DOI: 10.24996/ijs.2021.62.10.35

ISSN: 0067-2904

Mapping Land Cover/Land Use for Change Derivation Using Remote Sensing and GIS Technique

Layla Kais Abbas
Surveying Engineer, College of Engineering, Baghdad, Baghdad, Iraq

Received: 13/12/2020 Accepted: 10/2/2021

Abstract
Deriving land cover information from satellite data is one of the most common applications employed to monitor, evaluate, and manage the environment. This study aims to detect the land cover/land use changes and calculate the areas of different land cover types in Baghdad, Iraq, for the period from 2015 to 2020, using Landsat 8 images. The supervised Maximum Likelihood Classification (MLC) method was applied to classify the images. Four land cover types were obtained, namely urban, vegetation, water, and barren soil. Changes in the four land cover classes during the study period were observed. The extent of the urban, vegetation, and water areas was increased by about 7.5%, 9.5%, and 1.5%, respectively, whereas the barren soil area was decreased by about 18.5%. This study shows that the MLC classifier is a very effective method to map land cover classes.

Keywords: Remote Sensing; Maximum Likelihood; Supervised Classification; Land Cover.

رسم خرائط الغطاء الأرضي/الاستخدام الأرضي لاشتقاق التغيير باستخدام تقنية الاستشعار عن بعد ونظام المعلومات الجغرافية

ليلى قيس عباس
هندسة المساحه ، كلية الهندسة، جامعة بغداد ، بغداد، العراق

الخلاصة
اشتقاق معلومات الغطاء الأرضي و الاستخدام الارضي من بيانات الأقمار الصناعية يعد من اهم التطبيقات الشائعة لمراقبة وإدارة البيئة .هذه الدراسة تهدف الى كشف التغيرات في الغطاء الأرضي في مدينة بغداد للفترة الممتدة من 2015 الى 2020.اضافة الى حساب مساحات أنواع مختلفة من الغطاء الأرضي ضمن فترة الدراسة وباستخدام صور القمر الصناعي landsat 8 .قد طبقت طريقة Maximum Likelihood Classifier في تصنيف الصور الى اربع مناطق غطاء ارضي و هي المناطق الحضرية ،الغطاء النباتي ،المياه والصحراء القاحلة. النتائج أظهرت التغيرات في الأصناف الأربعة خلال فترة الدراسة وكما يلي : المناطق الحضرية ازدادت بنسبة 7.5% ، الغطاء النباتي ازداد بنسبة 9.5% ،مناطق المياه ازدادت بنسبة 1.5 % و الصحراء القاحلة نقصت بنسبة بنسبة 18.5% من المساحة الكلية لمنطقة الدراسة. هذه الدراسة أظهرت ان طريقة Maximum Likelihood Classifier أداة فعالة في تصنيف خرائط الغطاء الأرضي و الاستخدام الأرضي.

1. Introduction

Over the past years, remote sensing data have been considered as a vital source to map the land use/ land cover (LULC), manage the natural resources, and monitor the environment.

*Email: layla.k@coeng.uobaghdad.edu.iq

Various satellite data sources were used in previous land cover classification studies to achieve historical trends of the changes in land cover [1].
Characterization of LULC over large areas is an essential task in any environmental, cultural, and political study because it provides a baseline for governments to take over and monitor policies that seek sustainable livelihoods in harmony with ecosystems. Remote sensing (RS) and geographic information system (GIS) currently provide new tools for advanced ecosystem management [2]. Remote sensing data, coupled with image processing, make it possible to identify and map the land cover system and to assess and monitor the resources at different spatio-temporal scales and on both global and regional levels [3]. Change detection is the process of identifying the differences in the state of an object (or phenomenon) by observing it at different times [4]. Change detection is a very essential process to monitor and manage urban development and natural resources because it provides a quantitative analysis of the spatial distribution of the population of interest [5]. Many automated digital image classification techniques have been developed and applied for organizing image datasets into classes, based on their spectral properties, using the similarity of spectral characteristics of each land surface. Supervised classification learning algorithms are used, for example, to classify pixels based on their spectral properties (reflectance values or Digital Number) with the selection of training data for each class, which are manually defined by the interpreter [6]; [7]. This approach is commonly used in the land classification using remote sensing. MLC method is one of the common supervised classification methods that was originated from the electrical engineering field of study [8].
The expected population increase in Iraq during the coming years and the increase in the average human life will possibly lead to the phenomenon of overcrowding in the major cities in the country. This is especially true in Baghdad, the capital, which has been clearly subjected to increased numbers of workforce newly-opened factories, workshops, etc. This would undoubtedly lead to serious environmental and economic impacts on humans and the environment at the same time. The estimates indicate that the population of the city exceeded 6 million people, which led to an increase in the level of population density in the unit area. The residents often find other areas to live in or establish various projects, including commercial, industrial, and service projects. Because of that, the city expanded at the expense of green spaces that were planned to remain green to achieve environmental balance, reduce the level of pollution, achieve economic balance, and maintain an appropriate level of food production. Consequently, this caused serious economic, social, environmental, and security problems.
This study aims to detect the land cover change in Baghdad, Iraq during the period from 2015 to 2020. In addition, we calculate the areas of the different land cover types using Landsat 8 images and supervised MLC.

