Monitoring urban growth and land use change detection with GIS and remote sensing techniques in Al-Nasiriyah city in Iraq

Hadeal H. Alzamili[1, 2], Mahmoud El-Mewafi [3], Ashraf M. Beshr[4]
[1] Mrs. Hadeal H. Alzamili Department of Building and Construction Engineering, University of Technology, Baghdad, Iraq
[2] Mrs. Hadeal H. Alzamili Research Scholar Department of Public Works, Faculty of Engineering, Mansoura University, Egypt
[3] Dr. Mahmoud El-Mewafi Professor Department of Public Works, Faculty of Engineering, Mansoura University, Egypt
[4] Dr. Ashraf M. Beshr Professor Department of Public Works, Faculty of Engineering, Mansoura University, Egypt

Abstract— This study aims to map the urban area in and around Al-Nasiriyah city between the year 1989 and 2,014 and predict its probable future growth using remote sensing (ERDAS 2013 software) and GIS techniques (ArcGIS10.1 software) form ESRI. Landsat TM and ETM+ satellite images of 1989, 2000 and 2014 from USGS were used for monitoring urban land use class to predict the urban in the future. Urban class was extracted / mapped using supervised classification technique. The accuracy assessment was carried out for classified maps. By using Regression Analysis we calculate the urban area in 2035 depending on the population increasing and estimate the relation formula between them. Transition probability matrix and area change were obtained using different classified images. The old marshland site detected at 1989 and then was changed to other land use classes. This study provides an insight into understanding of urban growth and aids in subsequent infrastructure planning, management and decision-making.

Index Terms— Monitoring, Geographic Information System GIS, Remote sensing, Iraq

1 INTRODUCTION

Urban growth is a worldwide phenomenon, but the scale of urbanization is very fast in a country like Iraq. It is essentially driven by unorganized expansion, the impact of immigration, and population increasing. In this meaning, land use and land cover change are represented one of the fundamental elements in current procedures for surviving natural resources and monitoring environmental changes .In Iraq, urban growth has produced dangerous losses of agricultural land and water bodies. In Al-Nasiriyah city marshlands drain represents a good example for change detection. Urban growth is responsible for a variety of urban environmental issues like decreased air quality, increased runoff and subsequent flooding, changing temperature, deterioration of water quality, etc. Iraq owned a number of fast-expanding cities. Al-Nasiriyah city in THIQAR governorate is expanding rapidly with differing growth times and patterns. In this meaning, geospatial technologies and remote sensing methodology afford fundamental tools which can be employed in the analysis of land use change detection. In this section we attempt to assess the land use change detection by using GIS and remote sensing in al-Nasiriyah city from 1989 to 2014. The results will be using to estimate Future prediction by using the Markov chain analysis. Information on urban growth, land use and land cover change analysis is very helpful to the local government and town planners for the betterment of future plans of sustainable development of the city. Land use and land cover change, as one of the main making forces of global environmental change is fundamental to the sustainable improvement debate. Land use/land cover change has been studied from different aspects in order to recognize the drivers of land use/land cover change, their process and consequences. Urban growth, especially the change of residential and commercial land to farm areas at the outside of municipal areas have long been recognized a sign of local economic vitality. The fast changes of land use and cover than ever before, especially in developing nations (such as Iraq), are often characterized by violent urban sprawling, land degeneration, or the conversion of the agricultural land to other class such as urban or barren lands (Sankhala and Singh, 2014).This class of changes very affects the local geographical environment, which would eventually affect the global environment. Human-induced changes in land cover, for instance, affect the global carbon round and add to the increase in atmospheric CO (Alves and Skole, 1996). It is, therefore, necessary to monitor the changes in land use/cover, so that its impact on physical ecosystem can be discerned, and sustainable land use planning can be expressed (Muttitanon and Tripathi, 2005).With the progress of technology, compression in data cost, availability of historic spatiotemporal data and high-resolution satellite images such as USGS website, Remote Sensing (RS) and Geographic Information System (GIS) techniques are now very helpful for conducting researches like land cover change detection analysis and predicting the future scenario (Lambin, E.F,2001).Many researchers have conducted a number of researches to discover the land use/land cover change over time and predict the future growth of urban areas. The future prediction will be used in future plan. They have introduced and applied different techniques to achieve the research objectives. (Griffiths et al. 2010) are among them, have approached to map of the urban growth of Dhaka region (1990 to 2006) using multi sensor data. They have used the post-classification comparison to reveal Spatial-temporal patterns of urban land use and land cover changes. The RS data has become a major source for change detection studies because of its high temporal frequency, a digital format suitable for computation, synoptic view, and large-scale selection of spatial and spectral resolutions (Chen et al., 2012; Coops et al., 2006). The general objectives of change detection in RS include classifying the geographical location and type of changes, quantifying the changes, and evaluating the accuracy of change detection results (Coppin et al., 2004; Im and Jensen, 2005).A challenge for future urban change detection is how to

