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DETERMINATION OF LAND USE AND LAND COVER CHANGE USING REMOTE SENSING AND GIS CASE OF STUDY; IN SHEKHAN DISTRICT

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PREFACE

First of all, my thanks to Allah the most gracious, the most compassionate, who give me the ability to complete this work. I would like to express my deepest gratitude to my supervisor prof. Dr. Alaaddin YÜKSEL for his guidance, suggestions and supports which played a major role in the completion of this work.

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Kovan Majid MAHMOD
Bingöl 2019

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UZAKTAN ALGILAMA VE CBS KULLANILARAK ARAZİ KULLANIMI VE ARAZİ KULLANIM DEĞİŞİMİNİN BELİRLENMESİNDE SHEKHAN BÖLGESİNDE DURUM ÇALIŞMASI

ÖZET

Irak’ta tarımsal kalkınma sürecini ve gıda güvenliğini etkileyen en önemli zorluklardan birisi arazi kullanımı ve arazi örtüsündeki değişimlerdir. Uzaktan algılama ve coğrafi bilgi sistemleri (CBS), bir dizi mekansal ve zamansal ölçekte arazi kullanımı ve arazi örtüsündeki değişikliklerin modellenmesi, izlenmesi ve haritalanması için oldukça önemlidir. Irak’ın Duhok Bölgesinde yer alan Shekhan’da, nüfus artışı ile birlikte şehirleşmenin sıklığı, arazi kullanımı ve arazi örtüsünde önemli değişikliklere neden olmuştur. Nüfus artışı, daha fazla miktarda gıda ve lif üretimini zorlayarak arazilere baskı uygulanmasına neden olmaktadır. Bu nedenle, arazi kaynaklarının sürdürülebilir bir şekilde kullanılması için arazi kaynaklarının sürdürülebilir kullanımı ve akıllı yönetim uygulamalarına gereksinim vardır. Mevcut çalışmanın temel amacı Irak'ın Shekhan bölgesinde bölgedeki arazi kullanımı ve arazi örtüsü değişimini belirlemektir. Arazi kullanımı ve arazi örtüsünde zaman içersinde meydana gelen değişiklikleri belirlemek için 2002 Landsat TM, 2013 ETM ve 2018'in ETM uydu verileri kullanılmıştır. ArcGIS ve ENDVI, CBS ve uydu verilerinin işlenmesinde kullanılmıştır. 2002 ve 2018 arasındaki değişiklikleri tespit etmek için arazi kullanımı ve arazi örtüsü analiz edilmiştir. Sonuçlar, 2002 ve 2018 yılları arasında bitki örtüsünde önemli bir azalma olduğunu ve bitki örtüsü örtüsündeki düşme oranının yıllık 3,24 ve 11,36 hektar olduğunu göstermiştir. 2002 yılında, %0,79 oranındaki konut alanı 1113,74 ha yer kaplarken, 2013 yılında 2400.65 ha'a, 2018'de ise %1,7 oran ile 2534,65 ha'a yükselmiştir. Konut alanına benzer şekilde, çalışma alanında su kütlesinin kapsama alanı da artmıştır. 2002 yılında yüksek bitki örtüsü alanı %1,87 oranı ile 2649,01 ha ilen ve 2018'de %4,71 ile 6681,25 ha olmuştur. Şekhan'ın kuzeyinde biriken alanlar, başka bir yönelime göre büyüme eğilimi olduğunu gösterdi. Mevcut çalışmanın sonuçları, kentsel planlamada sürdürülebilir bir çözüm önerisi sağlayabilecek niteliktedir

Anahtar Kelimeler: Shekhan, CBS, arazi kullanım değişiklikleri, arazi örtüsü değişiklikleri, uzaktan algılama.

DETERMINATION OF LAND USE AND LAND COVER CHANGE USING REMOTE SENSING AND GIS CASE OF STUDY; IN SHEKHAN DISTRICT

ABSTRACT

One of the most important challenges that strongly influence the agricultural development process and food security is the changes in land use and land cover in Iraq. Remote sensing and geographic information systems (GIS) are essentially important for the modeling, monitoring, and mapping of the changes in land use and land cover across a range of spatial and temporal scales. High frequency of urbanization coupled with the population growth led to a significant change in land use and land cover in Shekhan, Duhok. Iraq. Population increase exerts pressure on lands to produce a higher amount of food and fiber. Therefore, sustainable use of land resources and wise management practices are needed to secure lands from degradation. The main objective of the current study was to determine the land use and land cover change in Shekhan district region of Iraq. Satellite data of Landsat TM of 2002, ETM of 2013 and 2018 were used to determine the changes in land use and land cover in time. ArcGIS and ENDVI were used in GIS and processing of satellite data. The detection of land use and land cover were analyzed to exhibit the changes between 2002 and 2018. The results revealed a significant decrease in vegetation cover between 2002 and 2018 and the decrease rate in vegetation cover was determined as 3.24 and 11.36 ha per year. Whereas residential area was 1113.74 ha with a ratio of 0.79 % in 2002, increased to 2400.65 ha in 2013 and to 2534.65 with a ratio of 1.7% in 2018. Similar to the residential area, the coverage area of the water body also increased in the study area. High vegetation area in 2002 was 2649.01 ha with a ratio of 1.87% and increased to 6681.25 ha in 2018 with a ratio of 4.71%. The built-up areas in the north of Shekhan showed that there was a growing trend according to another orientation. The results of the present study are capable of providing a sustainable solution for urban planning.

Keywords: Shekhan, GIS, land use changes, land cover changes, remote sensing.

1. INTRODUCTION

All human activities are performed on earth surface which is the platform and the source of materials needed for such activities. Land is the most important natural resource for countries as well as for Iraq especially for agricultural production. Modification in land use and land cover plays a major role for the studies on world change. Land use /land cover (LULC) changes cause to the losses in biological diversity, deforestation, global warming and increase of the frequency and intensity of natural disaster (Mas et al. 2004; Zhao 2004; Dwivedi, 2005). The environmental problems usually related to the LULC changes. Therefore, available information on LULC changes can supply crucial changes will offer crucial input to decision making of environmental management and designing the longer term (Fan 2007; Prenzel 2004). Human have indirectly or directly affected the earth surface through different activities. Land use/Land cover (LULC) maps describe the water, vegetation and natural features on the land surface. Though the terms land cover and land use are often used interchangeably, their actual meanings are quite distinct. The increase population with the quick expansion of urbanization and increasing socioeconomic necessities create a pressure on the land cover and land use. Many lands have been converted from rural to city. Enlargement of urbanized zone is of more significant since from its powerful impact on another land cover classes like cultivated lands non built areas and woods.

The LULC is one of the major causes of global environmental change and is the central to the debates in sustainable development. The LULC changes have significant influences on a broad variety of environmental and landscape attributes including the air and land resources ecosystem, quality of water, processes and the climate system. Land deterioration results generally as a result of population increases which lead to extreme land use without suitable management practices. The increase population makes people to travel towards sensitive areas like agricultural lands. Land use without considering the fertility and chemical richness of the lands causes several problems. The incorporating of remote sensing (RS) and geographic information systems (GIS) has widely applied and been acknowledged as a powerful and effective tool in detection urban land use and land cover change. In digital image analysis, data and information are by no means synonymous with each other. Practically, remotely sensed data represent values or digital number of the pixel (Satiprasad 2013).

Geographical Information Systems (GIS) and Remote sensing (RS) are powerful tools to derive precise and timely information on the spatial sharing of land use/land cover changes over large areas (Carlson and Azofeifa 1999; Rogana 2004; Zsuzsanna et al. 2005). Past and present studies accompanied by organizations and institutions around the world, mostly, have concentrated on the application of LULC changes. Geographical information systems offer a flexible environment for collecting, storing, displaying and analyzing digital data required for change detection (Wu et al. 2006).

The utility of satellite images not only used for mapping but also to monitor temporal changes in the environment. The growth of population, industries and economic developments, immigration from the small town or rural to cities due to destroying about %90 of the Kurdish villages because of the war and Anfal operations, which caused increase in proportion of population within the urban centers.

The monitoring of urbanization in Iraq is difficult due to the lack of required data. In last years the Geospatial technique that regards as a modern tool was applied in Iraq region. Monitoring Ecofriendly practices is becoming increasingly essential wherever there is increasing population and expansion pressure placed on delicate in arid and semi-arid surroundings (Sun et al. 2005). Globally arid and semi-arid lands cover more than 70% of total landmass (Weigand and Florian 2000) and support around one sixth of the world's population (Veron et al. 2006).

The map showing the changes in land cover is important for any individual who needs to predict the future changes in landscape. The existing information must be utilized to test the model for land cover change. Strains on natural resources has been increasing day-to-day because of steady population increase, bad-use of lands constitutes a significant potential threat. Successful planning strategies have been developed in order to decrease the stress on productive agricultural lands. Tools such as remote sensing (RS) and geographic information system (GIS) are important to develop successful planning strategies (Karakus et al. 2014).

This study was carried out to reveal and analyze the LULC changes in Shekhan district area by using RS and GIS systems. The specific objectives were:

1. To monitor the urban extension and LULC during the years between 2002, 2013 and 2018 using the Landsat satellites images.
2. To create LULC maps for the selected years.
3. To determine the effects of urbanization and changes in land cover on degradation of agricultural lands.
4. To assess the accuracy assessment of the classification techniques.
5. To mention probable reduction measurement to lessen the impact of land use alterations.
6. To investigate the prominent and principal causes of LULC variations and subsequent effects of LULC changes on the environment and livelihoods of human.
7. To analyze the alteration of land use pattern between 2002 and 2018.

2. LITERATURE REVIEW

The LULC changes are the most important and easily measurable indicators of modification in ecosystem and subsistence systems (Gilani et al. 2014). Considering the complexity of the LULC changes, the assessment and monitoring of LULC changes are essential for sustainable use of natural resources, food security and environmental conservation (Drummond et al. 2012, Foley et al. 2005; Garedew et al. 2009; Jin et al. 2013). Studies on the LULC changes are also useful to predict likely forthcoming tendencies and to make the decisions on management planning of natural resources (Fan et al. 2007; Gilani et al. 2014; Prenzel 2004).

The population of world is expected to growth by 72 % on 2050 (3.6 billion in 2011 to 6.3 billion) this was reported by United Nation. for the expected four decades, the urban areas of the world will be ingested all the population growth while reverse migration from urban to rural will be increase due to assumption of rural life that is simpler and less stressful (Desa 2012).

Due to the precise and timely information of LULC change is much useful to many groups; remotely sensed data can be applied as it supplies the land cover information. Therefore, geospatial instruments are needed to reveal the rapid growth dynamics on developments of urban expansion, and quantify the spatial extent of urbanization (Araya and Cabral 2010).
The detection of LULC change in a region can be performed by determining and identifying the changes in LULC properties using co-listed multi-temporal satellite data. It is an important privilege that LULC change can be defined between remote sensing data and more than two dates of the past. In order to increase the efficiency of the method, change detection methods should maximize the difference between the dates in spectral and spatial areas (using vegetation indices and texture variables). A large number of researchers have pointed out the problem of accurately monitoring land cover and land-use change in a wide range of highly successful environments (Chan et al. 2001).

The objective of this study is to detect and analyze LULC changes in Shekhan region by combining RS, GIS and spatial modeling tools.

2.1. The Use of Remote sensing in Land Use and Land Cover Change Studies

Remote sensing is the acquisition of information about an object or area during the analysis of the data collected by the sensors on the device called satellite, which does not come into contact with the object, field or phenomenon being examined (Lillesand et al. 2008). Remote sensing is a tool for collecting and explaining information about an object, area, or events without physically contacting objects, fields, or events. Remote sensing is the science of acquiring information about the surface of the earth without physical contact to the earth surface. This process is performed by sensing and recording the reflected or radiated energy and by processing, analyzing and applying the information to specific purposes (Goodchild et al. 2005). Remote sensing is a technique in which sensors are used to assess the amount of electromagnetic radiation emitted from an object or geographical area. The remote sensing operates well in accordance with other spatial data collection techniques or tools of mapping sciences mapping and geographic information systems (Clarke et al. 2002).

2.1.1. Satellite Images in Remote Sensing

A variety of satellite imageries is available for the purpose of remote sensing to use for the assessment of LULC changes on the earth. Landsat satellite images are preferable due to the high temporal resolution coupled with the near and mid-infrared bands permitting close examination of vegetation and other landscape types (Zeledon and Kelly 2009). The first satellite, which was used to obtain remote sensing data at certain intervals on the Earth's surface, was started to be used on 23 July 1972 with a spatial resolution of less than 100 meters (Gibson et al. 2000). Two sequences of Landsat satellites have been initiated as Landsat-1-3 and Landsat-4-5, and Landsat-6, 7 and 8 were in 1993, 1999 and 2013.