2. Materials and Methods

2.1 Study area

The study area is located in the center of Iraq, represented by Baghdad Governorate (the capital of Iraq), which is the smallest of Iraq's governorates by area. However, it is ranked first among the governorates of Iraq in terms of population, being populated by about 8.4 million in 2016. Baghdad governorate is located between latitudes 32° 48' – 33° 45' N and longitudes 43° 50' - 45° 00' E, as shown in Figure 1. Baghdad is distinguished by the passage of the Tigris River through it, dividing it into the two parts of Karkh and Rusafa. Administratively, the governorate is divided into many districts, which are further divided into sub-districts. Municipally, it is divided into 9 municipalities, which have responsibility for local issues [9]. Baghdad is one of the capitals of the world that has suffered from the phenomenon of urban growth since the beginning of the fifties of the twentieth century [10]. It has faced a growing migration from the countryside to the city due to the peasants leaving their lands to escape from feudalism. A large population waves migrated to it from other Iraqi cities for economic, social, and political reasons, which was accompanied by a parallel increase of births.

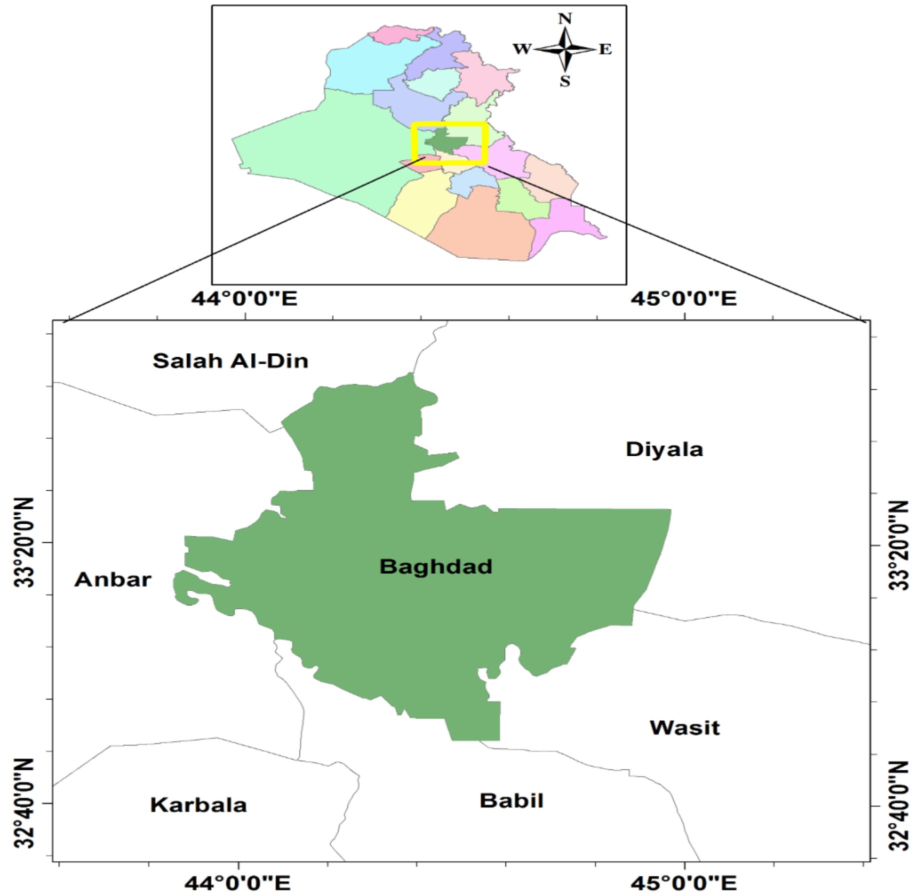

Figure 1-The map of Baghdad city representing the location of the study area.