use images from different sensors, using images from different sensors can enhance the result of the change detection or sometimes images from the same sensor are not available (Griffiths et al. 2010).Urban land cover/use mapping has received an accumulating amount of study from urban planners and experts including geographers. A numbers of important studies were made for environmental quality supervision. Thus, many techniques have been used for mapping urban land use/land cover. The aims of the this study are to present a land use/land cover map for one of the important cities in Iraq and ThiQar governorate that because a fast increase of urban population in the recent decades at different years in order to detect changes that have taken place particularly in the urban land and subsequently to analyze the urban sprawl of the different time periods and to predict the urban area growth.

2 STUDY AREA

Al-Nasiriyah is a city in Iraq located to the east of ThiQar governorate. It is on the Euphrates River. About 225 miles (370 km) southeast of Baghdad, near the ruins of the ancient city of Ur. According to the 1987 census, the city had a population of 265,937. The population in 2014 was 560,968. (Figure 1)

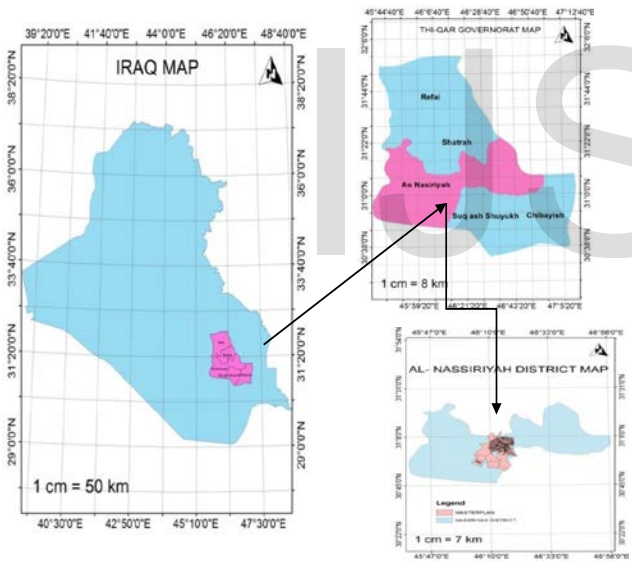


Fig. 1: study area Iraq map, ThiQar map, and Al-Nasiriyah map

1. Data resources and methodology

The present study involves the collection of topographic sheets from ThiQar governorate and city map from relevant authorities. The required satellite imagery for the study area is to be downloaded from the USGS Earth Explorer. Composite bands, removed blanks (black background) and clipping desired part from downloaded image done in ArcGIS 10.1 from ESRI. Processing the imagery and image interpretation for the development of land use/land cover maps is done in ERDAS Imagine software. The obtained maps are studied and analyzed to identify the change in urban. Future prediction is done based on past data (figure 2).