2.1.2. Image Processing in Remote Sensing

Image processing is mostly composed of the restoration, development, classification and transformation stages. The correction and calibration in the image restoration stage is carried out to obtain a reliable representation of the world. Images are modified to optimize their appearance in the development phase of the image processing. Visual analysis is very important in processing of digital images, and the effects of visual analysis can be striking. Image classification is a vital stage of image procession and refers to the computer-assisted interpretation. New images are derived in the image transformation stage by conducting mathematical processing in the raw image data.

Prior to classification and detection of changes in LULC, the image processing stage includes a series of sequential processes including atmospheric correction or normalization, image recording, masking, radiometric and geometric corrections. Radiometric corrections of raw digital image data are used to eliminate distorted brightness due to sensor standardization or fault problems. Continuous changing of atmosphere causes scattering of the reflected electromagnetic light energy which results in changes in the images. This is considered a serious sensor calibration error. Geometric adjustments are aimed to correct the inaccuracy between the location coordinates of the picture elements in the image data and the actual location coordinates of the earth surface (Deby 2001).

2.1.3. Image Enhancement

Image enhancement techniques have been widely used in many image processing's where personal image quality is needed for human interpretation. Contrast is an important characteristic for instinctive assessment of image quality. The contrast is the difference in brightness reflected from two neighboring surfaces. Changing the images for better human interpretation is considered an image enhancement. In spite of the extent of digital intervention, visual interpretation invariably plays a significant role in all aspect of remote sensing. Enhancements provide better visual explanation and understanding of images. Improved image does not need to look like a conventional image, but it should be understood that the changes resulting from the process should allow accurate visual interpretation (Campbell 1996). The enhancement technique is used before the main processing where an image should be interpreted by an expert prior to further operations.

2.1.4. Change Detection Techniques

The change detection is a process that determines the differences in the state of an object or phenomenon by analyzing them at different times. The detection of change quantifies temporal effects using multi-temporal data collection (Singh, 1989). Accurate determination of LULC change on time is required to figure out the human interactions with characteristics of the world and inform politician for necessary precautions (Lambin et al. 2001; Lu et al. 2004; Verburg et al. 2006). There are two basic approaches for the detection of changes, which are the comparison of autonomously produced classifications for different periods and concurrent evaluation of multi-temporal data (Singh, 1989).

The determination of the appropriate technique or algorithm for the detection of changes is important to obtain a high accuracy change. Restrictions such as spatial, spectral, thematic and temporal characteristics affect the quality of digital change detection. Image differences can give information about changes; however, some techniques, such as post-classification comparison, may provide a complete matrix of change aspects. There are numerous change detection methods in remote sensing. Change detection from digital imagery has recently been divided into various methods called the image rationing, image regressing, image differencing and change detection after classification (Lunetta and Elvidge 1999; Xu et al. 2009; Bekalo 2009). Different change detection methods can generate various change maps depending on the algorithm used (Bekalo 2009).

2.1.5. Accuracy Assessment in Detection of Land Use and Land Cover Changes

The term accuracy refers to the correctness or classification of a map (Foody 2002). The confusion matrix method in the basic accuracy data was applied to the images classified to calculate and arrange the general accuracy and Kappa Coefficient and to evaluate accuracy for users and producers. It requires access to the accuracy of spatial data, which is derived from remote sensing techniques and used in GIS analysis, and has been accepted as a vital constituent of many studies (Congalton and Green 1993).

The preparation of a classification error matrix is a commonly used method to express the accuracy of the classification (Lillesand et al. 2004). An error matrix is a sequence of numbers kick in rows and columns expressing the sizes of sample units allocated to a given category in a classification based on the number of sample units allocated to a specific group in an alternative classification (Congalton and Green 1993).

2.1.6. The Use of Normalized Difference Vegetation Index (NDVI)

NDVI is a calculation used to identify vegetation and its health through the levels of chlorophyll detected in the leaves, and provides a measure of the plant cover on the earth surface for a given region. NDVI is calculated from the differences between visible and near infrared light emitted from plants. Healthy plants absorb most of the visible light and reflect a portion of the near infrared (NIR) light (RED). Unhealthy or scarce plant cover reflects more visible and less NIR lights. The following rule is used to calculate the NDVI (Sabins 1987; Jensen 1996; Tucker 1979; Leica 2008):

$$NDVI = (NIR - RED) / (NIR + RE) \quad \ldots\ldots\ldots\ldots\ldots \quad \text{Eq. 1}$$

NDVI is used to measure the enhancement of vegetation cover, vegetation cover characteristics and reported in several forest assessment studies (Wulder 1998). NDVI can also be used to accurately define earth surface and classification of vegetation. Images with multi-resolution and integrated analysis methods have been included with NDVI for classification of land cover.

2.2. Geographic Information System (GIS)

Another modern advanced technology that uses satellite data and helps to interpret is GIS. The GIS refers to well-ordered gathered computer hardware, software, geographic data and personnel intended to adequately pick up, store, improve, manipulate, analyze and exhibit all forms of geographically referenced information (Baral 2004). The GIS takes advantage of the ever-increasing geographic data along with satellite data. Geographic data defines the real-world objects based on their location, attributes, and spatial relationships with each other. The position is defined by a known coordinate system. The attributes are not related to a position such as the incidence of illness, population, calcium carbonate content, carbon, temperature, etc. The spatial relationships of objects or interests with each other define how they connect with each other or how they can travel between each other (Burrough 1986).

Geographical information can be acquired from various maps such as topographic map, soil map, geological map, satellite images and from various sources such as GPS recording coordinates. After the relevant information is collected, the data is stored as a layer collection in the GIS database (Evans et al. 1976). GIS is a computer-based system for retrieving, storing, processing, evaluating, visualizing and specifically integrating the data referenced and integrating them with other computer-based data. It is widely used for modeling and analyzing the complex research, management and planning problems. GIS is a system that will support the decisions to be made by producing possible solutions for the configuration and evaluation of the problems (Huisman and Rolf, 2001).

2.3. Land Use and Land Cover

Land use is the way in which human beings employ the land and its resources. For instances of land use include agriculture, urban development, grazing, logging, and mining. In difference, land cover describes the physical state of the land surface. Land cover categories include cropland, forests, wetlands, pasture, roads and urban areas. The term land cover originally referred to the type and state of vegetation, like forest or grass cover, although it has widened in subsequent usage to include human constructions such as buildings or pavement and other aspects of the natural environment, such as soil type, biodiversity, and surface and groundwater (Meyer 1995).

Land use and land cover change is a main issue of global environmental modification. It is commonly recognized that land use and land cover changes play a very important role on regional to worldwide scales, with impacts over ecosystem functioning, ecosystem services and biophysical and human variables such as climate and government policies. Changes in land cover comprise changes in biotic diversity actual and potential primary productivity, soil quality, runoff and sedimentation rates (Lambin et al. 2001). Remote sensing has made an important source of data for land use and land cover and it is an authoritative tool to keep an update of universal inventories (Satiprasad 2013).

2.4. Definition and Detection of Land Use and Land Cover Changes

Land cover is a physical structure such as forest, crop, buildings, river which is located on the surface of a certain piece of land. Land use can be defined as the human activity that uses land for housing, agricultural land or industrial purposes (Barnsley et al. 2005). Land use may consist of various land cover. For example, a farm owned by a person; home, barn, pond, pasture, and cotton, wheat and corn. The combination of the surfaces of various uses determines the land use in a region (Anderson et al. 1976).

Nowadays, land cover changes are so widespread that, when they come together globally, they significantly affect the crucial features of the world's functioning system (Lambin et al. 2001, Lambin et al. 2003). It also has a significant impact on many basic environmental processes. Any transformation in the world has a significant impact on the local and global environment.

Land use significantly affects land cover. Similarly, changes in land cover also influence land use. However, a change in both may not be related to each other. Any change in land use does not necessarily require deterioration of the soil. However, many of the land-use changes that occur for a variety of reasons lead to changes in biological diversity, water and radiation budgets, global climate, and other processes that affect the biosphere (Meyer and Turner 1994).

Changes in land use can be divided into two main categories: change and conversion. In general terms, the change can be defined as a condition change. For example, a poorly managed pasture can be improved to a better managed pasture. Transformation is a change from one land use to another, such as the conversion of forests or wetlands into agricultural land. The transformation of forests for agricultural production has been an important focus of research in many parts of the world (Meyer and Turner 1994).

Spatial data play a leading role in replacing existing policy trends with robust policy making and implementation. Land cover data can establish a reference base for various applications such as forest and pasture monitoring, planning and investment statistics, monitoring of biodiversity, climate change and desertification (Jansen and Gregorio 2002).

Significant changes in the land surface cover are known to cause significant environmental problems such as soil erosion, surface flow, flood, carbon dioxide emission to the atmosphere and climate change (Lambin et al. 2003). Determining the change of land cover, modeling and evaluating with environmental problems are very important in terms of strategy development for solving the problems (Turner et al. 2004). Demonstrating and specifying the spatial structures of LULC change will enable understanding and predicting the change process (Petit et al. 2001). Studies on determining land change contribute to the identification and classification of the LULC, helping to understand the mechanism of change and the mechanism of drivers, as well as the creation of models that can be used to predict future changes and impacts (Xu et al. 2002).

2.5. Causes of Land Use/Cover Change and Consequences

Excessive pressures to meet the need for increased populations exert negative influences on the hydrology of a region. Studies to assess the effects of LULC changes, water resources and runoffs are often required for hydrological modeling and have become more important in recent years. Changes in land use can be influential on hydrology at local, regional and global scale. The most important land change events causing hydrology are afforestation and deforestation. Afforestation has a significant positive effect on annual and seasonal flows and runoffs as well as water quality and soil erosion (Calder 1993).

Changes in the LULC may result from direct and indirect consequences of human activities. It is thought that the first LULC changes begin with the burning of forests and pastures for settlement and agriculture (Ellis and Pontius Jr. 2006). LULC change is defined as a complicated process that results from interactions between environmental and social factors at different temporal and spatial scales (Valbuena et al. 2008; Rindfusset al. 2004). The current land cover change model in the Shekhan Region should be attributed to a complex interface of environmental, demographic and socio-economic factors (Figure 2.1).

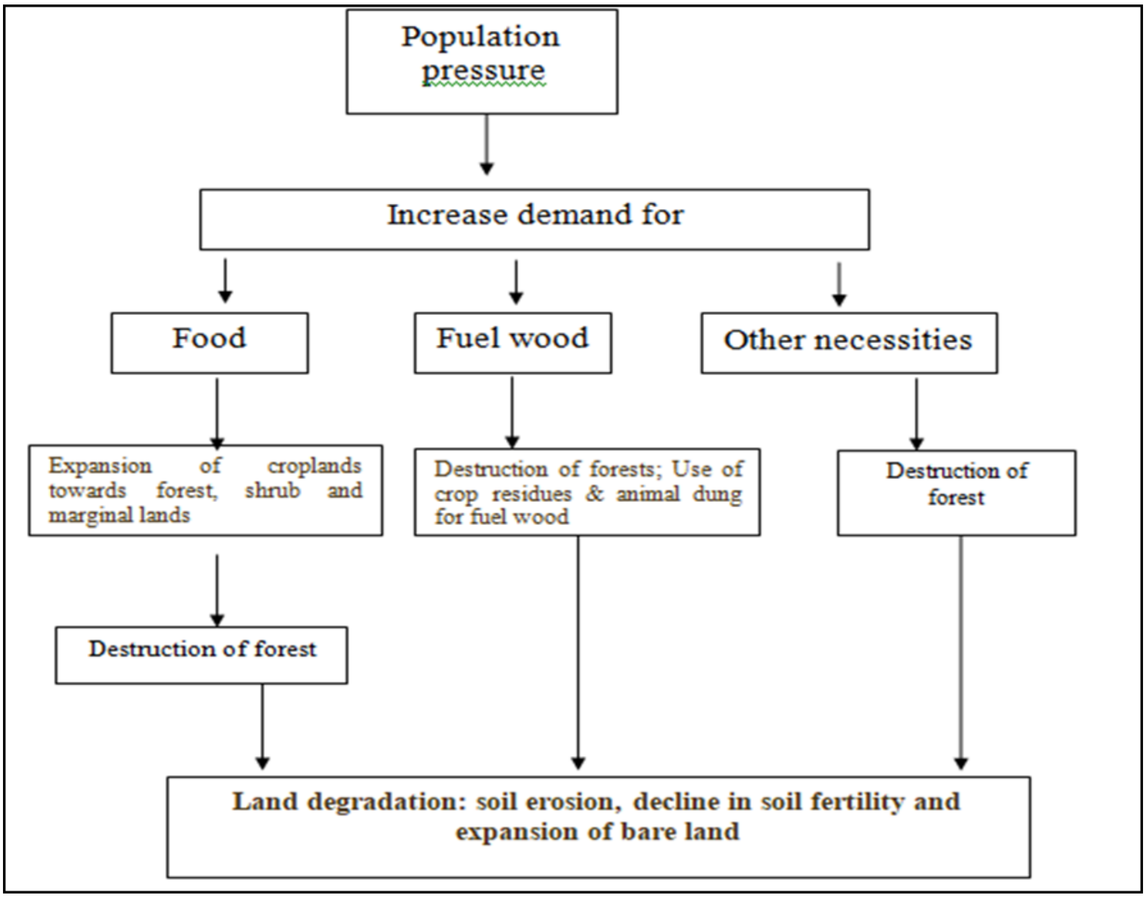

Figure 2.1. Causes and consequences of land use and land cover changes (Rimal 2011)

2.6. The Role of Remote Sensing on Land Use and Land Cover Change Studies

Remote sensing provides valuable information to assess the degree of deforestation, destruction of habitats, urbanization, wetland degradation and many other landscaping events. In addition, some of the useful information obtained by remote sensing can be included in models on many local/international scales, including models used to develop parameters for hydrological cycles and carbon sequestration.