2.2 Dataset

Landsat-8 satellite images with spatial resolution of 30m, obtained from U.S. Geological Survey (USGS), were used in the study, . The data were collected on yearly basis on March of 2015 to March 2020 (Table 1). Over the last 40 years, Landsat data provided one of the most valuable datasets for mapping and monitoring the Earth's surface [11] and [12].

Table 1- showing the description of the Landsat 8 scenes used in this study.

Path/Row	Date	Bands	Resolution (m)
168/37	3/2015	Multispectral	30
169/37	3/2015	Multispectral	30
168/37	3/2020	Multispectral	30
169/37	3/2020	Multispectral	30

2.2 Maximum likelihood classifier

Supervised classification algorithms are usually divided into two major approaches, namely parametric and non-parametric classifications. The traditional parametric methods (e.g., MLC and Minimum-Distance) are based on statistical assumptions, such as the normal distribution of data. This assumption, unfortunately, is not always satisfied with the data.

Despite having the constraints of statistical assumption, the MLC is considered among the most established algorithms for land cover change detection studies [13] and [14].
MLC was originated from the electrical engineering field of study [8]. The MLC algorithm is based on the assumption that the statistics for each training class in each band should be following Gaussian distribution, i.e. bell-shaped distribution. Mean and variance is calculated from each training class to form the probability distribution of each pixel in an image. An unknown pixel will be assigned to a specific class if it has the highest probability of belonging to that class. A sufficient number of training data should be required for calculating the mean and variance of each class [15].
In this study, the MLC method was used to extract four land cover/land use types using ArcGIS 10 based on Landsat 8 images. The methodology flowchart is shown in Figure 2.

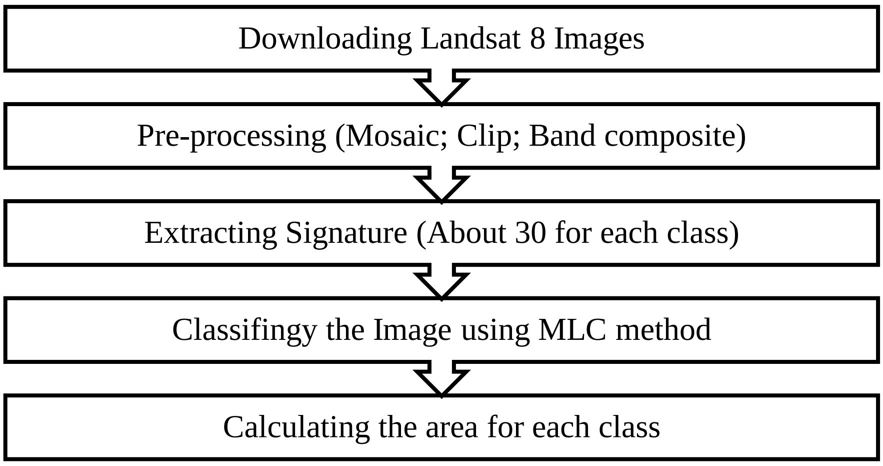

Figure 2 - The methodology flowchart for this study.

3. Results and Discussion

The change detection analysis is a beneficial method to describe the changes in each land cover category. In this study, the MLC classification method was applied and the land cover was classified into four classes, namely vegetation, water, urban area, and barren soil. ArcGIS 10.5 software was used to classify the Landsat 8 images, calculate the percentage of the total area for each class, and produce the final map shown in Figures 3 and 4. The results obtained using the MLC method show that there are noticeable and visible changes in land cover in the study area for the period 2015-2020. An increasing trend in vegetation, urban area, and water, and reduction in barren soil area were recorded. Table 2 illustrates the percentage area of each land cover class.
For the year 2015, the percentage of each class was as follows: Urban area represents 35.3%, vegetation represents 26.7 %, water represents 1.5%, and barren soil represents 36.5 % of the total studied area. While, for the year 2020, the percentages were as follows: Urban area represents 42.8%, vegetation represents 36.2%, water represents 3%, and barren soil represents 18%. Table 2 illustrates the changes in the four land cover classes during the study period, which are as follows: urban area increased by about 7.5%, vegetation area increased by about 9.5%, water area increased by about 1.5%, and barren soil decreased by about 18.5% of the total study area. This study showed that MLC classifier is a very effective method to map the land cover classes. Studying and analyzing the land cover changes could be very useful to make plans for sustainable development.

