multiband combination image, were entered into the ERDAS environment software and the images were processed using a structured classification method. The NDVI index was used to investigate vegetation change during the mentioned time period.

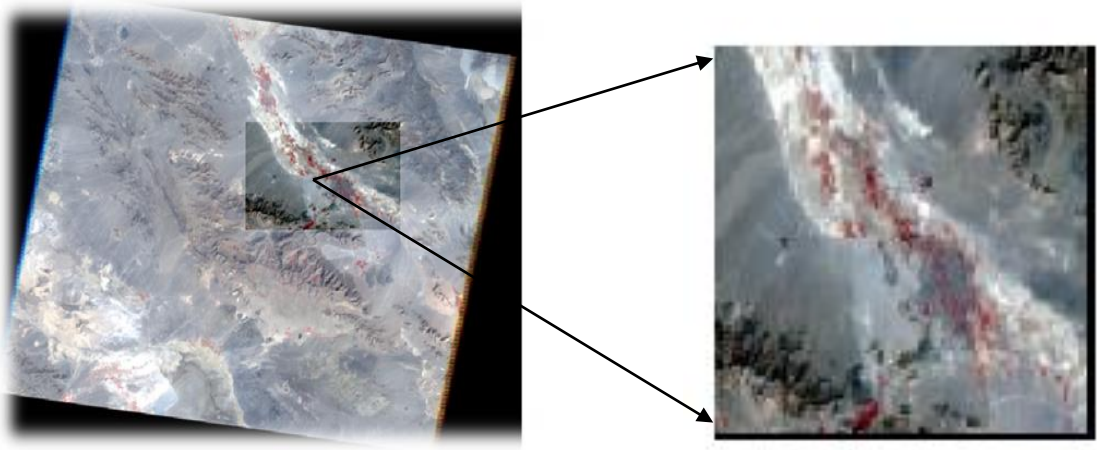

Figure 2. Determining the area under study on the satellite image

DOI : 10.7324/IJERAT.2018.3211

2.4 Preparation and pre-processing satellite imagery:

The pre-processing stage of satellite images involves various steps including identifying and fixing errors, mosaicking operations, subset operations, and geometric correction. One of the steps that takes place before processing satellite data is geometric correction done using a roadmap of Yazd city on geometric correction area. The RMSE obtained from the geometric correction of the images was estimated to be 0.78, the resulting digit was less than one, which indicates the high accuracy of the geometric correction operations [Fig. 3].

Figure 3. Geometric Correction Operations Using Yazd Province Road Map

2.5 Classification and processing of satellite imagery:

The classification of images was carried out in two supervised and non-supervised methods. In this research, the supervised method was used to categorize the images [Fig. 4]. In this method, a number of pixels are selected as reagents and samples. Error matrix and ground control points were also used to check the accuracy of classification.

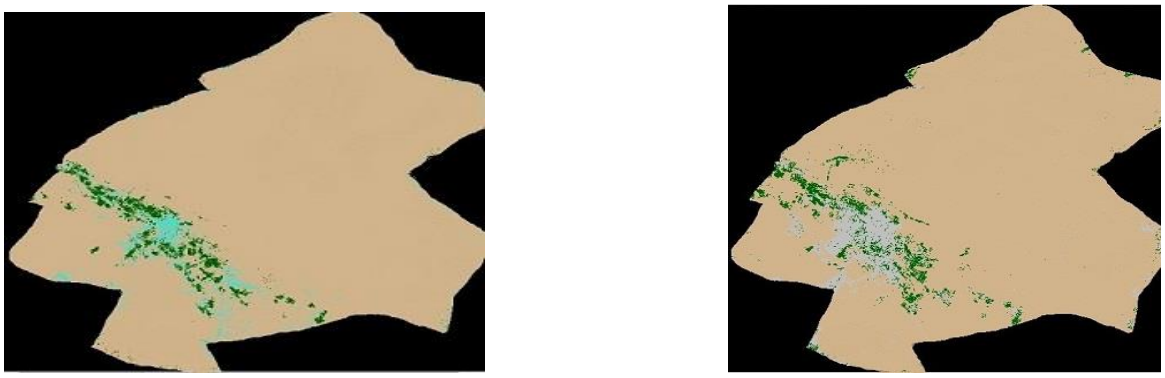

Figure 4. Classification map of use/ Land cover of Yazd city. a)1987 b) 2012

2.6 Evaluating the accuracy of classified maps:

The classification accuracy of the maps was calculated by Kappa coefficient. In calculating the Kappa coefficient, the pixels that are not correctly classified are also interfered, thus, it is a suitable criterion for comparing the results of different classifications [6]. In this study, the kappa coefficient was <1.

$$\text{Kappa coefficient} = \frac{N\sum_{i=1}^{r} X_{ii-} \sum_{i=1}^{r}(X_{i+} \times X_{+i})}{N^2 \sum_{i=1}^{r}(X_{i+} \times X_{+i})}$$

Where r is the number of rows in the matrix, Xii, the number of observations in row i and the columns i, xi + and x + i represent the sum of the rows i and the sum of the column iof the error matrix, respectively, and N is the number of elements of the error matrix.