Remote sensing data can be used to answer ecological problems of regional or global importance (Vogelmann et al. 2001). Therefore, remote sensing data and analysis retrieved at the right time and in sufficient detail are utilized to reliably detect changes in the LULC (Rimal 2011).

2.7. Factors affecting the LULC change and consequences in Iraq

LULC changes are influenced by a variety of factors, with multiple spatial and temporal complex and time-specific relationships being effective. New theories have been developed in natural and social sciences and recently in interdisciplinary research to define and explain the LULC exchange. These are; i.) Reasons and outcomes of LULC, ii.) The role of remote sensing on LULC changes: iii.) Loss of biodiversity: Biodiversity is significantly reduced depending on land use or land cover change. iv.) Climate change: Today, the most important land use changes are the conversion of forest areas into agricultural land (Ellis and Pontius Jr. 2006). Land use and the change of the cover have a significant impact on climate change at regional, local and global scales. v.) Pollution: Changes in the land use for agricultural production or settlement purposes cause the pollution of the environment. The environmental impacts of LUCC can also be attributed to the destruction of stratospheric ozone layer due to the release of various gases, particularly nitrogen gases from agricultural lands and the change of regional and local hydrology. vi.) Agricultural lands: Agriculture is the main food and fiber production activity, which is largely dependent on the presence of soil (Andres et al. 2004). vii.) Population increase: The greatest fear against the growing population is the long-term supply and production of other essential foodstuffs in the future (Pontius Jr. and Chen 2006), and viii.) Impact of urbanization on vegetation cover.

3. MATERIALS AND METHODS

3.1. Materials

The study starts with downloading the necessary satellite data. Three different images belonging to 2002, 2013 and 2018 were downloaded. The images have been cropped for the study area, and overlaid for the region of interest and subset of the area. Residential areas, water bodies, high and low vegetation cover and others land use and land covers (LULC) have been extracted and identified to determine the changes in LULC from 2002 to 2018. After the supervised classification completed, change detection for 2002, 2013 and 2018 was determined, and finally accuracy of the data was assessed.

3.1.1. Description of the Studied Area

The study area was located in the northeast of Kurdistan region, Iraq, and situated about 35 km north-north-east of Mosul city, 40 km Duhok city and about 60 km Erbil city. Climate of the study area is considered to be semi-arid and temperature ranges between 7.9°C in January to 39.1°C in July with an annual average of 24°C. The coldest month of the region is January with an average monthly temperature of 11°C, while August is the warmest month with temperature maximum rise up to 30°C. Rainfall is bimodal with annual averages ranges from 383 to 550 mm. The long-term rainy months of the region are January, February, and March while the ‘short rains’ are experienced in October and December. The people in the region are predominantly farmers and rely mostly on the long rains occur in January and February. The rainfall data revealed a significant decline in the precipitation recorded throughout the years to date. Droughts are common in the area and prolonged droughts cause a significant reduction in vegetation and most other agricultural crops.

3.1.2. Location and Area of the Study Area

The Shekhan District which called as Ain Sifni is located in the Duhok Governorate of Iraqi Kurdistan. The district is surrounded by the Amadiya and Duhok districts. The Duhok is situated on the north, the Akre district is on the east, Al-Hamdaniya district is on the south and the Tel Kaif District is on the west of Sheklan district. The Shekhan district with the center of Ainsefni lies about 35km to the southeast of Mosul city. The district extends from Ain Al-Safra and Bartellah in the south up to Alqosh mountain and Al-Shekhan district center on between 43º16´ and 46º37´ east longitudes and 36^{o} 14` and 36$^{o}$ 35` latitudes (Figure 3.1).

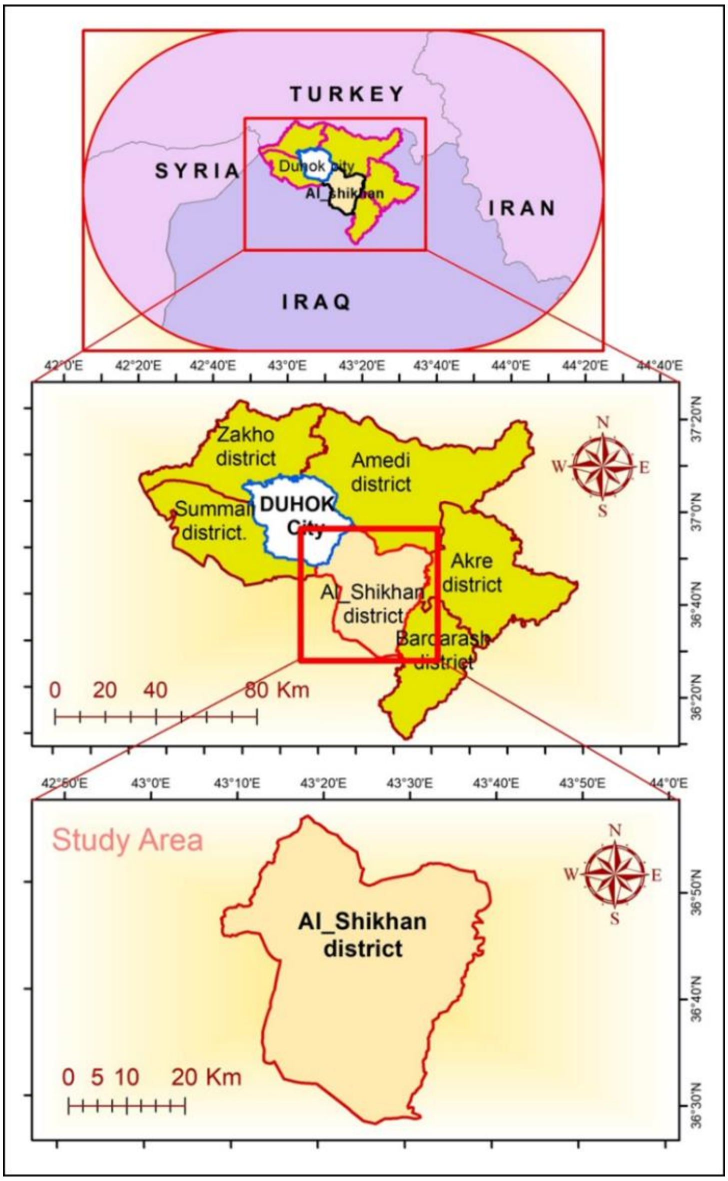

Figure 3.1. The Location of Sheklan district in northern Iraq

3.1.3. Climate of the Study Area

The study area is covered with mountains and climate is Mediterranean. The annual evaporation is higher than annual rainfall (Figure 3.2). The climate is defined by wide diurnal and annual ranges of temperature. The average temperature is 20 ºC with an average in summer high of 39.1 ºC in July and in winter low of 7.8 ºC in January .A unimodal rainfall regime lasts 4 to 5 months. The rainfall is low, irregular, and total dry period of the region is about 6 to 8 months. Mean annual rainfall is about 550 mm which occurs between December and April. The climate can be classified under semi-humid and semi-arid according to the classification schemes proposed by Emberger and Lang (Aziz 2002).

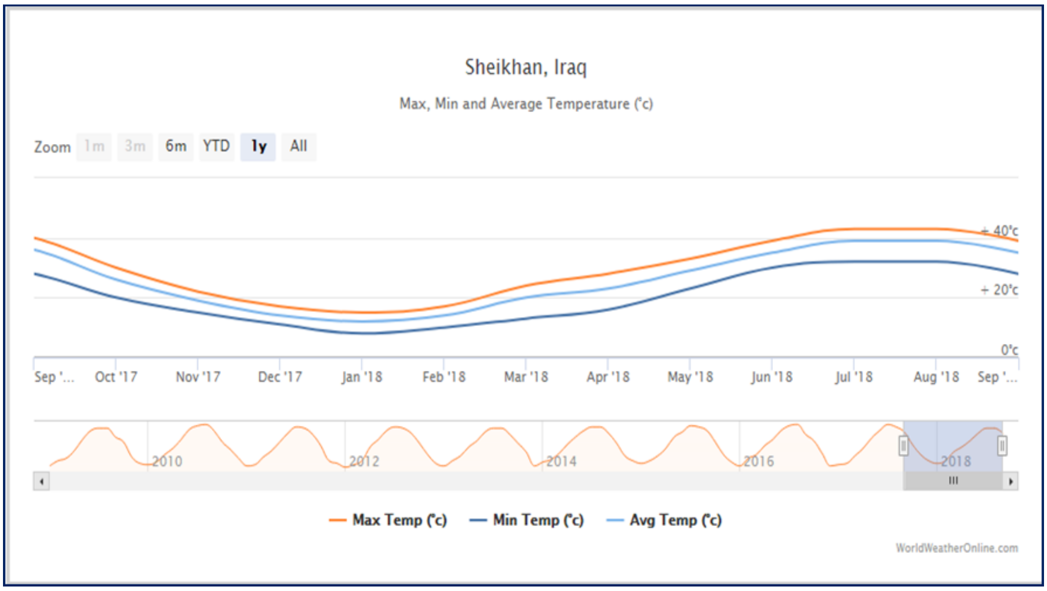

Figure 3.2. Average High/Low Temperatures for Shekhan, Iraq

The data for annual rainfall was obtained from the meteorological station in Mosul Governorate for 2002, 2013 and 2018 (Table 3.1). The climate of Shekhan district is warm and temperate. Significant precipitation occurs throughout the year. The district is classified as C_{fa} according to Koppen and Geiger. The average long-term annual temperature is 7.8 °C, and the average annual rainfall is 550 mm (Table 3.1, 3.2 and Figure 3.3). The minimum, maximum and the mean air temperatures and the relative humidity of the study area have been derived from the Ministry of Agriculture (Table 3.2).

Table 3.1. Annual rainfall for the studied years

Rainfall (mm)			
2002	2013	2018	Av.
545.6	574	457	525.533

Table 3.2. The air temperature of the Shekhan for the years 2002, 2013 and 2018

Air temperature (^{0}C)								
2002			2013			2018		
Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.
38	8.2	23.4	39.8	8.4	24.1	39.9	10.1	25

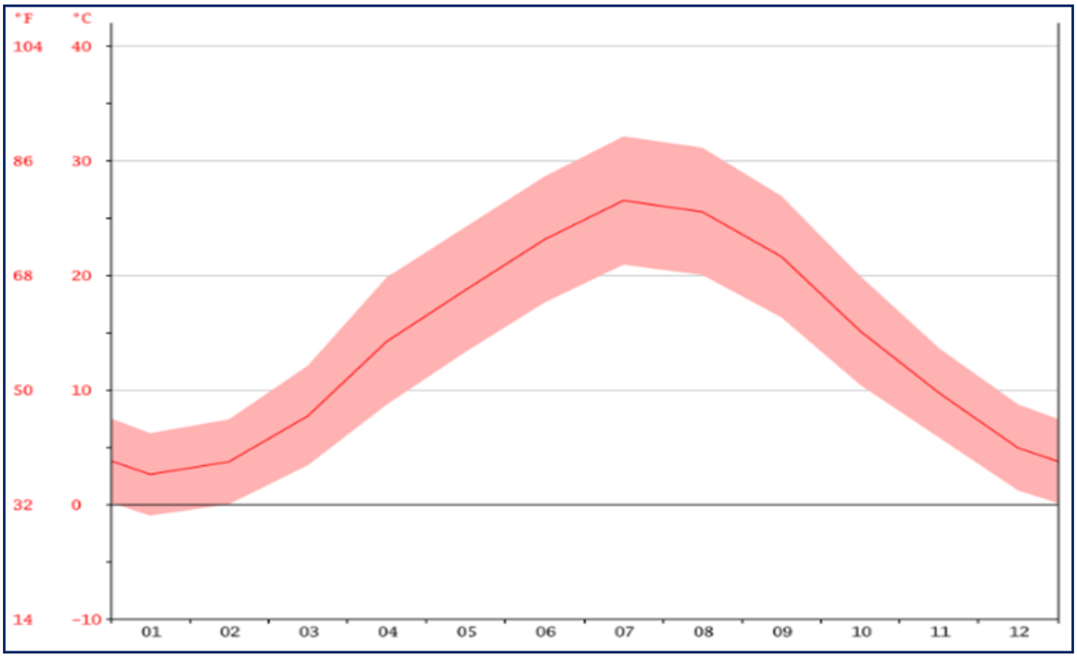

Figure 3.3. Average temperatures of Shekhan district

3.1.4. Vegetation Cover and Land Use

The LULC subjected to various differences in place and time due to the effects of land management activities and global warming. In order to take corrective and protective measures, it is essential to have accurate information about any area in the form of maps. Pasture, forest and agriculture lands are the main land uses in the district. The agriculture is non-intensive and tillage is mainly conventional using moldboard plow. The forest region includes forestlands in different degree of declination reaching from totally treeless spots close to villages present roads and areas exhibited to land sliding or dense erosion to almost dense forests at the distant sites or some sharp slopes (Guest, 1966)

Agriculture and livestock are the most general land use activities in Shekhan District. Small-scale agriculture is widely practiced with most production being for subsistence use while, medium-scale horticulture is to produce fruits in certain parts of the district. Increasing human population has led to loss of vegetation through deterioration, draught, farming, overgrazing and fuel wood (Mbugua 2002; Sindiga 1984).