Fig. 2: methodology stages and data used

3.1. Image preprocessing

Digital image processing was handled by the software used. The scenes were chosen to be geometrically adjusted, calibrated, and removed from their dropouts. These data were layered into 'zones', where land cover types within a zone have related spectral attributes. Other image improvement procedures similar histogram equalization is also done on each image for improving the quality of the image. By depending on ThiQar topographic maps and Al-Nasiriyah city plan map obtained from ThiQar governorate headquarters the study area has been delineated. The data of ground truth were accommodating for each single classifier generated by its spectral signatures for producing set of classification maps.

3.2. Images classification

There are two types of classifications, unsupervised and supervised classification methods. We apply classification methods on the pre-processed images. In unsupervised classification method, the ERDAS Imagine depend on the ISO DATA clustering algorithm which will classify according to the number of classes required and the digital number of the pixels available. The maximum likely hood algorithm use in the supervised classification technique, which will classify the image based on the signatures sets provided by the user based on his field knowledge and image resolution. The signatures are given by the user leads the software as to what classes of pixels are to be selected for the specific land cover type. The result of the classification finally gives the land use/land cover image of the area. Four land cover class's namely agricultural land, urban area, barren lands, and water bodies are identified in the study area.

3.3. Land use / land cover

Clearly the human activities affecting on changed land cover in Al-Nasiriyah city during the past three decades. Before 1989, the marshlands in Al-Nasiriyah were the proper environment for farming and animal productions but political sides affected on marshlands by starting the government projects for draining the waters of marshlands. Land is one of the most important natural's resources. All agricultural, animal productions depend on the productivity of the land. The understanding of the impact of human's activities on his natural resource base over time. In situations of fast and often out of laws and may be unrecorded land use change, observations of the surface from space give good information of human activities and utilization of the landscape. The classified images present all the information to explain the land use and land cover of the study area

3.4. Change detection analysis

Change detection analysis explains and quantifies variations between images of the same scene at different times. By make a comparison between results the classified images of the three dates can be used to calculate the area of different land covers and recognize the changes. This analysis is very much significant to distinguish various changes occurring in different classes of land use like an extension in urban built-up area o, decrease in

agricultural land or draining marshlands and so on. To estimate the needed land for urban after twenty or more years we depend on the results of classification and calculate the growth rate.

4. Results and discussion

4.1. Land use/land cover images

Figure 3, figure 4 and figure 5 shows The classified images obtained after preprocessing and after apply the supervised classification and shown the land use and land cover of the study area. These images provide the information about the land use in the pattern of the study area. The classification was done on the images of 1989, 2000 and 2014.The red color represents the urban area in each year and built-up area, green color shows the agricultural area, blue color shows the water bodies in rivers and marshlands and light brown color shows the barren lands land.