2.7 Detection of changes:

Detecting changes is the process of identifying differences in the status of an object or phenomenon by observing it at different times. The accurate and timely detection of surface changes and the ground low and high parts provides a basis for a better understanding of human relationships, interactions and natural phenomena for better resource management and, in general, it is one of the essential requirements in the management and assessment of natural resources [10, 13, and 14]. Comparison after classification is the most commonly used method for detecting changes that was used in this study.

3. RESULTS AND DISCUSSION:

The results of the interpretation of aerial photos, pre-processing, processing of satellite images and the detection of changes in the study area are as follows:

3. 1. Selected

The most important step in the process of detecting changes is selecting the appropriate data for the desired time interval. Selection of data from different aspects such as image taking time, quality, scale and similar conditions is of utmost significance [2]. In order to maximize the possible time interval for detecting changes, MMS images of the year 1944 and the ETM sensor related to 1987 and TM sensor of the years 2001 and 2006 were used in this study. The high quality of satellite images and the lack of cloud cover in the data used to prepare the land cover map is important [18]. In this study, the images were of good quality for processing. Also, data production time is one of the main elements that influences the process of detecting changes and is important in image processing to detect changes [2].

3.2. Geometric Correction

One of the steps that occurs before processing satellite data is geometric correction. The RMSE obtained from the geometric correction of satellite images was 0.78. The resulting digit was less than one, indicating high accuracy of operations of geometric correction. Kupin et al., in their review article, stated that an error of less than one pixel for geometric correction of satellite images in the process of detecting changes is acceptable [2].

3.3. Providing land cover maps

The map of land cover produced from aerial photographs in three classifications of residential areas, vegetation areas, and non-vegetation areas was provided. In order to separate the green cover from other lands, NDVI plant index was used in all three images.

3.4. Evaluation of the accuracy of production maps

Since the accuracy of the detection of the changes is dependent on the accuracy of the production maps of different years, it is therefore necessary to estimate the accuracy of the production maps. In this study, in order to obtain ground control points for estimating the accuracy of the land cover map of the years 1987 and 2012, MMS sensor images of the year 1977 and ETM sensors related to the year 1987 and TM sensor of the years 2001 and 2006 were used in respectively. The kappa coefficient was calculated for all provided maps.

3.5. Comparison of produced maps of different years

The method of comparison after classification was used to detect changes. This method is one of the most commonly used methods for detecting changes. The comparison method after classifying, the nature of the changes from one classification to another, unlike other methods, is easily identifiable [2].

4. CONCLUSION

The expansion of the city and the development of urbanization are considered as one of the problems of human civilization. The destruction of agricultural lands, gardens, pastures and its transformation into residential areas and transportation routes in cities of Iran is very tangible. Choosing the right method to identify changes depends on the purpose of the study, the characteristics of the region and the available and existing data and also influences the results obtained [10]. In this study, the comparison method after classification was used to examine the changes in order to determine the nature of the changes along with the magnitude of the changes. The advantages of this method are to provide the ability to use different sensor images, minimize atmospheric effects, differences in sensors and environmental differences between multi-image images, and the ability to provide spatial and descriptive information for time variations. But since in this method, the pixels are compared to the pixels, the resulting geometric correction is of particular importance [1,4]. The comparison method after classification is one of the few methods for detecting

DOI : 10.7324/IJERAT.2018.3211

changes that is well illustrated for changes occurring among land cover classes [20]. The degree of success of this method depends on the accuracy and accuracy of provided maps [16 and 19].

4.1 Investigation land cover and population changes:

Due to the fact that population growth is an effective factor in the expansion of cities, population changes were also studied in this study. The population of Yazd in 1987 was about 326230, while in 2012 it reached 582682. Various factors can be attributed to increasing the population of Yazd, the most important of which is the rapid and extensive industrial growth. The presence of large industrial units such as tile industries and many other industrial units has made this city an important industrial hub in the country and has led to the migration of a large number of people from other cities and villages of the province and from other provinces to this city. Creating academic units can also be effective in increasing the population, although the contribution of these factors is not significant in comparison with the effects of industrial growth and the creation of multiple job opportunities.