3.2. Methods

The method section will contain information on field, laboratory and office works (Figure 3.4). There are abundant models related to LULC change. Despite the differences, the fundamentals and basic assumptions of the models were similar. Erdas 2015, ArcGIS (V. 10.4), Excelis ENVI 5.1 and Microsoft Office 2010 were used to produce maps in this study.

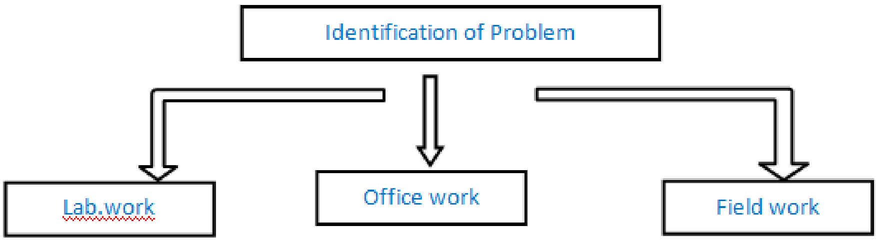

Figure 3.4. The flowchart of methods used in LULC assessments

3.2.1. Data Sets

Landsat images used included August 19/2002, August 9/2013 and 7 August 2018 Enhanced Thematic Mapper plus (Table 3.3). The three images were cloud free and dates of acquisition were close to each other.

Table 3.3. Characteristics of Landsat images (Anonymous, 2019)

Satellites	Two Landsat ETM+7 (2002)	Two Landsat 8 (2013)	2 Landsat 8 (2018)
Landsat Scene Identifier	LE71700342002231SGS00	LC81700342013221LGN02	LC81700342018219LGN00
	LE71700352002231SGS00	LC81700352013221LGN02	LC81700352018219LGN00
Date Acquired	2002/08/19	2013/08/09	2018/08/07
	2002/08/19	2013/08/09	2018/08/07
Center Latitude	37°28'33.60"N	37°28'28.78"N	37°28'27.37"N
	36°02'38.40"N	36°02'36.02"N	36°02'34.98"N
Center Longitude	43°06'37.80"E	43°12'36.07"E	43°14'09.56"E
	42°41'25.44"E	42°47'19.07"E	42°48'50.11"E

3.2.2. Soft System Methodology for the Study Area

Soft System Methodology is the way used for organizational process modeling and can also be used for common problems (Checkland 2001). The SSM aims to shape interventions in organizational administration and policy issues. However, it is usually applied where there are no simple problems or simple answers. It differs remarkably from the procedures developed in the 1960s and further reflects the research in its philosophy and approximation.

3.2.3. Land Use and Land Cover Effects of Changes

Climate change in recent decades has led to significant soil deterioration and LULC changes. Therefore, the problem of land degradation is considered to be one of the most important environmental problems to be addressed at the global level. Land degradation covers two interconnected systems in the form of natural ecosystems and socio-economic systems. The purpose of this study is to evaluate the dynamics of historical land degradation under changing of the land covers.

3.2.4. Land Use Change Trend

Numerous studies indicated that the globe had undertaking the largest wave of urban growth in past. The United Nations Population Fund revealed that fast population growth had severe in sectors of the world (UNFPA 2013). The report pointed out that the wide common of this growth will be noticed by the year 2030 in the developing countries of Africa and Asia where urban growth is so focused. The figure 3.5 shows the estimated and projected urban and rural population size of the world.

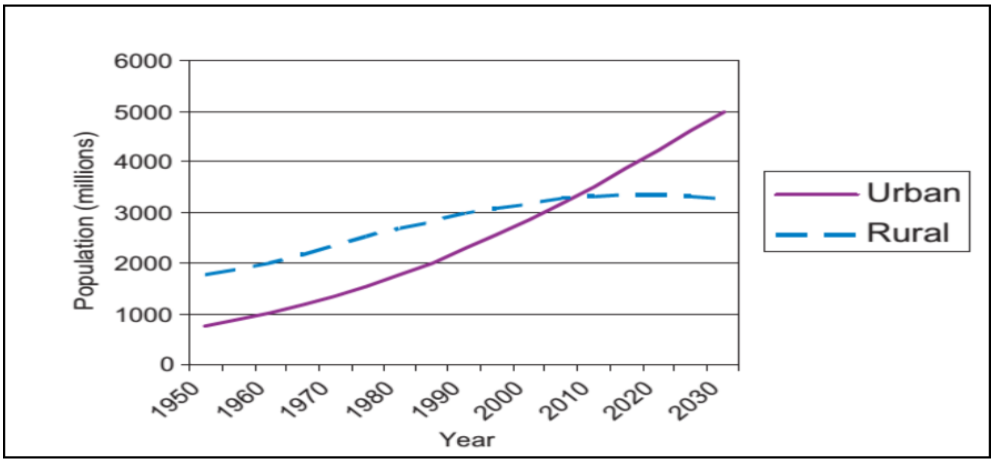

Figure 3.5. Estimated and projected world urban and rural population size from 1950 to 2030 (Cohen, 2006)

The transformation of agricultural land into industrial or residential areas has led to significant changes in the spatial distribution of the economy and population. Landowners play an important role in changing the use of their land and therefore their decisions determine the direction and extent of the changes (Ettema et al. 2007). The decisions of the landowner will significantly affect the impact of the land transformation. The landlord can change the land use type to improve and use it. Land use type can be improved and sold by the landowner. The owner may leave the land under current conditions or sell the land to the other owner. However, the options may differ for some landowners. If a farmer does not have the necessary investment capacity and ability, he/she is not qualified to improve his/her land in a suburban area. In addition, all actions may not be allowed, given the architectural plan arrangements.

3.2.5. Predicting Future Land Use Pattern

Continuous urbanization, which is the result of natural population growth and migration from the city center to the fringe regions of the city, leads to the formation of large and more comfortable and environmentally convenient living territories. The towns and cities continue to develop and evolve to meet the growing demands of the public. Continuous expansion of towns and cities results in a significant degradation in urban environment and quality of life beyond the loss of identity of their cities.

Land use planners contemplate and predict alternative future land use and activity patterns to change the existing state of affairs (Brail and Klosterman 2001). Due to the diversity of factors, it is a very difficult task to assess future land change. For this reason, a detailed scientific evaluation should be performed to understand the consequences of land use change (Meyer and Turner, 1994). A typical land use planning process requires the landscape planners to carry out, categorize, explore the prevailing conditions to plan future development design and recommend schema according to existing information (Brail and Klosterman, 2001).

A basic or traditional and methodological approach is used to predict future LULC changes (Brail and Klosterman 2001). The traditional approach predicts the outcomes for the impacts of land use change. The methodological approach imitates the current alternative strategies and compares the results. One of the most commonly used approaches to consider and simulate the effects of human decisions on LUCC has been the use of multiple factors (Parker et al. 2003; Matthews 2006; Robinson et al. 2007; Valbuena et al. 2008). This approach is defined as modeling tools that enable farms or people to make decisions based on pre-defined factors. Indeed, factors in the system represent groups of people or individuals (Valbuena et al. 2008; Sawyer 2003; Bonabeau 2002; Crawford et al. 2005).

3.2.6. Approaches to the LUCC Modeling

Several models have been developed to model the changes in LULC. Despite the differences in their names of the groups who worked on them, they basically rely on basic facts and similar assumptions. The most widely used LULC models are economic models

(Irwin and Geoghegan 2001), spatial interaction and cellular automata (Yang et al. 2008), statistical models (Veldkamp and Lambin 2001), optimization techniques (Ducheyne 2003), rule-based models, multiple agent models (Torrens 2006b) and microsimulation (Timmermans 2003).

This study aimed to introduce an overview to traditional and current LULC modeling techniques and eventually suggest multi-agent-based systems as a complementary tool. In a few words, the strengths and weaknesses of some models will be discussed here. This assessment is not in-depth and only presents the best methods which can be complemented by multi-agent systems (MAS). Some of commonly used models are; i.) Equation-Based Models, ii.) System Models, ii.) Cellular Models, iv.) Hybrid Models, v.) Multi-Agent Models, and vi.) Microsimulation.

3.2.7. Agricultural Lands, Loss of Agriculture Lands

Cotic and Kenk (1983) defined agriculture as the ability to produce by using systematic and controlled use of living organisms and the environment to improve human living standards. Agricultural land is a part of the plant where animal and vegetable productions are carried out and it is a valuable natural asset which is absolutely necessary for the sustainability of food and fiber production. Agricultural land is a natural asset for the production of fiber and fuel as well as the food required for human and animal consumption. Biological, chemical, physical, and mechanical inputs are necessary for crop production and are finally supplied by soil, moisture, temperature, plants, humans, animals and creatures living within soil system. In a fertile agricultural structure, necessary inputs are controlled by conservative agricultural practices including the selection of seeds, planting, fertilizer application, irrigation and all kinds of management works. Sustainable land use provides and maintains the inputs required for efficient agricultural production (Agyemang et al. 2011). Some agricultural lands are convenient to produce several types of agricultural products. The main limiting factors in agricultural production are the slope and other aspects of topography, climate characteristics such as low and very high rainfall, low and high temperature, and the existence of water for irrigation. Climate is responsible for the heat energy and humidity inputs required for agricultural production. Topography limits the ability to use equipment for planting and may cause superficial flow (Andres et al. 2004).

The use of agricultural lands with different purposes, such as urbanization and the industrial sector, jeopardizes the security of agricultural production. Many of the lands which have been used for agricultural production have lost their productivity, due to the loss of their functions. The agricultural production in the lands close to the cities or industries are not feasible due to the intensive interactions of human activities. The population increase along with urbanization led to the intensive migration from rural to urban areas had significant negative effects on agricultural lands surrounding the cities. Urbanization exerts a higher pressure on agricultural lands due to the demand for more agricultural products both to provide food and fiber for increased urban populations and to compensate for the changes in the demands of new generations. This situation has caused and continues to lead fundamental changes in the farmers, companies, corporations and local and national economies to meet the demands of increasing populations. It may also bring important challenges for the security of urban and rural food supply (Mcgranahan et al. 2009). As urbanization expands, the disposal of agricultural land accelerates and food production is affected more significantly. Neglect of agricultural lands begins to increase when a trend towards urbanization initiates. Urbanization leads to the failure of the land to fulfill its fundamental functions, to the fragmentation of lands, to the increase in the demand for land and to a rapid rise in the land values. Therefore, the use of agricultural lands for urban settlement causes a decrease in the quantity and quality of the lands (Dinye et al. 2013).

3.2.8. Impact of Urbanization on Vegetation Cover

The vegetation coverage within the urban areas plays a major role in providing an environment for recreation for the inhabitants also as energy conversion and material circulation of the Earth and vegetation cover is a visual sign of ecosystem health. Although the dynamic evolution of vegetation cover is affected by natural and anthropogenic factors the impact of anthropogenic factors on the vegetation cover change is more significant than that of natural factors in the regions with frequent human activities (Huang et al, 2013).