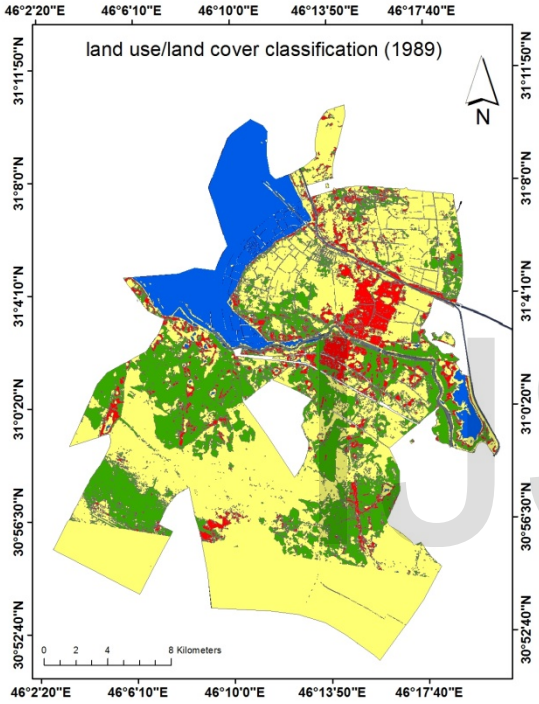


Fig. : 3 land use/land cover classification at 1989

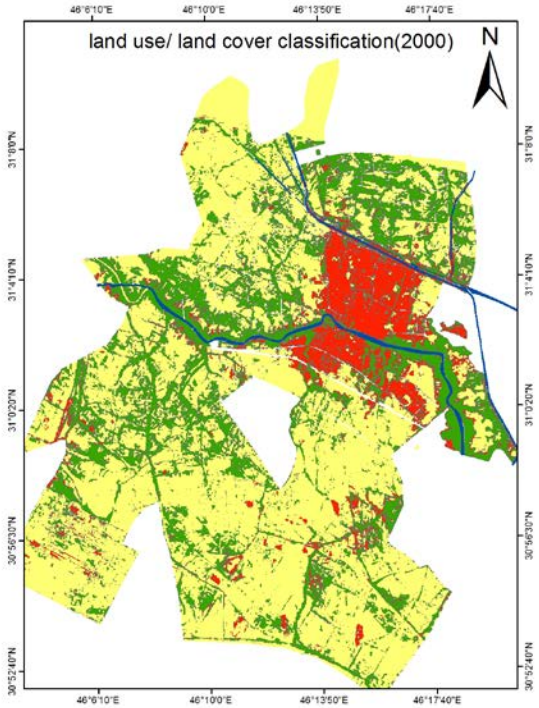


Fig. 4: land use/land cover classification at 2000

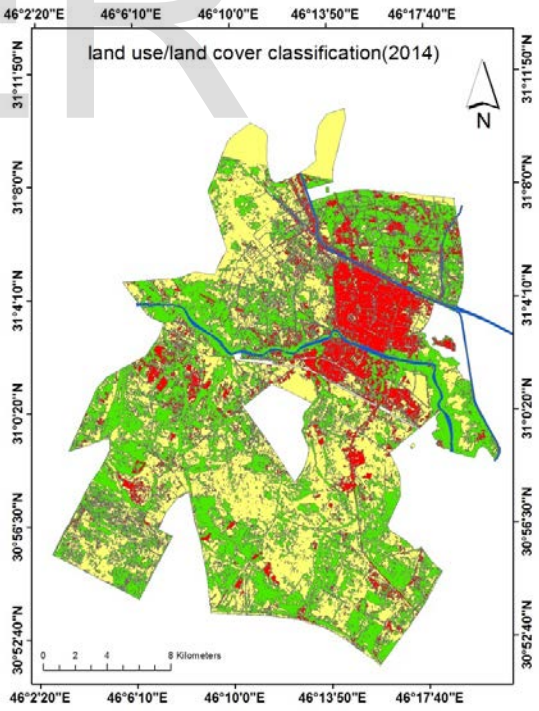


Fig.5: land use/land cover classification at 2014.

Map unit	Area 1989	Area 2000	Area 2014

	Km2	%	Km2	%	Km2	%
Agriculture	117	23.2	171.5	34.02	195.2	38.73
Urban	40	7.93	53	10.51	101	20.0
Barren lands	284	56.3	273	54.8	199	39.4
Water	63	12.5	6.5	1.29	8.8	1.74
Total	504	100	504	100	504	100