Table 2-Area and percentage each class, each year in study area with difference between them

class	2015		2020		change	
	Area (Km2)	**percentage**	**Area (Km2)**	**percentage**	**Area (Km2)**	**percentage**
Urban area	1824	35.3%	2212	42.8%	388	7.5%
Vegetation	1382	26.7%	1874	36.2%	492	9.5%
Water	77	1.5%	145	3%	68	1.5%
Barren soil	1891	36.5%	943	18%	-948	-18.5%
Total	5174	100%	5174	100%		

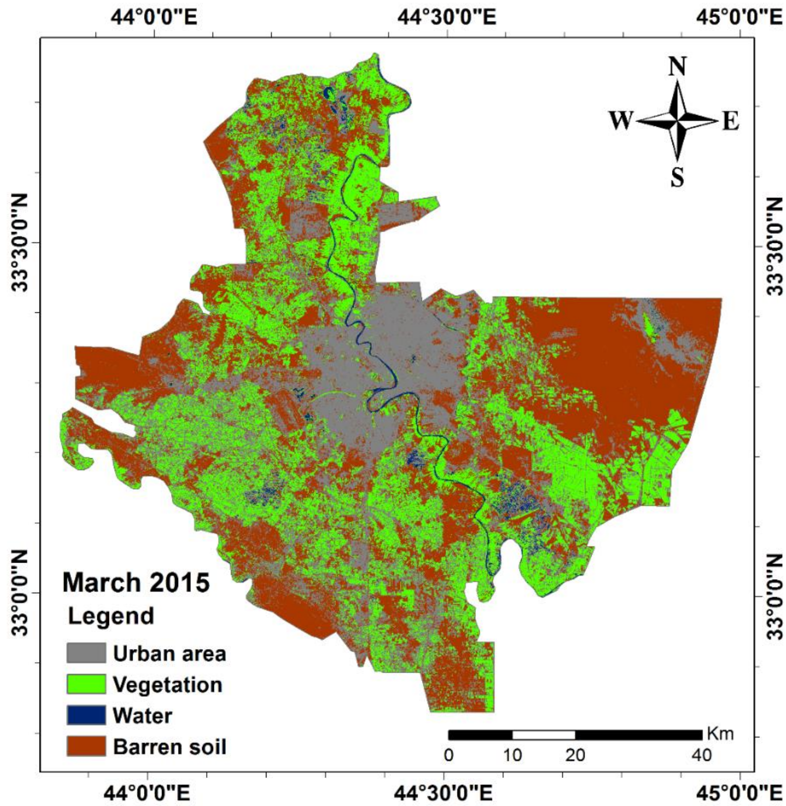

Figure 3-Classification of land cover/ land use for Baghdad city at 2015.