Studies on human population and vegetation mostly focus on the negative effects of vegetation on human activities. A large part of the plant-covered areas in or around many cities are being transformed due to the increase in land, and the ones that remain gray are threatened by urban land use. Manawadu and Wijesekera (2009) reported significant negative relationship between the area of vegetation cover and the level of urbanization and human activities. The density of green vegetation was used to test the presence and health of plants. Urbanization, which is constructed by the destruction of natural vegetation, causes serious and permanent changes in the natural vegetation cover. In particular, the expansion of industrial areas in urban areas towards agricultural lands has had a significant impact on the depletion of vegetation cover. Conversion of forests and natural pasture areas into agricultural production areas has led to the destruction of a large part of the original vegetation cover.

3.2.9. Climate Change

Climate change can be defined as an irregularity in the arithmetic distribution of parameters such as temperature and precipitation over a long period of time. Climate change at regional, local and worldwide scales caused significant changes in LULC. Climatic change is the most serious threat facing the world. The change in climate is mostly due to the fact that greenhouse gas concentrations in the atmosphere (GHG) naturally exceed the expected threshold values. It is believed that the burning of fossil fuels such as oil, coal and natural gas as a source of energy is the main reason for increasing greenhouse gas concentrations.

3.2.10. Soil Properties and Their Reflectance

The characteristics of various soil components can provide information about the reflection from the soil or, conversely, soil reflection may contribute to the descriptive information on soil properties and soil quality. Significantly high correlation was reported between the soil composition, mineral composition, organic matter content, moisture content, texture, the presence of various iron oxides, color and soluble salt content (Bowers and Hanks 1975). The absorption of the energy is increased and the spectral reflection rate is decreased with the increase in organic matter content of the soil surface. Generally, the amount of organic matter in the soil has a decisive effect on the spectral reflecting properties of the soils (Salman 2006). Moist soils appear darker in the spectrum at all short wavelengths due to reduced radiation of reflection (Bowers and Hanks 1975). Reflection spectra of moist soils are prominent at 1.4 and 1.9 cm wavelength. Mohan

(2008) pointed out that soil color is one of the basic soil physical properties and that the color of soil in a field is usually related to the specific chemical, physical and biological properties and some other important soil characteristics. The soil color is defined as a function of the physical, chemical, mineralogical composition and moisture content of soils (Tangasamy et al. 2005).

Very few of the minerals found in nature are pure. Depending on the trace elements held in the crystal lattices during the formation of the minerals, the color of the same mineral may change. This situation results a complexity of the mineral's reflective properties. The spectral reflection and absorption characteristics of some soil minerals were given in (Table 3.4).

Table 3.4. Spectral reflectance and absorption features of soil minerals

Soil Mineral	**Absorption bands**
Silicates	1.4 - 2.5μm
Calcite	1.8 - 2.3 μm
Kaolinite (1:1 clay mineral)	1.4 - 2.2 μm
Gypsum	1.8 - 2.3 μm
Montmorillonite (2:1clay mineral)	1.4 - 1.9 μm

Increase in the electrical conductivity of soil results in an increase in spectral reflectance curves. When the value of electrical conductivity reaches to 14 dS m^{-1}, the spectral curve starts to decrease (Salman 2006). The soil texture is defined as the size distribution of the soil particles. Mohan (2008) defines the soil texture as a relative evaluation of soil particle sizes. Since the proportional distribution of sand, silt and clay particles, which is a genetic characteristic of the soil, is a basic soil property, it cannot be easily changed by the applications in land. Landey et al. (1982) described the structure of soil as a structure in which sand, clay and silt particles are combined with organic material-like cementing agents. Soil structure plays an important role in controlling the water movement, heat transfer, porosity, reflection and mass density in soil (Iron et al. 1989).

4. RESULTS AND DISCUSSION

4.1. Remotely Sensed Datasets

4..1.1. Landsat images

Three Landsat (ETM^+) images acquired on August 19 2002 (7 bands) and August 09 2013 ETM^+ sensor on board Landsat 8. The images were downloaded from the http//earth explorer usgs.gov. While the last image was acquired on August 07 2018 (8 band) by ETM^+ sensor on board Landsat 8. The ETM^+ image has an extra panchromatic band (band 8) with spatial resolution of 30 meters. Figures 4.1a, b and c exhibit the color composite (RGB 741) of the study area for 2002, 2013 and 2018.

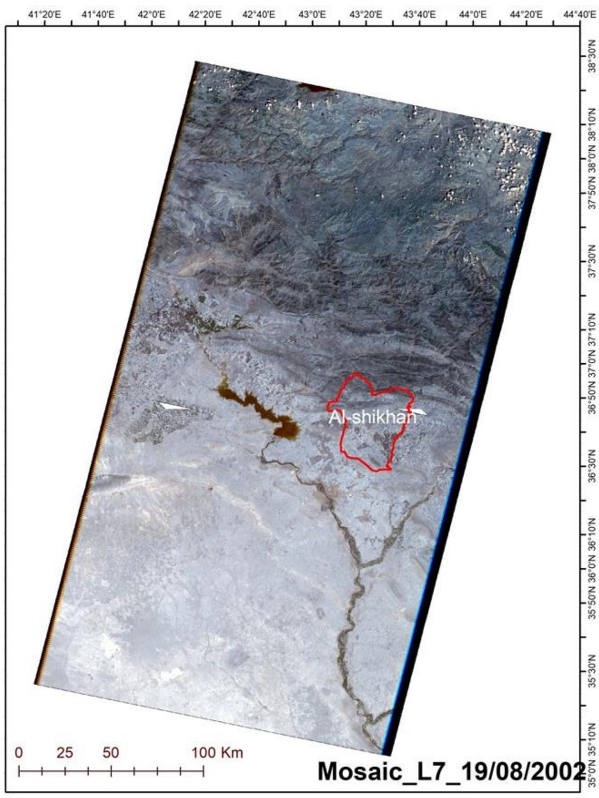

Figure 4.1a. A color composite (RGB 741) of the study area for 2002

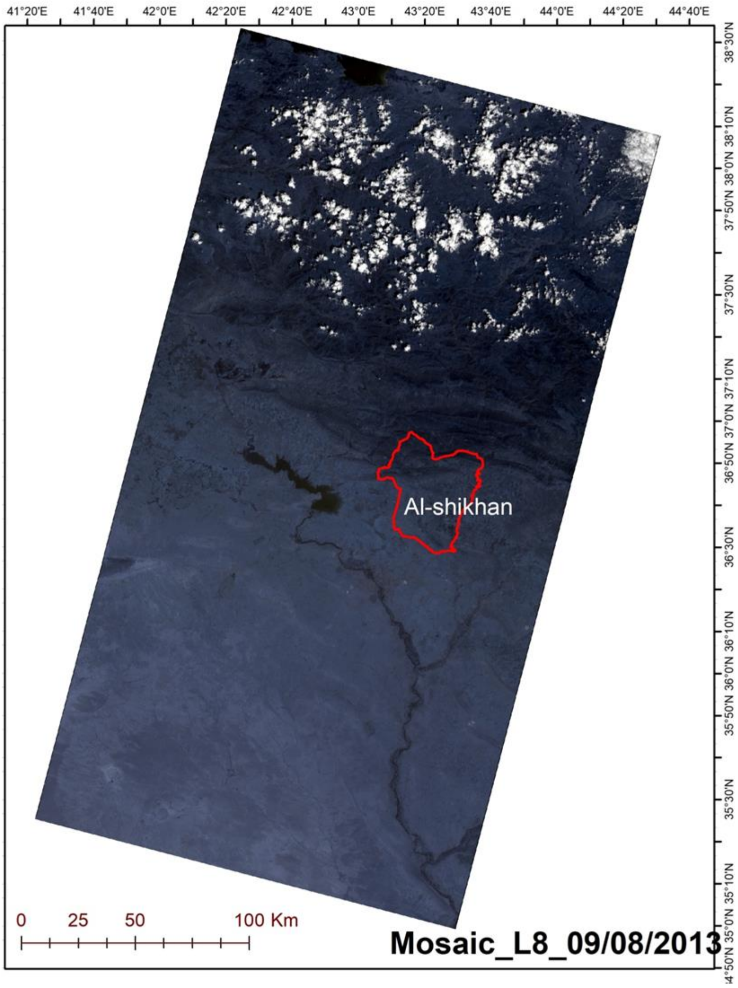

Figure 4.1b. A color composite (RGB 741) of the study area for 2013

Figure 4.1c. A color composite (RGB 741) of the study area for 2018

4.1.2. Landsat Data

Landsat images used in this study included are presented in the following figures (Figures 4.1a, b and c) and information on images were presented in Table 4.1. The dates of images were determined based the cloud free conditions. The dates were acquisition were chosen as possible as they can.

Table 4.1. Characteristics of the Landsat images (from USGS Earth Explorer website)

Satellites	Two Landsat ETM+7 (2002)	Two Landsat 8 (2013)	Two Landsat 8 (2018)
Landsat Scene Identifier	LE71700342002231SGS00	LC81700342013221LGN02	LC81700342018219LGN00
	LE71700352002231SGS00	LC81700352013221LGN02	LC81700352018219LGN00
Date Acquired	2002/08/19	2013/08/09	2018/08/07
	2002/08/19	2013/08/09	2018/08/07
Center Latitude	37°28'33.60"N	37°28'28.78"N	37°28'27.37"N
	36°02'38.40"N	36°02'36.02"N	36°02'34.98"N
Center Longitude	43°06'37.80"E	43°12'36.07"E	43°14'09.56"E
	42°41'25.44"E	42°47'19.07"E	42°48'50.11"E