The study of population and area data indicates the correlation and coordination of urban development process with increasing population, thus, with increasing population, the area of the city has also increased, indicating that population growth is one of the important factors controlling the urban expansion and urban development. Except for population factors, such as socio-economic conditions, government investments in employment, goals and areas of industrialization, tourist activities and distance to important places such as railway tracks in the expansion of cities are influential and can be taken into consideration. There are certainly many factors that are considered as barriers to urban development. Among these factors the presence of mountains and hills around the city can be mentioned. Comparison of the images demonstrates that the process of reducing vegetation due to the conversion of gardens and agricultural lands to residential areas, population growth and changes in social, economic and industrial conditions are among the visible changes in the studied area [Figure 4].

REFERENCES

1. Coppin, P., Jonckheere, I., Nackaerts, K. and Muys, B., 2004, Digital change detection methods in ecosystem monitoring: a review, International Journal of Remote Sensing,Vol. 25, pp. 1565-1596.
2. Coppin, P. and M. Bauer. 1996. Digital Change Detection in Forest Ecosystems with Remote Sensing Imagery. Remote Sens. Rev. 13: 207-234.
3. Foody, G. M., 2000, Mapping Land Cover from Remote Sensed Data with a Softened Feedforward Neural Network Classification, Journal of Intelligent and Robatic Systems, Vol. 29, No. 4, pp. 433-44.
4. Freitas, S.R., Mello, M.C.S. and Cruz, C.B., 2005, Relationship between forest structureand vegetation indices in Atlantic Rainforest, Forest ecology and management, Vol. 218, pp. 353-362.
5. Ghorbani, Mehdi, Mehrabi, Ali-Akbar, Servati, Mohammad Reza, NazariŞsamani, Ali Akbar. 2011. Study of population changes and its impacts on land use changes (case study: Aliat-e-Alaghan area), Journal of Rangeland and Watershed Management (Natural Resources of Iran), Volume 63, Issue 1, Pages 75-88

6. Islam Bonyad, Amir and Haji Ghaderi, Ta'ah. 2008. Providing Map of Natural Forests of Zanjan Province Using Landsat 7 ETM + Satellite Data. Journal of Agricultural Science and Technology, Vol. 42 (11), pp. 627-638.

7. Jensen,J., 1996, Introductory digital image processing: a remote sensing perspective, 2nd edn, Prentice-Hall, New Jersey.

8. Lambin, E.F. and H. J. Geist. 2006. Land Use and Land Cover Change Local Processes and Global Impacts. Heidelberg, New York.

9. Latifovic R, Fytas K, Chen J and Paraszczak J. 2005. Assessing land cover change resulting from large surface mining development. International Journal of Applied Earth Observation and Geoinformation,7(1):29-48

10. Lu, D., Mausel, P., Brondizio, E. and Moran, E., 2004, Change detection techniques, International Journal of Remote Sensing, Vol. 25, No. 12, pp. 2365-2401
11. Mapping Organization of the country, 2012, Investigation of the process of changes in land cover and population growth in the city of Isfahan using remote sensing data for the years 1366- 1366, Geomatics conference 90, Tehran
12. Opeyemi, Z. A., 2006, Change detection in land use and land cover using remote sensing data and GIS, Master thesis, Department of Geography, University of Ibadan.

13. Rabiei, Hamid Reza, Ziaian, Parviz and Ali Mohammadi, Abbas. 2006, Recovery of land use change and land cover in Isfahan using Remote Sensing and Geographic Information System, Journal of Mechanical Science, Vol. 9, No. 4, pp. 19-32.

14. Ridd, M. K. and Liu, J., 1998, A comparison of four algorithms for change detection in an urban environment, Remote Sensing of Environment, Vol. 63, No. 2, pp. 95-100.

15. Sanjari, Saleh and Boroumand, Nasser, 2013. Monitoring of land use change / land cover in the past three decades using remote sensing technique (Zarand area of Kerman province), Journal of Remote Sensing and GIS in Natural Resources Science, Year 4, No 1, Spring 2013.

16. Singh, A., 1989, Digital change detection techniqes using remotely sensed data, International journal of remote sensing, Vol. 10, pp. 989-1003.

17. Tachizuka, S., Hung, T., Ochi, S. and Yasuoka, Y., 2002, Monitoring of Long-term Urban Expansion by the use of Remote Sensing Image from Different Sensor, Asian conference on Remote sensing, Nepal.

18. Tommervik, H., K.A. Hogda and H. Solhemi. 2003. Monitoring vegetation changes in Pasivik (Norway) and Pachenga in Kola peninsula (Russia) using multitemporal Landsat MSS/TM data. Remote Sens. Environ.

19. www.sc.chula.ac.th/courseware.21/4/1387

20. Yuan, F., Sawaya, K. E., Leoffelholz, B. C. and Bauer, M. E., 2005, Land cover classification and change analysis of the Twin cities (Minnesota) metropolitan area by multitemporallandsat remote sensing, Remote sensing of environment, Vol. 98, No. 2-3, pp. 317-328.

DOI : 10.7324/IJERAT.2018.3211