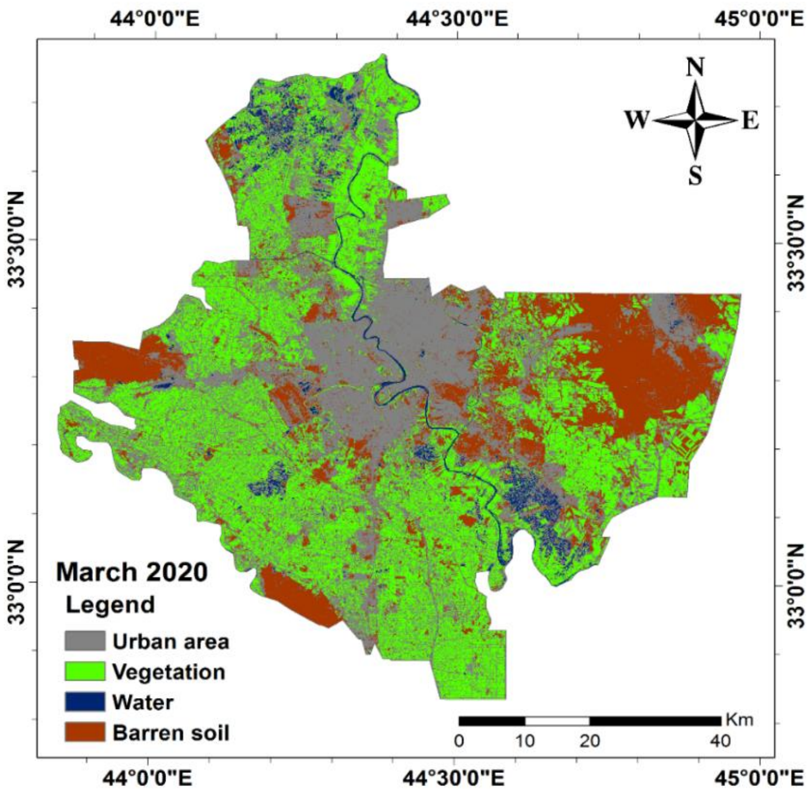

Figure 4-Classification of land cover /land use for Baghdad city at 2020.

4. Conclusions

Detecting the change in land cover/land use is considered a major field where remote sensing is applied to monitor and manage environmental activities. This study demonstrates the capability of remote sensing and GIS to capture spatiotemporal data. An attempt was made to capture as accurately as possible four lands cover classes as they change through time between 2015 to 2020.

The results show changes in the four land cover classes during the study period; the urban area increased by about 7.5%, vegetation area increased by about 9.5%, water area increased by about 1.5%, and barren soil decreased by about 18.5% of the total study area. This study showed that MLC classifier is a very effective method to map the land cover/land use classes.

Reference

[1] Rosenfield, G.H. and Fitzpatrick-Lins, K. A" Coefficient of Agreement as a Measure of Thematic Classification Accuracy". Photogrammetric Engineering and Remote Sensing, 52, 223-227,1986.

[2] Wilkie, D.S., Finn, J.T., and Finn, "Remote Sensing Imagery for Natural Resources Monitoring: A Guide for First-time Users". Columbia University Press,1996.

[3] Rogan, J., Chen, D. "Remote sensing technology for mapping and monitoring land-cover and land-use change". Progress in planning 61 (4), 301-325,2004.

[4] Singh, A. Review article digital change detection techniques using remotely-sensed data. International journal of remote sensing, 10(6), pp.989-1003,1989.

[5] Kadhim, M.M. "Monitoring Land Cover Change Using Remote Sensing and GIS Techniques: a Case Study of Al-Dalmaj Marsh, Iraq". Journal of Engineering, 24(9), pp.96-108,2018.

[6] Campbell, J. B., and Wynne, R. H." Introduction to remote sensing". Guilford Press,2011.

[7] Chuvieco, E. "Fundamentals of Satellite Remote Sensing: An Environmental Approach", CRC press,2016.

[8] Nilson, N. J." Learning Machines: Foundations of trainable pattern-classifying systems". McGraw-Hill. ,1925.

[9] Al-Akkam, A.J. "Urban characteristics: the classification of commercial streets in Baghdad city". Emirates Journal for Engineering Research, 16(2), 49-65 ,2011.

[10] Al-Hasani, M.K. "Urban space transformation in old city of Baghdad–integration and management". Megaron, 7, 79-90 ,2012.

[11] Kennedy, R.E., Andréfouët, S., Cohen, W.B., Gómez, C., Griffiths, P., Hais, M., et al. **2014**. "Bringing an ecological view of change to Landsat-based remote sensing". Frontiers in Ecology and the Environment, 12(6), 339–346.

[12] Zhu, Z., Wang, S., and Woodcock, C.E. 2015. "Improvement and expansion of the Fmask algorithm: cloud, cloud shadow, and snow detection for Landsats 4–7, 8, and Sentinel 2 images". Remote Sensing of Environment, 159, 269-277.

[13] Shalaby, A., and Tateishi, R. "Remote sensing and GIS for mapping and monitoring land cover and land-use changes in the Northwestern coastal zone of Egypt". Applied Geography, 27(1), 28-41. ,2007.

[14] Strahler, A. H. "The use of prior probabilities in maximum likelihood classification of remotely sensed data". Remote sensing of Environment, 10(2), 135-163,1980.

[15] Richards, J. A., and Richards, J. "Remote sensing digital image analysis "(Vol. 3), Springer, 1999.