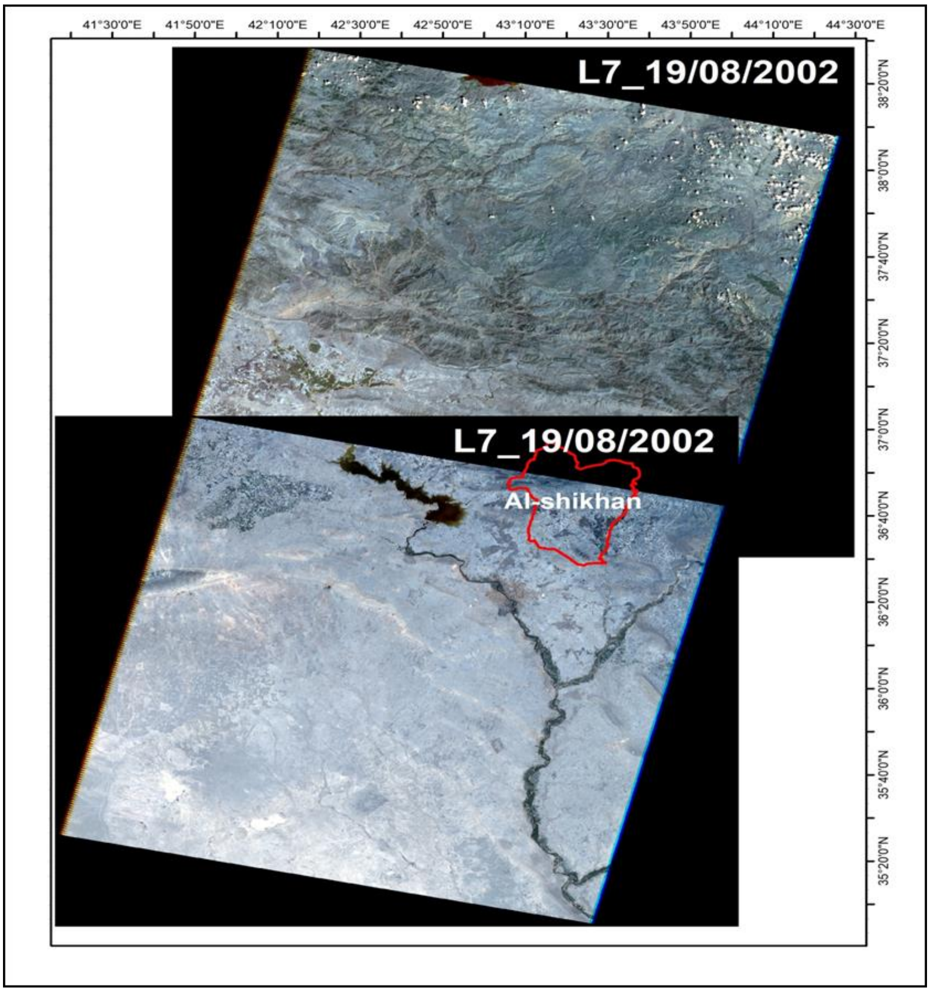

Figure 4.2a. The Satellite image of the study area for 2002

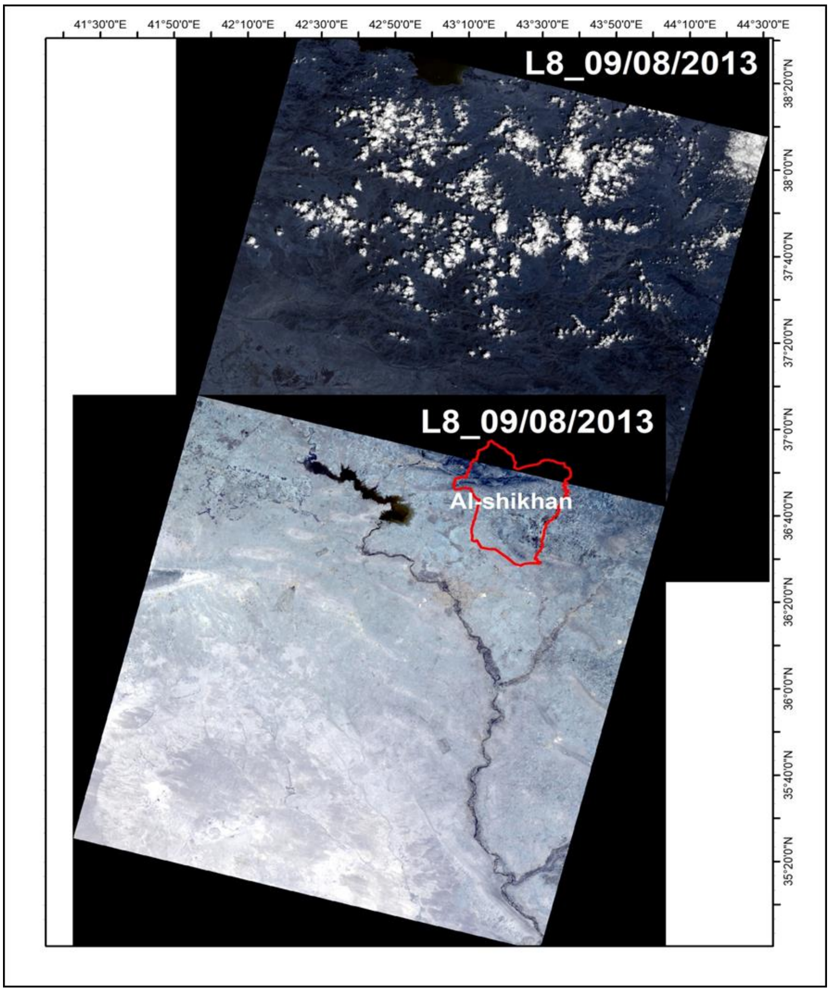

Figure 4.2b. The Satellite images of the study area for 2013

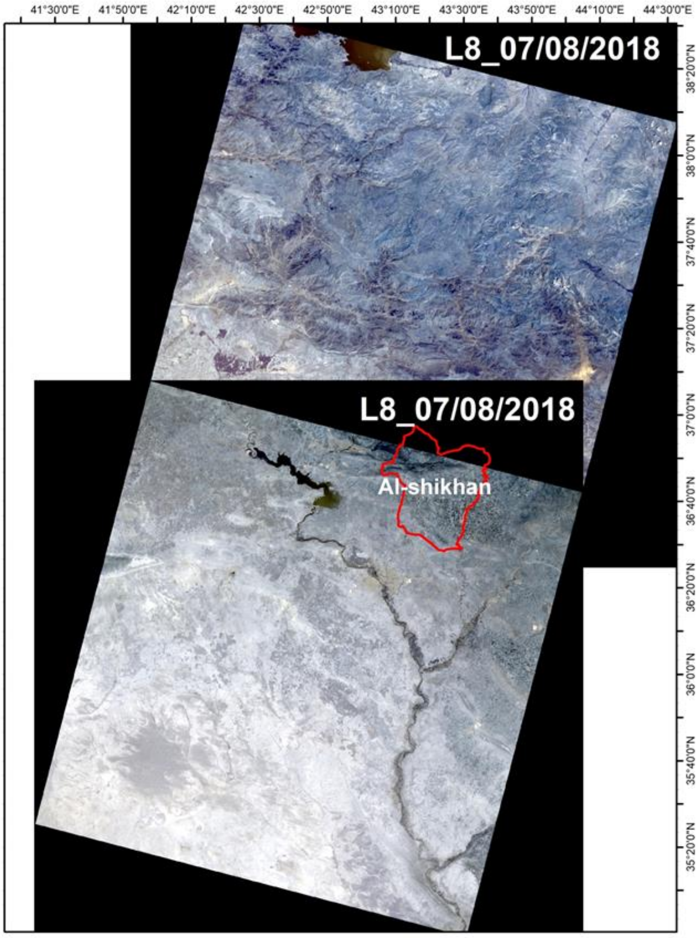

Figure 4.2c. The Satellite images of the study area for 2018

4.2. The Normalized Difference Vegetation Index (NDVI)

The normalized difference vegetation index was calculated as the ratio of band 3 (Red - R‖: 0.63 - 0.69 μm) and band 4 (Near Infrared - NIR‖: 0.76 - 0.90 μm) of the Landsat TM, and ETM+ dataset images. NDVI is a very frequently used vegetation index that assigns values of zero for the areas where vegetation is not available, but assigns values ranging from -1.0 to 1.0 for places with plants. While the negative values of NDVI indicate vegetation surfaces, the values of approximately 1.0 indicate the presence of very dense vegetation cover. The NDVI method is capable of reducing external noise factors such as topographic effects and solar angle changes. Rouse et al. (1974) stated that NDVI is sensitive to rain and that there is a positive relationship between them. In this study, NDVI algorithm was used to monitor vegetation changes.

NDVI = (TM4 – TM3) / (TM4+TM3) which is (Near infrared wavelength – red wavelength)/ (Near-infrared wavelength + red wavelength).

4.3. Image Processing

The three Landsat images were already geo-rectified and the images were re-projected to UTM zone 38N and subset to the study area using Shekhan district boundary shapefile. MODIS images were subset to Shekhan district and then re-projected to UTM zone 38N. Preliminary processing of satellite images prior to classification and change detection analysis is a very important step in terms of increasing the reliability of the process. The pretreatment for this purpose consists of four consecutive steps which are atmospheric and geometric corrections, registration of the image and masking. The image preprocessing steps are usually performed before the enhancement of post-processing, retraction and image analysis to retrieve the information. Generally, image data is preprocessed by the specified operations before delivering the data to the user. Preliminary processing of image data includes radiometric and geometric corrections.

4.4. Layer Staking

The combination of several images into a single image called a layer stacking. Therefore, the images must have the same number of rows and columns. This means that other bands with different spatial resolution need to be resampled in order to obtain the appropriate resolution. That is, all images / bands must have the same spatial resolution in order to achieve layer stacking. Combining images/bands will increase the stacked image size, and then increase the processing time of the analysis (Figure 4.3, 4.4 and 4.5).

ENVI ⟶ Basic tools ⟶ Layer Stacking

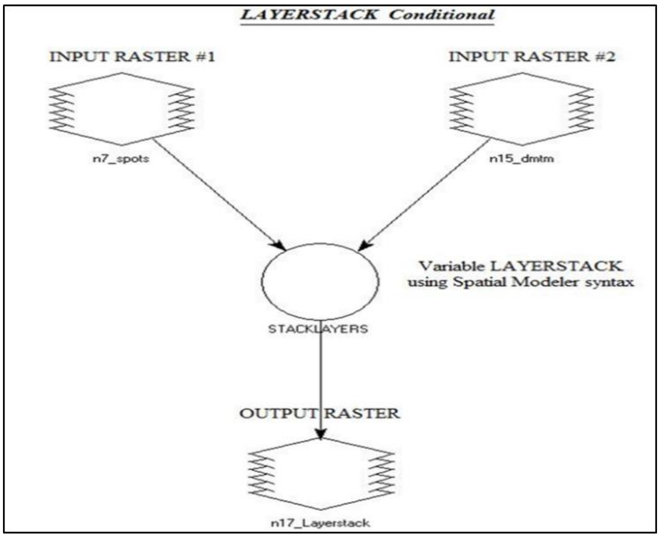

Figure 4.3. Workflow of layer stacking process (ERDAS imagine software)