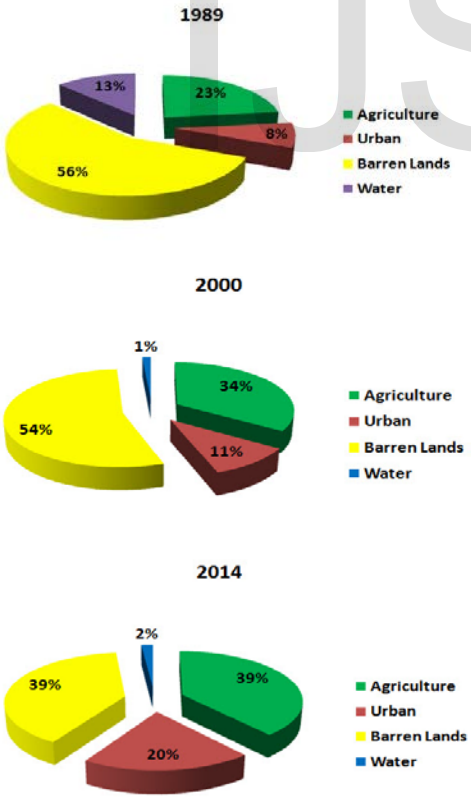
Table 1: Change detection analysis in Al Nasiriyah city.

As shown in table [1], the change detection analysis gives us urban growth rate and the effect of draining marshlands on the land use/land cover classification. Table [2] shows the urban growth rate in Al Nasiriyah city between 1989 and 2000.

Map unit	Change area 1989/2000 km2	Change rate %
Agriculture	+ 45.5	+10.82
Urban	+ 13	+2.585
Barren lands	- 11	-2.195
Water	- 56.5	-11.21

Table 2: urban growth rate in Al Nasiriyah city 1989/2000

Table [3] shows the urban growth rate in Al Nasiriyah city between 2000 and 2014.
Figure *6* shown by colors the changing in each class between 1989 and 2014



.

Fig. 6: land cover at 1989, 2000 and 2014.

4.2. Classification accuracy assessment

To assess the accuracy of the classification, we matched each of the land use and land cover map to the reference data. The reference data were provided by analyzing random sample points by using Google earth, the field knowledge and archives. A handheld GPS (Global Positioning System) was used during the field visits to distinguish the correct position of the place under study with latitude and longitude and its class by visual check. All these data used data so to verify the classification analysis accuracy. Overall classification accuracy of Al-Nasiriyah city for the years 1989, 2000 and 2014 are 82.62%, 81% and 85.2% respectively.

4.3. Urban growth rate

4.3.1. Regression Analysis

Population planning is mainly based on the estimation of population growth over multi years. (Pradhan B, Suleiman Z ,2009) to specific estimate the size of the population during the term of the future plan and the importance of this it is due to the effect of appreciation of the population in urban planning in all its dimensions In the field of land use, architecture and planned, which would require careful familiar overlapping variables that contribute In the geographic changes in the study area is so variable population of the most important variables that help to explore the future direction of land use in the city of Al-Nasiriyah and expansion. It turned out through the use of growth equation (Composite equation to predict in estimating the size of the population of the city of Al-Nasiriyah, who numbered 1989 is (282132 People), in 2003 to reach (390538) and so people can realize what will size him up city in 2014 to become the (450100) people. A growth rate of 3.1% compared to 2003 and by the year 2035 Up to the size of the city of Al-Nasiriyah (450 215) people and accordingly, the growth in the population of the city of Al-Nasiriyah is heading About the increase which shows the expansion in the future uses of the city is not toxic residential and industrial And commercial and other requirements to meet the growing number of hand building materials and provide the necessary services

	1989	2000	2014
Population	282132	390538	450100
Urban km2	40	53	101

Table [4] Population and urban growth

Depending on Regression Analysis and the relation between Populations and urban, we obtained the following equation:

$$Y = 0.000X - 60.17$$

Where Y is urban and X is Population.
By calculate estimate in 2035, we have the ability to estimate the desired urban area at 2035
Urban at 2035=166KM^2