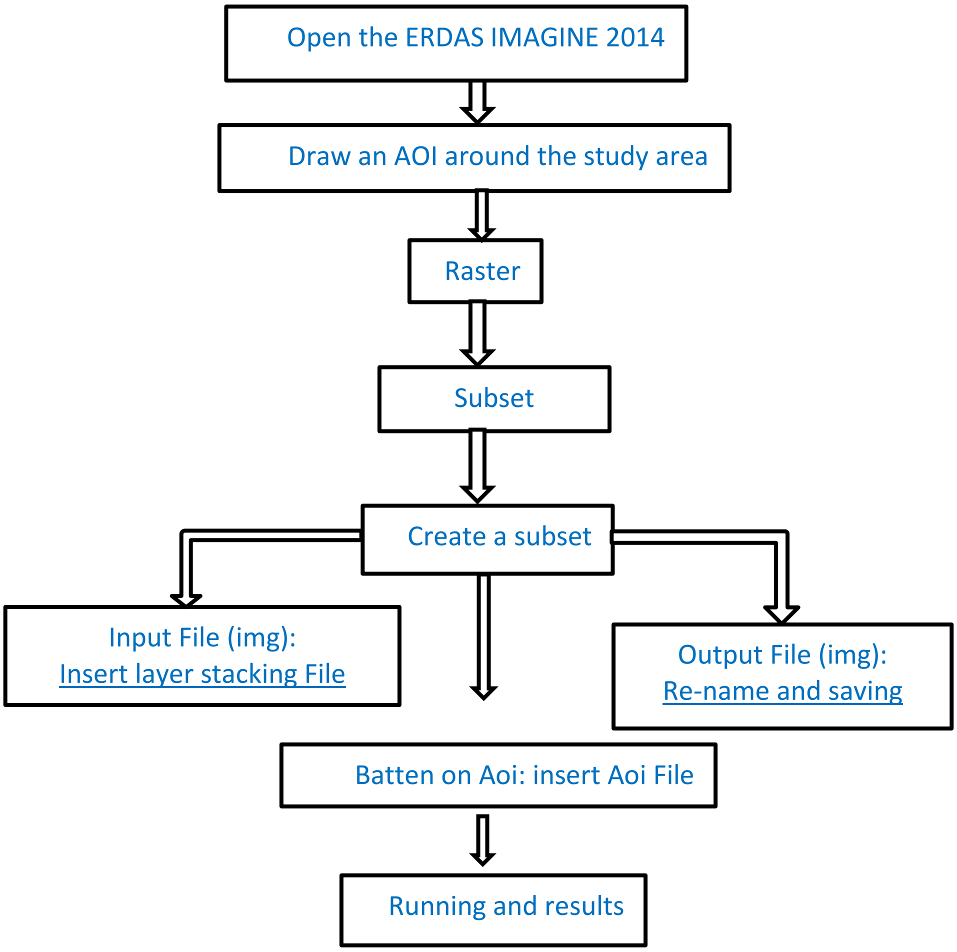

Figure 4.4. Workflow of the subset process in ERDAS IMAGINE 2014 software

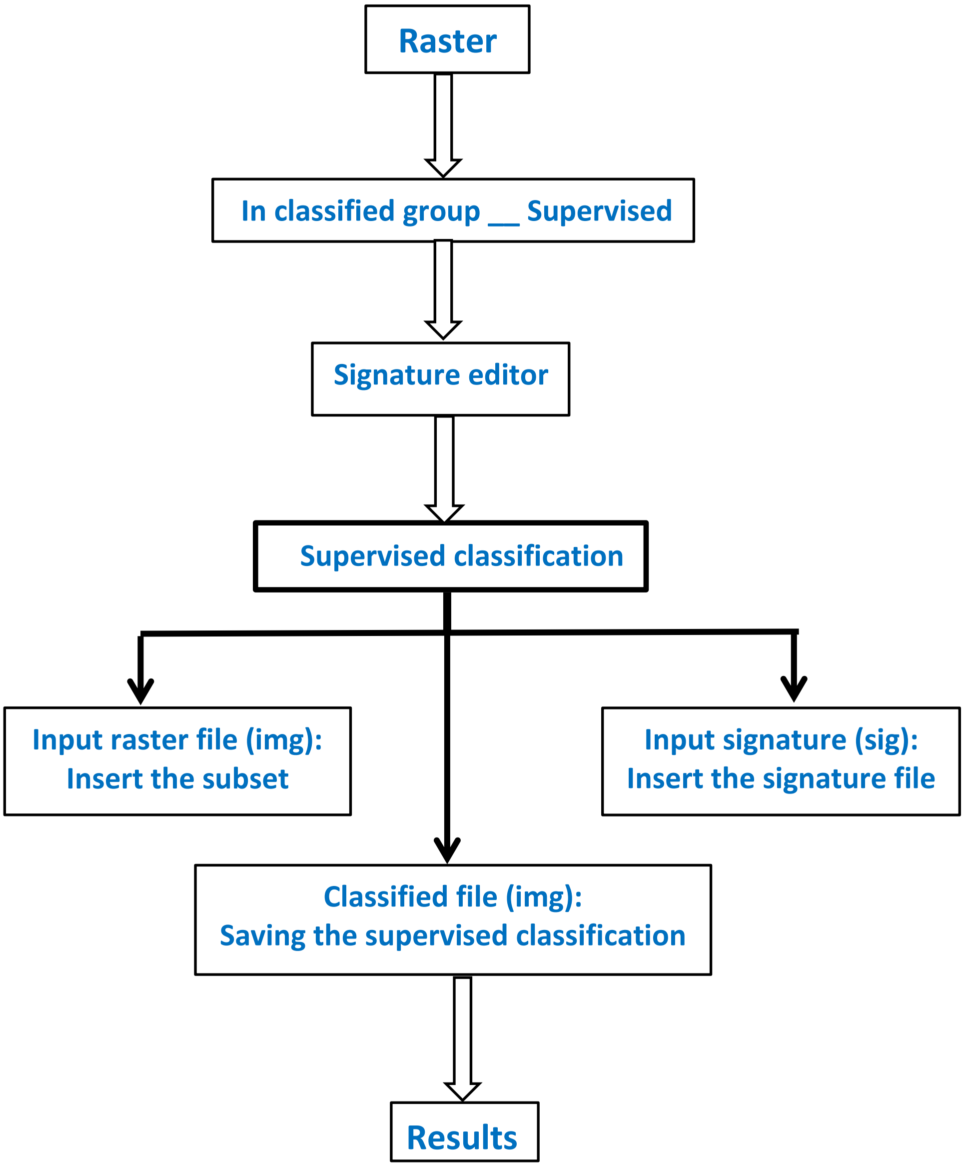

Figure 4.5. Workflow defining the supervised classification method

4.5. Classification of the 2002 Landsat TM Image

The supervised classification was run on 2002 Landsat TM image yielded results with most of the classes mixed. The residential area was well separated with the resulting spectral cluster. The residential area was well separated from most of the other classes. The image of 2002 has spectral similarities between classes and the classification of image resulted in five classes. The class defined as other covered 58.81% of the study area followed by low vegetation with 38.30%. High vegetation land covered 1.87%, residential area was 0.79% and water body was 0.22 % (Table 4.2 and Figure 4.6).

Table 4.2. Coverage area of land cover classes in 2002 in land cover map

Classes	2002	
	Area (km^2)	**Percentage %**
Residential area	11.1374	0.79
Water body	3.17	0.22
High vegetation	26.4901	1.87
Low vegetation	541.6924	38.30
Others	831.64.23	58.81
Total	1414.1322	100

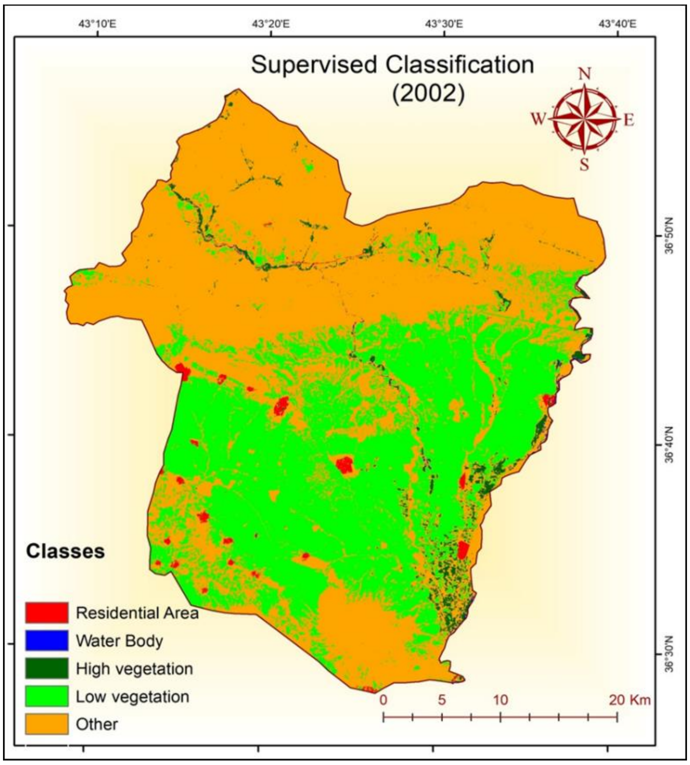

Figure 4.6. Land use and land cover change map of the study area for 2002

4.6. Classification of the 2013 Landsat ETM+ Image

The image of 2013 was classified, and the resulting spectral clusters were mostly mixed. The classification of the image resulted in a 2013 land cover map with five classes (Figure 4.7). The class of other covered 53.02% of the study area followed by low vegetation at a rate of 41.54% which increased compared to the 2002 image. High vegetation land covered 3.49 %, residential area covered 1.70% and water body was 0.25% (Table 4.3 and Figure 4.7).

Table 4.3. Area covered by each land cover class in 2013 land cover map

Classes	**2013**	
	Area (km^2)	**Percentage**
Residential area	24.0064	1.70
Water body	3.5556	0.25
High vegetation	49.3622	3.49
Low vegetation	587.405	41.54
Other	749.803	53.02
Total	1414.1322	100

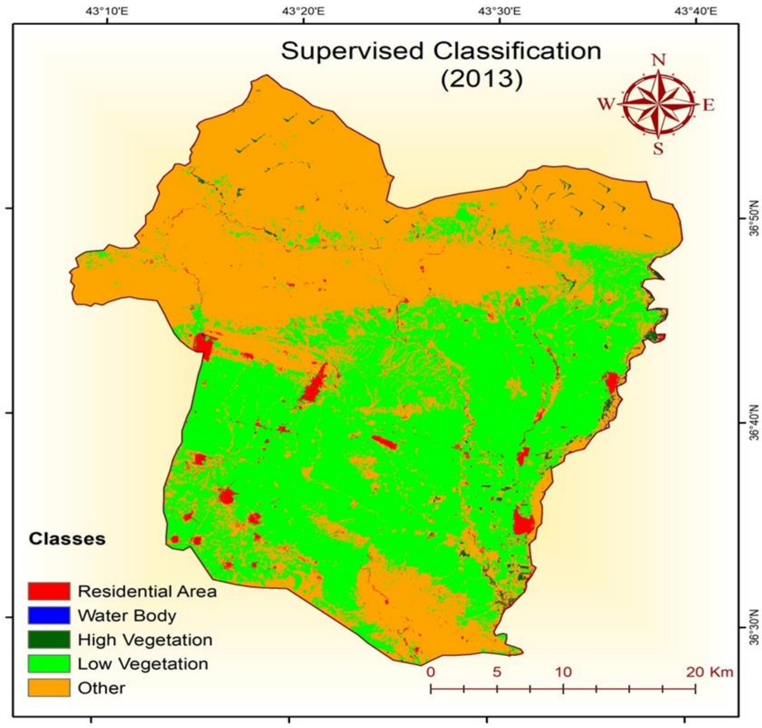

Figure 4.7. Land use and land cover change map of the study area for 2013

4.7. Classification of the 2018 Landsat ETM$^+$ Image

The classification of the image for 2018 resulted in five land cover classes (Figure 4.8). The class of other covered 62.9% followed by low vegetation at a rate of 30.18%. The high vegetation land covered 4.72 %, residential area covered 1.79% and water body was 0.36 % (Table 4.4).

Table 4.4. The area covered by each land cover class in 2007 land cover map

Classes	**2018**	
	Area (ha)	**Area (%)**
Residential area	2534.65	1.79
Water body	511.02	0.36
High vegetation	6681.25	4.72
Low vegetation	42675.5	30.18
Other	89010.8	62.9
Total	141413.22	100

4.8. Subset

A sub-process was applied in the ERDAS Imagine program to choose the trained area of Landsat images (Figure 4.9).

Envi → Basic tools → Subset Data Via ROIs

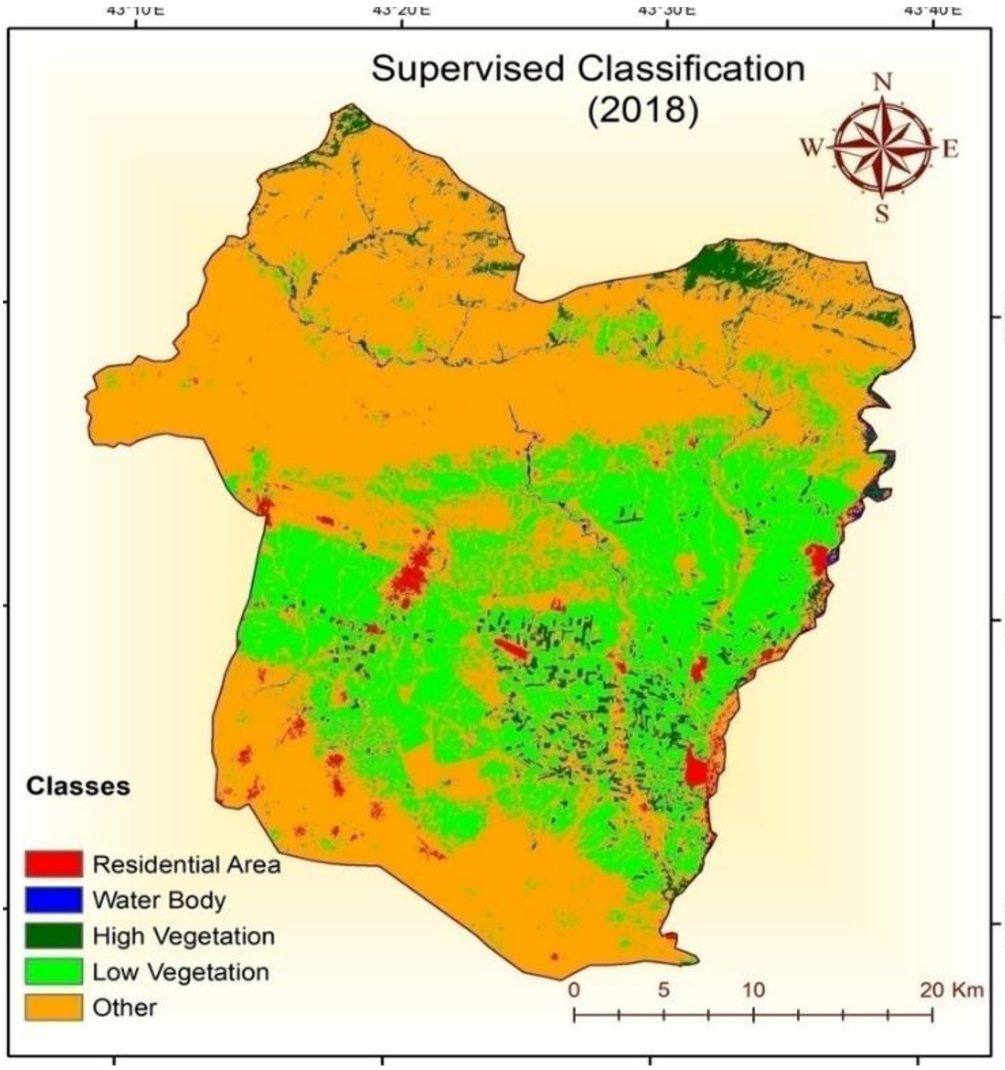

Figure 4.8. Land use / land cover change map of the study area for 2018

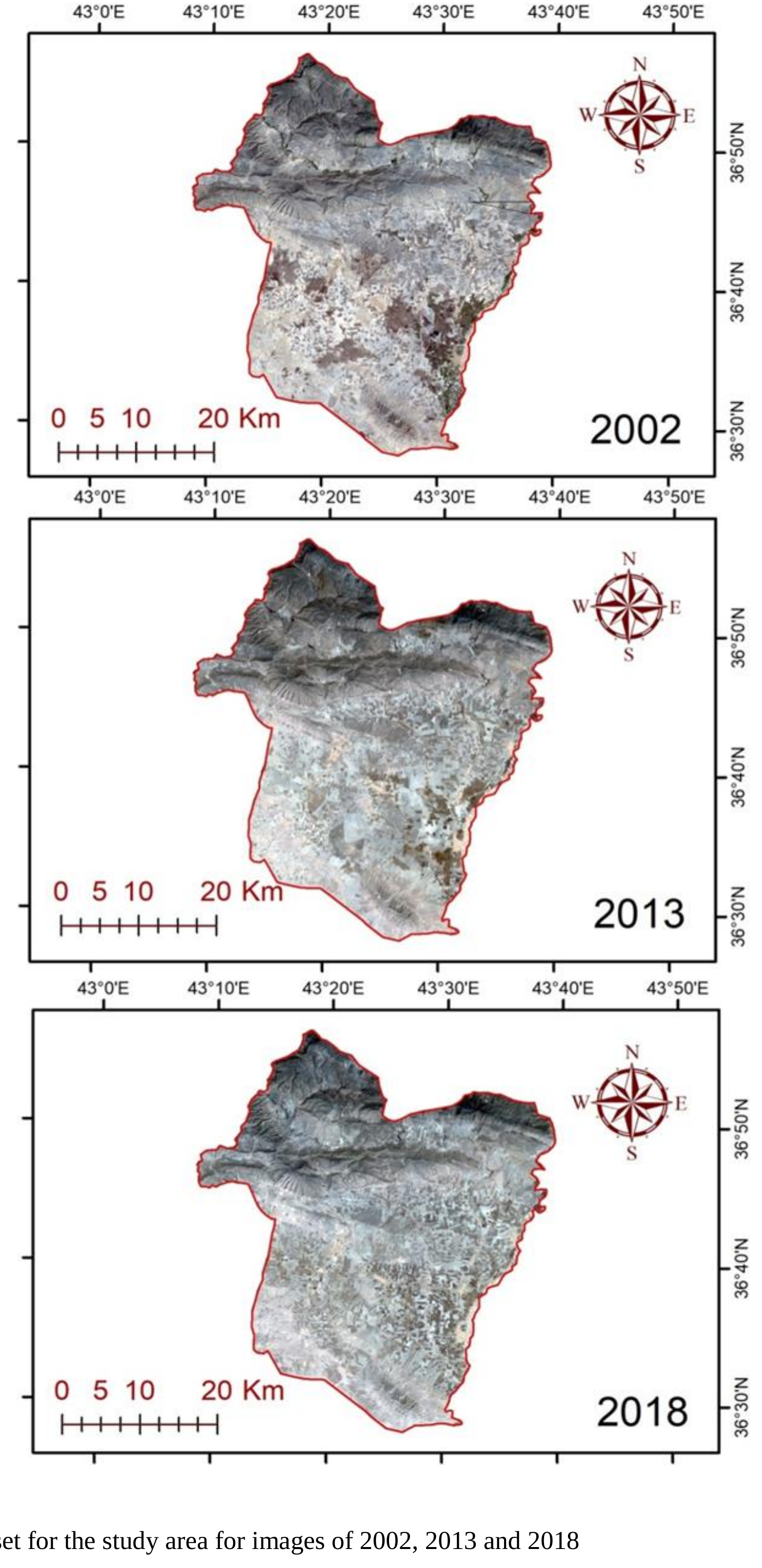

Figure 4.9. Subset for the study area for images of 2002, 2013 and 2018

4.9. Classification

Classification of the three Landsat images allowed to separate the five classes indicated in the classification tables. The classes were defined based on field work experience and an alteration of classification scheme (FAO 1997), and a hierarchical class system was adopted. The five criteria for including an area within boundary are residential area, water body, high vegetation, low vegetation and others (Table 4.5). The maximum likelihood of supervised classification was utilized to determine the LULC change and detect any change among the land cover classes between 2002, 2013 and 2018. The results of image classification indicated a variation among the classes between 2002 and 2018. The differences can be visually grasped in Figure 4.10 which demonstrated the chief land cover types. Red color in Figure 4.10 presents the residential area, blue color shows water body, dark green color indicates high vegetation. Green color presents low vegetation and the other shows soils, grass land, shrubs and wrong pixels on the image.

Table 4.5. Landsat classification of study area for 2002, 2013 and 2018

Classes	2002	2013	2018
	Area (ha)	Area (ha)	Area (ha)
Residential area	1113.74	2400.64	2534.65
Water body	317	355.56	511.02
High vegetation	2649.01	4936.22	6681.25
Low vegetation	54169.24	58740.5	42675.5
Other	83164.23	74980.3	89010.8
Total	141413.22	141413.22	141413.22

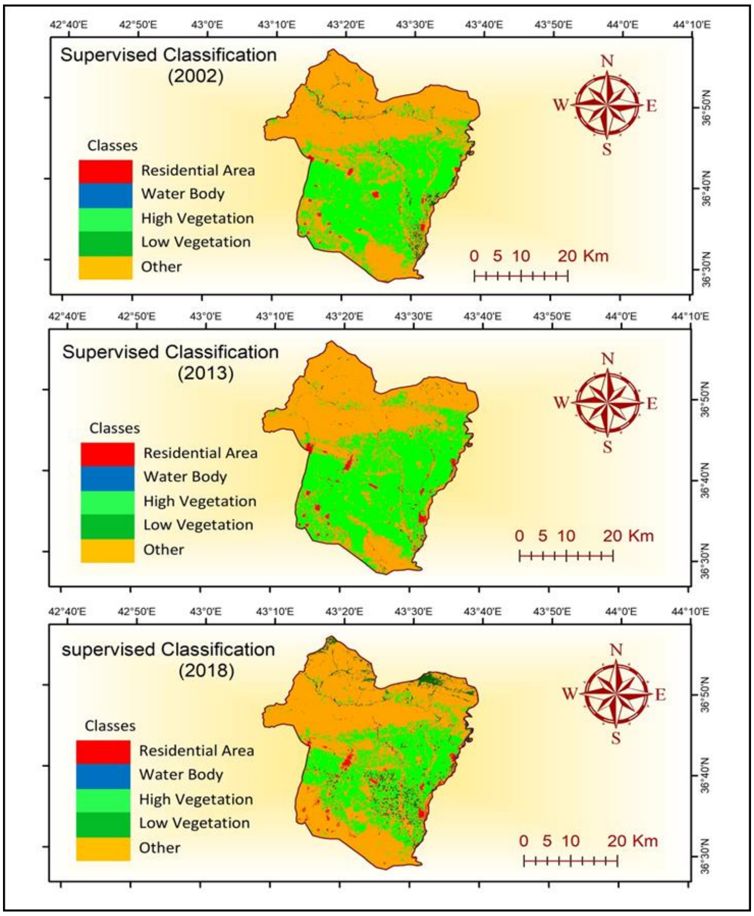

Figure 4.10. Supervised classification map of the study area for 2002, 2013 and 2018

The classification of three Landsat images was set to separate five classes as indicated in the following classification scheme (Table 4.6).

Table 4.6. Description of land use and land cove classes of the study area

Classes	Description	Color
Residential area	Houses, streets, concrete, asphalt, industries	Red
Water body	Dams, rivers, lakes.	Blue
High vegetation	Wet agriculture, national park, garden forest area, around the rivers.	Dark green
Low vegetation	Dry agriculture.	green
Other	Soils, grass land, shrubs, wrong pixels on the image.	Orange

4.10. Change Detection

Change detection is a process that allows the observation of changes in the field at a given time interval (Tewolde and Cabral 2011). Class-level metrics, such as the transition matrix, have been considered in order to determine the change. Several change detection techniques were used in this study and their applicability in mapping land cover change in arid lands evaluated. The techniques included classification comparison vegetation index differencing.

Noticeable changes occurred in resedintial area. The residental area was 1113.74 ha with a ratio of 0.79% in 2002, increased to 2400.65 ha in 2013 and to 2534.65 with a ratio of 1.7% in 2018 (Table 4.7). Similar to residental area, coverage area of water body also increased in the study area. High vegetation area in 2002 was 2649.01 ha with a ratio of 1.87% and increased to 6681.25 ha in 2018 with a ration of 4.71%.

Table 4.7. The LULC change detection between 2002 and 2018

Classes	**2002**		**2013**		**2018**	
	Area ha	**Area %**	**Area ha**	**Area%**	**Area ha**	**Area %**
Residential area	1113.74	0.79	2400.64	1.70	2534.65	1.79
Water body	317	0.22	355.56	0.25	511.02	0.36
High vegetation	2649.01	1.87	4936.22	3.49	6681.25	4.72
Low vegetation	54169.24	38.30	58740.5	41.54	42675.5	30.18
Other	83164.23	58.81	74980.3	53.02	89010.8	62.9
Total	141413.22	100	141413.22	100	141413.22	100

The LULC change analysis in study area indicated that residential area, water body, high vegetation and other land cover types have increased from 2002 to 2018 (Table 4.8). Population pressure between 2002 and 2018, the number of households in the area increased whereas the total population grew at a rate of 5.5% per year and more than tripled in size. This may indicate that half of the population is young and economically dependent. Therefore, human pressure on land resources is not only high but may also continue to be high in the foreseeable future.

Table 4.8. The percentage of changes in LULC classes between 2002 and 2018

Classes	% difference (2002-2013)	Description	% difference (2013-2018)	Description
Residential area	0.91	Increase	0.09	Increase
Water body	0.03	Increase	0.11	Increase
High vegetation	1.62	Increase	1.23	Increase
Low vegetation	3.24	Increase	11.36	Decrease
Other	5.79	Decrease	9.88	Increase

4.11. Accuracy Assessment

After the classification process, accuracy of the process was assessed by using method of confusion matrix by using ENVI software in remote sensing. The result of the overall accuracy and kappa coefficient for 2002, 2013 and 2018 were shown in Table 4.9. The accuracy estimation is a term used to compare a classification of geographical data that are assumed to be correct. The error matrix compares the basic fact data with the classification results. The error matrix columns represent the reference data and the rows indicate the classification generated from the classified image. It also presents an excellent summary of two thematic errors, such as neglect and commission (Senseman et al. 1995; Maingi et al. 2002).

The process of classifying the correct measurement at the highest level is derived from an error matrix. The most commonly used percentage for this process is correctly allocated cases. Accordingly, while the accuracy of the user indicates the likelihood of the estimated pixel by default on the ground, as in the categorized image, the manufacturer's accuracy refers to the fraction of a given class that is correctly defined on the map (Yesserie 2009).

Table 4.9. Error matrix summary for the classified Landsat images

Landsat images	Overall classification accuracy	Overall kappa statistics
L7 image 2002	87.20%	0.76
L8 image 2013	89.20%	0.80
L8 image 2018	93.20%	0.87

Overall accuracy is a total of classification accuracy. The accuracy in 2002 was 87.2%, 89.2% in 2013 and 93.2% in 2018 (Table 4.9). The Kappa coefficient greater than 80% indicates that it has a strong regulation and significant accuracy. In this study, the value of kappa coefficient was 0.76% in 2002, 0.80 in 2013 and 0.87% in 2018 (Table 4.9).

4.12. Causes of the Land Cover Change

The land cover change pattern in Shekhan District might be attributed to a complex interaction of environmental, socio-economic and demographic factors. Shekhan has experiencing moderate population growth. The center of district population density was 69132. According to population data for the Nineveh Governorate, the population density increased. Based on population census, the Shekhan district population has increased at a rate of 0.5% with an average family size of around three persons per family. Agriculture is the chief economic activity with over 65% of the population depended on farming. Rapid population growth has therefore translated to increase in clearance of vegetation for agriculture, manmade and overgrazing.

Land tenure system, human causes of land-use change and poverty, high dependency ratio, infrastructure, natural factors are the other factors causing the land cover change. Insufficiency level in the district stands at above 21%. High poverty levels can be attributed to over dependence on agriculture, drought and irregular rainfall. Poverty has led to subdivisions of the already small pieces of land for reselling.

Shekhan district population density is high in urban areas and along the main roads in the district. Based on noticeable land cover alteration in this study, land cover change in Shekhan District can be attributed to several natural factors.

5. CONCLUSIONS AND RECOMMENDATIONS

Similar to many other countries of the world, land is the special issue of the Iraq. It is not only used to produce goods or possess as property but it is also the foundation for the life of people and one of the most essential factors of environment resources. Three land cover maps for 2002, 2013 and 2018 Landsat images were created. The overall accuracy of the maps was over 87%, and the overall kappa statistics was over 0.80. Different land cover classes have different levels of accuracy to contradictory producer and user, indicating different neglect and commission errors.

5.1. Conclusions

1. The use of high-resolution imageries for the study area such as IKONOS and Quick Bird.As urban region have multifaceted and heterogonous topographies. High resolution imagery allows to produce maps with higher accuracy.
2. Further studies on LULC change are needed using with high resolution images in the district.
3. Working with multi-resolution imagery and LULC datasets are important.
4. Shekhan district needs to strengthen record keeping for meteorological data.
5. Using modern images up to date for studying LULC change and decrease in agricultural lands use.

5.2. Recommendations

LULC change is a very difficult condition to detect because of the interaction between different subjects. The results showed that there was a trend of a general LULC change depending on the demographic change at different altitude ranges in the study area. Because of the diversity and complexity of the factors involved, the level and causes of LULC exchange are not the same even in a small geographic unit. It is well known that

GIS and remote sensing have been widely used for years for the production of LULC facts. Based on the results of this research, the following recommendations can be made:

1) Shekhan district is undergoing moderately rapid LULC change and hence there is a need for increased application of digital land cover change determination to ensure clear understanding of the trends of the changes.

2) Additional research is needed to integrate both fields based and digital based data on land cover change methods to ensure high accuracy.

3) Future research should focus on application of higher temporal and spatial resolution data to achieve higher accuracy.

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