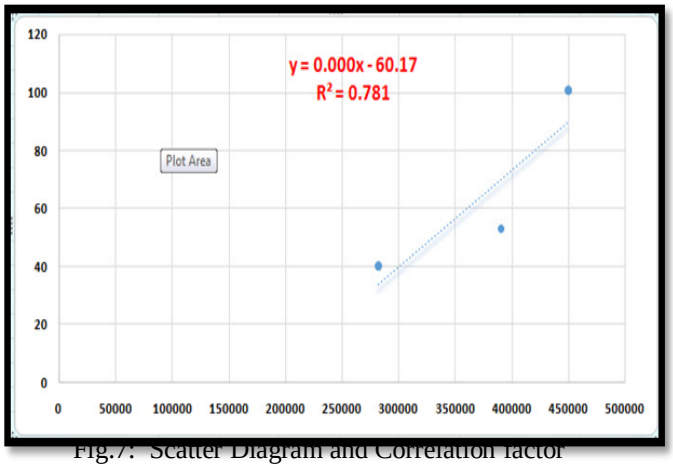


Fig.7: Scatter Diagram and Correlation factor

5. Conclusion

In this study, it is principally highlighted the urban sprawl analysis and the rapid growth of urban areas of Al-Nasiriyah city in Iraq and their environs also, we highlighted the marshlands conversion to another type of land use after water draining projects using remote sensing and GIS techniques. The supervised classification method can be easily implemented using ERDAS software system to facilitate the measurement of urban sprawl between 1989 and 2014 depending on USGS data set archives. We use GIS software to composite images bands and clip study area part. The main reason of urbanization is the rapid population growth and the Violation of land use and illegal conversion of farmland to urban .This problem needs to be seriously studied, through multi-dimensional fields in order to preserve and detect a change. Based on this study, the analysis of the results leads to the future findings, urban in 2035 will be 166 km2 and depending on this value, any development planning or town planning occur in Al-Nasiriyah city in the future must considered the desired area of land.

6. References

[1] Alves, D., Skole, D., 1996. Characterizing land cover dynamics using multi-temporal imagery. Int. J. Remote Sen. 17 (4), 835–839.

[2] Chen, G., Hay, G.J., St-Onge, B., 2012b. A GEOBIA framework to estimate forest parameters from lidar transects, Quickbird imagery and machine learning: a case study in Quebec, Canada. International Journal of Applied Earth Observation and Geoinformation 15, 28–37.

[3] Coops, N.C., Wulder, M.A., White, J.C., 2006. Identifying and Describing Forest Disturbance and Spatial Pattern. Understanding Forest Disturbance and Spatial Pattern. CRC Press, pp. 31–61.

[4] Coppin, P., Jonckheere, I., Nackaerts, K., Muys, B., Lambin, E., 2004. Review article digital change detection methods in ecosystem monitoring: a review. International Journal of Remote Sensing 25, 1565–1596.

[5] Griffiths, P.; Hostert, P.; Gruebner, O.; Linden, S.V.D., 2010.Mapping mega city growth with multi-sensor data. *Remote Sens. Environ.* , *114*, 426-439.

[6] Im, J., Jensen, J.R., Hodgson, M.E., 2008a. Optimizing the binary discriminant function in change detection applications. Remote Sensing of Environment 112, 2761–2776

[7] Lambin, E.F... , 2001. Remote sensing and GIS analysis. In *International Encyclopedia of the Social and Behavioral Sciences*; Smelser, N.J., Baltes, P.B., Eds.; Pergamon: Oxford, UK; pp. 13150-13155.

[8] Muttitanon, W., Tripath N., 2005. Land use/cover changes in the coastal zone of Bay Don Bay, Tailand using i, Landset 5 TM data. Int. J.Remote Sen. 26 (11), 2311–2323.

[9] Pradhan B, Suleiman Z., 2009. Landcover mapping and spectral analysis using multi-sensor satellite data: a case study in Tioman Island, Malaysia. J Geomatics 3(2):71–78

[10] Sankhala, S., Singh, B., 2014. Evaluation of urban sprawl and land use land cover change using remote sensing and GIS techniques: a case study of Jaipur City, India. Int. J. Emerging Technol. Adv. Eng. 4 (1), 66–72